



Challenging intersections: Securing sustainable food systems in turbulent times

Nordic-Baltic food systems conference and
policy forum 26-28.5.2025 Helsinki, Finland

Conference proceedings



NORDIC-BALTIC FOOD
SYSTEMS NETWORK



Nordic-Baltic food systems network

Conference organised by Finnish Environment Institute & University of Helsinki

Editor: Minna Kaljonen

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1 Securing sustainable food systems in turbulent times

The Nordic-Baltic food systems conference and policy forum

- fosters interaction between food system actors
- encourages thinking across disciplines and sectors
- seeks solutions to systemic challenges

Food systems face multiple and by large, intertwined challenges. Climate change, biodiversity loss and pollution call for immediate actions across the food system, from the fields to the plates. At the same time the geopolitical turbulences have raised food security concerns to the political agendas of the European states and the European Union. The meaning of food for our wellbeing and health is unquestionable and calls for stronger appreciation across society and by the people.

Dealing with such complex problems is a challenge for both research, policy makers, and food system actors. The intertwined challenges cannot be solved by focusing on a single element of the food system, or by a specific sectoral policy or individual scientific discipline. In recent years, food systems thinking therefore has become more established in international forums such as UN, FAO, EU, as well as amongst scholars. In Europe the Farm to Fork strategy was a game-changer in bringing a holistic and coordinated approach to sustainable food systems. It was the first time that the production and consumption of food were considered together at the EU level. Many of the initiatives put forward in the strategy have, however, been delayed or put to halt now due to instabilities in food markets, geopolitics and changing political constellations.

The geopolitical instabilities force also the Nordic and Baltic countries to rethink their premises for sustainable food systems and food security and many of them are now updating their food strategies and policies. The Nordic nutrition recommendations with environmental sustainability criteria were also published in 2023. The guidelines recommend shifts to more plant- and fish-based diets. According to cumulating scientific evidence this would be good for both human and planetary health. However, the ways in which agriculture, food industry and citizens will respond to this remains an open challenge. Furthermore, what would be required from public policies to ensure just transition can vary from one country to another.

Answering all these questions requires forward looking, transformative research, where researchers, food system actors and policy makers come together to seek solutions across the system boundaries.

The 1st Nordic-Baltic food systems conference and policy forum brings researchers, policy makers and food system actors to take stock on the food system challenges across the Nordic and Baltic countries, share experiences and look for innovative solutions and future collaborations.

The conference is part of Finland's presidency of the Nordic Council of Ministers.

2 Program

Monday 26.5.2025

8:15	Registration University of Helsinki, Main building, Aula Sirén, Fabianinkatu 33	
9:00	Results Seminar of the Strategic Research Program Food University of Helsinki, Main building, Small hall (F4050), Fabianinkatu 33 In-person or online (In Finnish)	PhD Creative Networking Event University of Helsinki, Main building, F3010 (3rd floor), Fabianinkatu 33
11:30	Lunch University of Helsinki, Main building, Agora, Fabianinkatu 33	
13:00	Food Policy Forum Securing Sustainable Food Systems in Turbulent Times University of Helsinki, Main building, Small hall (F4050), Fabianinkatu 33 In-person or Online	
16:00	End of day 1	
19:00	Reception at the City Hall Pohjoisesplanadi 11-13, 00170 Helsinki	PhD Dinner with Brainstorming Green Hippo Punavuori, Punavuorenkatu 2, 00120, Helsinki

Tuesday-Wednesday 27-28.5.2025

	27.5.2025	28.5.2025
8:15	Registration University of Helsinki, Viikki Campus, A-building, hall, Latokartanonkaari 9	
9:00	Welcome Keynote session 1 Transformative governance: Science-policy engagements Viikki campus, A-building, room 110 (Is B1)	Keynote session 2 Transformative innovations: Science-practice collaborations Viikki Campus, A-building, Raisio-hall (Is B2)
10:45	Parallel paper sessions Viikki Campus, A-building, the Forest Sciences Building + Meeting Center	Parallel paper sessions Viikki Campus, A-building, the Forest Sciences Building + Meeting Center
12:15	Lunch	
13:15	Parallel paper sessions Viikki Campus, A-building, the Forest Sciences Building + Meeting Center	Workshop Future research needs & activities for transdisciplinary food systems research Viikki Campus, A-building, Raisio hall (Is B2) Closing
15:30-17:00	Poster Session with Coffee and Snacks Viikki Campus, A-building hall	Coffee
16:30-18:00	Workshops Challenges and opportunities in building a Nordic - Baltic database on sustainable food systems Viikki Campus, A-building, Meeting Center, Tiimi A4 Planetary Plate Puzzle: A serious game for deliberating sufficient future diets Viikki Campus, A-building, Meeting Center Hall	
19:00	Dinner at Koskenranta Katariina Saksilaisenkatu 9, 00560 Helsinki	

3 Results seminar of the strategic research program food

Date: 26.5.2025

Time: 9.00–11.30

Place: University of Helsinki, Main building, small hall (F4050), Fabianinkatu 33

The results seminar is held in Finnish

Strategisen tutkimuksen ohjelman Kohti kestävää, terveellistä ja ilmastoneutraalia ruokajärjestelmää (FOOD) päätösseminaari on tarkoitettu kaikille suomalaisen ruokajärjestelmän toimijoille: yritysten ja julkisen sektorin päättäjille, poliitikoille ja virkamiehille sekä järjestöjen edustajille. Tarkasteltavana uusimman tutkimustiedon pohjalta ovat ne mahdollisuudet ja keinot, joilla nykyistä kestävämpään ruokajärjestelmään on mahdollista päästä. Seminaari on ajankohtainen myös hallitusohjelman mukaisesti poikkihallinnollisessa valmistelussa olevan Kestävä ja kannattava ruokajärjestelmä-kokonaisuuden kannalta.

Ohjelma

- | | |
|--------------|---|
| 08:30 | Tervetulokahvit |
| 09:00 | Avaus: ST FOOD-ohjelman tarkoitus ja teemat, Juha Helenius, ohjelmajohtaja |
| 09:10 | Oikeudenmukainen ruokamurros: miten eteenpäin? Just food – hankkeen johtaja, tutkimusprofessori Minna Kaljonen sekä hankkeen tutkijat |
| 09:45 | Palkokasveilla kohti kestävää ruokajärjestelmää ja terveyttä, Leg4Life-hankkeen johtaja, professori Anne-Maria Pajari sekä hankkeen tutkijat |
| 10:20 | Kahvitauko |
| 10:35 | Maanviljelyn monihyötyiset ratkaisut ilmastokestävään ruokajärjestelmään, ST Multa-hankkeen johtaja, tieteellinen johtaja Jari Liski sekä hankkeen tutkijat |
| 11:10 | Tutkimuksen avainviestit ja keskustelu |
| 11:30 | Lounas |

4 Food Policy Forum: Securing sustainable food systems in turbulent times

Date: 26.5.2025

Time: 11:30 am–4 pm

Place: University of Helsinki, Main building, small hall (F4050), Fabianinkatu 33

The Food Policy Forum brings together food system actors, policy makers and researchers to discuss intertwined challenges in securing sustainable food systems in turbulent times.

Program

11:30 Lunch

13:00 Opening

Research professor Minna Kaljonen, Finnish Environment Institute, director of Strategic Research Project Just food

13:05 Perspectives to Sustainable Food Security across the Nordic and Baltic States

- Food policy in the Nordic cooperation
Senior Advisor for Food Policy, Nordic Council of Ministers, Jonathan Eng
- Long term food strategy and sustainable food security in Finland
Secretary of State, Ministry of Agriculture and Forestry Finland, Päivi Nerg
- Sustainability and preparedness, Swedish perspectives
Professor, Swedish University of Agricultural Sciences, director of Mistra Food Futures, Helena Hansson
- Integrating Readiness into Food and Agricultural Policy
Deputy Secretary General, Ministry of Regional Affairs and Agriculture Estonia, Tõnis Tänav
- Food Security in Conflict
Chief Preparedness Specialist, National Emergency Supply Agency, Member of NATO Food and Agriculture Planning Group, Miika Ilomäki

14:30 Coffee

15:00 Panel discussion: How sustainable food security can be boosted across the value chains

Moderated by journalist Hanna Nikkanen

Panelists:

- Professor Lars Grøn Hansen, University of Copenhagen
- Senior Vice President Harri Kallioinen, Valio, Finland
- Student of Agricultural Economy, Farmer Emilia Karell, University of Helsinki, Finland
- Director Marja-Liisa Meurice, EIT Food North and East, Leader of EITFood's Think Tank on Protein Diversification
- Chief Operating Officer Margus Muld, Agrone Ltd, Estonia

16:00 Closing

5 Keynote sessions

Two thematic keynote and panel sessions are organized to stimulate discussion on and sharing of experiences of transdisciplinary research in practice. The first session will concentrate on transformative food policy measures and governance and the other on transformative innovations from systems perspective. The discussion is kicked off by three keynote speeches followed by a panel discussions with questions.

Session 1 Transformative governance: science-policy-engagements

Date: 27.5

Time: 9-10:45

Place: Viikki campus, A-building, room 110 (Is B1)

Chair: Research professor Minna Kaljonen, Finnish Environment Institute

Facts, Interests and Values: Why is agricultural policy so difficult to agree on?

Alan Matthews, professor Emeritus of European Agricultural Policy at Trinity College Dublin, Ireland.

The new Danish CO₂e-tax on agriculture – observations on the role of scientific advisers

Lars Gårn Hansen, professor at the Department of Food and Resource Economics (IFRO), University of Copenhagen

Development and implementation of dietary guidelines: Possibilities and barriers

Jelena Meinilä, Jelena Meinilä, university researcher, Department of food and nutrition, University of Helsinki, Finland

Session 2. Transformative innovations: science-practice-collaborations

Date: 28.5

Time: 9-10:45

Place: Viikki Campus, A-building, Raisio-hall (Is B2)

Chair: Vice Dean, Professor Mari Sandell, University of Helsinki

Applied systems science in food systems transformations

Deniz Koca, researcher and principal investigator at Lund University (LU), Centre for Environmental and Climate Science (CEC), chair of EIT FOOD Protein EIT Food Protein Diversification Think Tank.

Resilience is the new efficiency: a vision for European farming in the new world order

Rogier Schulte, professor on the Future of Farming and Food at Wageningen University and Research

Interaction and collaboration between science, industry and consumers, ecosystem challenges for ensuring the sustainability of food and packaging

Sandra Muizniece-Brasava, professor, Food Institute of the Faculty of Agriculture and Food of the Latvia University of Life Sciences and Technologies

6 Keynote speakers



Alan Matthews is Professor Emeritus of European Agricultural Policy at Trinity College Dublin, Ireland. His research interests include EU agricultural policy, agricultural trade policy, and agricultural trade and development issues. In addition to academic papers, he has contributed to policy reports on food and agricultural issues for the FAO, the OECD, and the European Parliament, among others. He is a former President of the European Association of Agricultural Economists and has been a member of Ireland's Climate Change Advisory Council. He is a regular contributor to the blog capreform.eu on issues relating to the EU's Common Agricultural Policy.



Lars Gårn Hansen, is a professor at the Department of Food and Resource Economics (IFRO), University of Copenhagen. His research focuses on the theory of regulation, compliance and enforcement. His main interest is environmental, resource and consumer regulation, but other areas such as consumer behavior regarding environmental and health implications (food and electricity) are covered as well. Basic research with applications to the aforementioned is also carried out within cooperation, norms and behavioral and experimental economics. He is currently one of the chairmen of the economic councils that advise the government on economic and environmental economic issues.



Jelena Meinilä is a university researcher (PhD, title of docent) at the Department of Food and Nutrition, University of Helsinki, Finland. She was involved in compiling the scientific evidence for the Nordic Nutrition Recommendations 2023 (NNR2023), which are the scientific foundation for nutrient recommendations and food-based dietary guidelines for the eight Nordic and Baltic countries. The NNR2023 is also used by numerous other countries outside the region for their national nutrition policies. She was a member of the working group developing the Finnish Nutrition Recommendations 2024. She is an author or co-author of 43 scientific publications, with the recent ones integrating environmental aspects to nutrition research.



Deniz Koca is a researcher and principal investigator at Lund University (LU), Centre for Environmental and Climate Science (CEC). He holds a Ph.D. in Geobiosphere Science, M.Sc. in Environmental Studies & Sustainability Science, and B.Sc. in Environmental Engineering. His main expertise lies in systems analysis, system dynamics modelling and facilitation of stakeholder participatory group modelling process. He has initiated and been involved in various transdisciplinary research projects with the main task of analysing, interpreting, modelling, simulating and communicating alternative scenarios of complex dynamic environmental and socio-economic issues with a systems approach and within the sustainability criteria. Deniz has been teaching systems analysis and system dynamics modelling courses at undergraduate, graduate and post-graduate levels. Deniz acts as the Coordinator and Director of Studies of BIOECONOMY Graduate Research School within the CEC and Vice President of EIT Food Protein Diversification Think Tank. He is a Donella Meadows Fellow and member of the Balaton Group and the International Institute for Applied Systems Analysis (IIASA) alumni.



Professor Dr Rogier Schulte is Chairholder of the Farming Systems Ecology group at Wageningen University and Research and Director of the Global Network of Lighthouse Farms. Rogier has over 25 years of experience in leading research on a sustainable future for farming and food. Together with a diverse range of stakeholders he specialises on the 'radical redesign' of food systems around the world, so that they are ready for tomorrow's challenges. Starting at Teagasc in Ireland, he has been looking for on-farm innovations around the world, that his team has brought together in the Global Network of Lighthouse Farms. He teaches the next generation of decision makers on the lessons-learnt from these farms in Wageningen's Masters Programme in Resilient Farming and Food. He is sharing the same insights with the current generation of decision makers in the Lighthouse Farm Academy.



Professor **Sandra Muizniece-Brasava** is a lecturer and researcher at the Food Institute of the Faculty of Agriculture and Food of the Latvia University of Life Sciences and Technologies (LBTU), as well as the Head of the Technology and Knowledge Transfer Office (TTO) of LBTU. Muizniece-Brasava is known for her contributions to the field of food storage and packaging sustainability. Her research interests are related to food quality preservation, improvement of storage conditions, and development of new product and packaging solutions specifically in the context of sustainability and circular economy. She is a full member of the Latvian Academy of Sciences and the Chairperson of the Board of the Packaging Association of Latvia and Project Manager of Eit Food Representative Office in Latvia. She is a co-author of more than 50 scientific publications, 5 Latvian Republic patents, books, and has participated in more than 30 projects of various levels. In 2024, S. Muižniece-Brasava is one of the 12 TOP scientists in Latvia 2024.

7 Tracks and parallel paper sessions

The paper presentations are organized into thematic tracks to enhance food systems research and dialogue across different disciplines and perspectives.

Thematic tracks

1. Sustainable food security and preparedness
2. Systems approaches and transdisciplinary methods
3. Role of animals in sustainable food systems
4. Dietary transitions 1
5. Dietary transitions 2
6. Sustainable farming systems and land-use
7. Circular food systems and novel foods

Thematic tracks and Parallel Paper Session Program

Track 1: Sustainable food security and preparedness		
Date: Tuesday 27.5.2025 Time: 10:45-12:15 Place: Viikki campus, A-building, room 540 (sh 13-14) Facilitators: Ants-Hannes Viira, Sivia Gaiani	Date: Tuesday 27.5.2025 Time: 13:15-15:30 Place: Viikki campus, A-building, room 540 (sh 13-14) Facilitators: Ants-Hannes Viira, Sivia Gaiani	Date: Wednesday 28.5.2025 Time: 10:45-12:15 Place: Viikki campus, A-building, room 540 (sh 13-14) Facilitators: Ants-Hannes Viira, Sivia Gaiani
Lähde, V. A New Conceptual Constellation of Food Systems and Crises Discussant Viira, A-H Viira, A-H. Towards sustainable food systems – evolving concepts in policy agenda in Estonia Discussant Eneroth, H. Eneroth, H. et al. Challenges and solutions for preparedness and sustainability in Swedish agriculture, a Q-methodology study of stakeholders Discussant Rimhanen, K Rimhanen, K. et al Building resilient food systems: A resilience assessment framework for food supply Discussant Lähde, V	Gaiani, S. et al. White Paper on Nordic Sustainable Food Systems: Pathways and intervention points Discussant Jansik, C. Stoddard; F. Can the Nordic-Baltic region be free of soy imports Discussant Sandström, V Jansik, C Protein production, consumption and self sufficiency of food in Finland Discussant Stoddard, F. Sandström, V. et al. Global impacts of agricultural input shocks: insights into vulnerabilities and resilience in food systems Discussant Gaiani, S.	Tienhaara, A. et al. Do Public Preferences for Agriculture Shift? Evidence from Repeated Choice Experiments in Finland Discussant Iwarsson, E. Andersson, M. et al. et al. Different approaches to food systems planning - examples from three Swedish municipalities Discussant Tienhaara, A. Iwarsson, E. Municipal policy on local food, agricultural land and food preparedness – integrated or siloed? Discussant Ala-Karvia, U. Ala-Karvia, U School meals in the Baltic Sea Region - different paths towards resilience and sustainability Discussant Andersson, M.

Track 2: Systems approaches and transdisciplinary methods		
Date: Tuesday 27.5.2025 Time: 10:45-12:15 Place: Viikki campus, A-building, room 104 (Is B7) Facilitators: Helena Hansson, Minna Kaljonen	Date: Tuesday 27.5.2025 Time: 13:15-15:30 Place: Viikki campus, A-building, room 104 (Is B7) Facilitators: Helena Hansson, Minna Kaljonen	Date: Wednesday 28.5.2025 Time: 10:45-12:15 Place: Viikki campus, A-building, room 104 (Is B7) Facilitators: Helena Hansson, Minna Kaljonen
Kuhmonen, I et al. Deconstructing the deep roots of vulnerabilities in the Finnish food system Discussant Salminen, J Hansson, H et al. Trends, targets and data quality across sustainability themes in the Swedish food system Discussant Kuhmonen, I Salminen, J et al. Environmentally-extended input-output modelling for food system sustainability studies Discussant Hansson, H	Sell, M et al. Food System Labs as a method for transforming food systems through transdisciplinary research and action Discussant Käle, M Huan-Niemi, E et al. Transdisciplinary research via a living lab: just transition, climate change, and sustainable food systems Discussant Sell, M Bergman Lodin, J et al. AgroDrive: a new center formation for the transition to fossil-free energy in Sweden's agri-food system Discussant Heiska, S Käle, M. et al. Transferability of Seed-Saving Practices: Insights from Latvia's and Ghana's Agrifood Systems' Collaboration Discussant Bergman Lodin, J Heiska, S et al. Participatory and iterative process for creating model food products supporting change towards sustainable food system Discussant Huan-Niemi, E	Kaljonen, M et al. Deliberating justice in food system transformation pathways: a transdisciplinary approach Discussant Lempa, K Lempa, K Urban agriculture for a resilient future: Identifying weak signals in Nordic-Baltic food systems Discussant Frey, S Frey, S et al. The transformative potential of Swiss visions for sustainable food systems Discussant Laila, A Laila, A et al. An overview of food systems injustices experienced by marginalised groups: A scoping review of reviews Discussant Kaljonen, M

Track 3: Role of animals in sustainable food systems		
Date: Tuesday 27.5.2025 Time: 10:45-12:15 Place: Viikki campus, A-building, room 107 (Is B4) Facilitators: Iryna Herzon, Annika Lonkila	Date: Tuesday 27.5.2025 Time: 13:15-15:30 Place: Viikki campus, A-building, room 107 (Is B4) Facilitators: Iryna Herzon, Annika Lonkila	Date: Wednesday 28.5.2025 Time: 10:45-12:15 Place: Viikki campus, A-building, room 107 (Is B4) Facilitators: Iryna Herzon, Annika Lonkila
Lonkila, A. et al. Paradigms of Finnish livestock production and consumption Discussant Niemi, T. Niemi, T. et al. Imagining biodiversity-respectful food systems: paradigms as drivers of transformation Discussant Herzon, I. Vanhatalo, A. Perspectives on the role of animal-sourced foods in the future northern food system Discussant Lonkila, A. Herzon, I et al. Sustainable niche for farmed animals in food systems: from principles to quantification Discussant Vanhatalo, A.	Niemi, J et al. Regional economic impacts of climate change mitigation in Finnish agriculture Discussant Koppelmäki, K Karlsson, J.O et al. Scenarios for long term conservation of Swedish semi-natural grasslands with limited climate impact Discussant Lamminen, M. Lamminen, M. Efficiency, sufficiency and consistency: strategic approaches for improving sustainability of animal production Discussant Niemi, J Koppelmäki, K. et al. Optimizing livestock production systems for local resource use – Balancing production and environmental impact Discussant Karlsson, J.O	Tiikkainen, A A simple lifetime productivity indicator to assess milk's carbon footprint and support herd-level decisions Discussant Kokkonen, T. Kokkonen, T. et al. Faba bean as a substituting protein feed for rapeseed in dairy cow diets: A meta-analysis Discussant Tiikkainen, A. Lundholm, I. Pressures from above: Dairy farmers' motivation to reduce climate impacts Discussant Järvinen, S Järvinen, S. et al. The Role of Dairy and Dairy Alternatives in Food Preparation Practice Discussant Lundholm, I

Track 4: Dietary transitions I		
Date: Tuesday 27.5.2025 Time: 10:45-12:15 Place: Viikki campus, A-building, Meeting Center, Tiimi A4 Facilitators: Sinne Smed, Deniz Koca	Date: Tuesday 27.5.2025 Time: 13:15-15:30 Place: Viikki campus, A-building, Meeting Center, Tiimi A4 Facilitators: Sinne Smed, Deniz Koca	Date: Wednesday 28.5.2025 Time: 10:45-12:15 Place: Viikki campus, A-building, Meeting Center, Tiimi A4 Facilitators: Sinne Smed, Deniz Koca
Mathijs, E et al. Tipping the protein transition: a transdisciplinary case study from Flanders, Belgium Discussant Lombardini, C Scheuermann, M et al. Actor power to change dietary patterns: a case study of grain legume actors in Sweden Discussant Mathjis, E Lombardini, C et al. Including Legumes in Crop Rotations in an Uncertain World: A Scenario-Based, Monte-Carlo Cost-Benefit Analysis Discussant Scheuermann, M	Smed, S et al. Why is the association between greenhouse gas emission and adherence to dietary guidelines so weak? Discussant Lehtonen, H Lehtonen, H Effects of healthy diets on Finnish agriculture and greenhouse gas emissions up to 2040 Discussant Mazac, R Jacobsen, M et al. Fostering unsustainability? An analysis of 4-year-olds' dietary impacts in Sweden Discussant Smed, S Pajari, A-M et al Impact of replacing animal-sourced proteins with plant-based proteins on nutrient intakes and chronic disease markers Discussant Jacobsen, M Mazac, R et al. Diversifying foods: A taxonomy of terms for emerging/functional alternatives to high-impact and resource-intensive foods Discussant Pajari, A-M	Matthiessen, L-E et al. Sustainable Public Food Procurement in Copenhagen: An Ex-Post Evaluation Discussant Allevievi, F. Yan, W et al. Nurturing Sustainable Food Choice: Information-Based Strategy to Promote Plant-Based Food in Education Institution Discussant Frieri, F Frieri, F et al. The impact of food labels on consumers' choices: the case of Eco-score and Nutri-score Discussant Matthiessen, L-E Allevievi, F. et al. Educating European chefs to bring sustainability to the table Discussant Yan, W

Track 5: Dietary transitions II		
Date: Tuesday 27.5.2025 Time: 10:45-12:15 Place: Viikki campus, A-building, Meeting Center, Tiimi A2 Facilitators: Birgitte Kopayinski, Rachel Mazac	Date: Tuesday 27.5.2025 Time: 13:15-15:30 Place: Viikki campus, A-building, Meeting Center, Tiimi A2 Facilitators: Birgitte Kopayinski, Rachel Mazac	Date: Wednesday 28.5.2025 Time: 10:45-12:15 Place: Viikki campus, A-building, Meeting Center, Tiimi A2 Facilitators: Birgitte Kopayinski, Rachel Mazac
Bunge, A Fika in the Anthropocene - Leveraging dietary transitions through food cultures Discussant Lindblom, T Lindblom, T et al. Stereotyping, vilifying and silencing: the clashing discourses of plant-based meat sold at Provinssi Festival 2024 Discussant Milford, A.B. Milford, A.B. et al. System lock-ins and interventions for sustainable dietary transitions: Comparative case study of Finland and Norway Discussant Bunge, A	De Bauw, M et al. From Fragmentation to Transformation: Multi-Level Policy Mixes for Sustainable Healthy Food Environments in Belgium Discussant Tuomasjukka, S Lombardini, C. Sihvonen, J. et al. Categorization theory as a means for promoting healthier and more sustainable diets rich in legumes Discussant Seppälä, T Tuomasjukka, S et al. In the Mood for Change? Predicting Changes in Food Habits Through a Single Question Discussant Sihvonen, J. Seppälä, T et al. Incorporating relational domain into the food environment framework Discussant De Bauw, M	Kortetmäki, T Beyond cost: capabilities and just dietary transition Discussant Kurki, K Mazac, R et al. Eco-culturally Sufficient Diets: How much is enough? Discussant Kortetmäki, T Kurki, K et al. Culturally Acceptable Sufficient diets: Negotiating a Sustainable Consumption Corridor for Finnish Diets Discussant Friman, A Friman, A Behavioural changes in households' efforts to reduce food waste in Finland, quantitative analysis Discussant Mazac, R

Track 6: Sustainable farming systems and land-use		
Date: Tuesday 27.5.2025 Time: 10:45-12:15 Place: Viikki campus, A-building, room 340 (sh 11) Facilitators: Kristine Valujeva, Mari Unnbom		Date: Wednesday 28.5.2025 Time: 10:45-12:15 Place: Viikki campus, A-building, room 340 (sh 11) Facilitators: Kristine Valujeva, Mari Unnbom
Valujeva, K et al. Balancing agricultural and forestry land use: a practical approach to sustainable agroecosystem management Discussant Krzywoszynska, A Lillemets, J Understanding farmers' perspectives on sustainable food systems Discussant Firse, J Krzywoszynska, A et al. In the shadow of carbon: the intersecting knowledge politics of carbon farming and regenerative agriculture Discussant Lillemets, J Firse, J et al. Exploring entry points to circularity in food production from a farming system perspective Discussant Valujeva, K		Norberg, A et al. The potential of sustainable and ecological intensification in mitigating planetary boundary transgressions Discussant Tidåker, P Tidåker, P et al Environmental and economic effects from intermediate crops in a cropping system in Sweden Discussant Virkkunen, H Virkkunen, H et al. Framework for quantification of land use–based greenhouse gas emissions according to crop and farm type Discussant Bergman Lodin, J Bergman Lodin, J et al. Farmers' attitudes and conditions for implementing the energy transition in Sweden Discussant Norberg, A

Track 7: Circular food systems and novel foods		
Date: Tuesday 27.5.2025 Time: 10:45-12:15 Place: Viikki campus, A-building, room 341 (sh12) Facilitators: Juha Helenius, Mari Sandell	Date: Tuesday 27.5.2025 Time: 13:15-15:30 Place: Viikki campus, A-building, room 341 (sh 12) Facilitators: Juha Helenius, Mari Sandell	Date: Wednesday 28.5.2025 Time: 10:45-12:15
Chatzopoulou, S. From organic waste to circular economy innovative biosolutions: governance challenges and opportunities Discussant Salenius, F Helenius, J et al. Agroecological symbioses for food system transformation Discussant Bergman Lodin, J Bergman Lodin, J et al. The potential of farm-based biogas production in Sweden: Farmer perspectives and experiences. Discussant Helenius, J Salenius, F et al. The economics of sustainable aquaculture in the Baltic Sea region: lessons from novel production systems Discussant Chatzopoulou, S	Seisto, A What kind of opportunities and future vision could cellular agriculture have for Finland? Discussant Heinola, K Heinola, K et al. New Genomic Techniques: Attitudes, Beliefs And Willingness To Use Across Farmers And Consumers Discussant Maniruzzaman, M Maniruzzaman, M et al. Interactions between faba bean and its Botrytis pathogens Discussant Ritala, A Bustamante, M et al. The role of business models in scaling sustainable agri-food innovations Discussant Seisto, A Ritala, A et al. Envisioning the 2040 circular food court: The role of cellular agriculture in future urban experiences Discussant Bustamante, M	

8 Workshops

Challenges and opportunities in building a Nordic - Baltic database on sustainable food systems

Facilitators: Silvia Gaiani, University of Helsinki, Ruralia Institute

Date: 27.5.2025

Time: 16:30-18:00

Place: Viikki Campus, A-building, Meeting Center, Tiimi A4

Building upon the necessity to urgently establish Nordic-Baltic sustainable food systems and taking inspiration from the FAO Food Systems Dashboard, the workshop will aim at exploring 1) what makes the Nordic and Baltic food systems unique in terms of structure and functioning 2) Which indicators could be selected and adopted in order to measure sustainability in Nordic Baltic food systems?

The workshop will start with a presentation about the current status of food systems followed by a guided brainstorming session where ideas and inputs will be collected from the participants. Slido, a polling platform for mobile phones, will be used to run an effective and inclusive Q&A session.

Planetary Plate Puzzle: A serious game for deliberating sufficient future diets

Facilitators: Rachel Mazac, Stockholm Resilience Center; Kaisa Kurki, Lappeenranta University of Technology; Iryna Herzon, University of Helsinki

Date: 27.5.2025

Time: 16:30-18:00

Place: Viikki Campus, A-building, Meeting Center Hall

Join us for a hands-on session where we introduce *The Planetary Plate Puzzle*—a serious game designed to explore what ecologically and culturally sufficient diets might look like in Finland by the year 2050. The game centers on the concept of dietary sufficiency, aiming to reduce the carbon emissions and land use of the average Finnish diet to stay within planetary boundaries, while still being nutritious and culturally acceptable.

In this session, you'll learn about the design, purpose, and rules of the game, and get the chance to play-test it as a deliberation tool. The Planetary Plate Puzzle was created to support open dialogue around dietary change—a topic that has become increasingly polarized, especially when it comes to culturally acceptable transitions. Serious gaming offers a way to foster respectful participation and co-creation within safe spaces, and this session invites you to experience and shape that process.

We welcome your feedback and reflections on both the game and the broader process, as we continue to develop serious gaming methods that encourage inclusive and constructive conversations about sustainable food futures.

Future research needs & activities for transdisciplinary food systems research

Facilitators of the parallel tracks

Date: 28.5.2025

Time: 13:15-15:15

Place: Viikki Campus, A-building, Raisio hall (Is B2)

In this workshop we deliberate future research needs and questions for transdisciplinary Nordic-Baltic food systems research. The workshop starts with the panel discussion, where research needs identified in the thematic tracks are discussed together with the facilitators of the sessions. The research needs are worked further in thematic groups in a World Café style. We welcome you also to initiate ideas and discuss networking activities for the strengthening of collaboration in Nordic-Baltic transdisciplinary food systems research.

Program

- | | |
|--------------|--|
| 13:15 | Panel discussion with facilitators (led by M.Kaljonen) |
| 13:40 | Instructions to World Café |
| 13:45 | World café on research needs and networking activities |
| 14:45 | Wrap up |
| 15:15 | End of workshop |

9 Poster session

Date: Tuesday 27.5.2025

Time: 15:30-17:00

Place: Viikki Campus, A-building hall

List of posters

1. Beitane Ilze; Krumina-Zemture Gita; Jenzis Janis; Sabovics Martins; Iriste Sandra. Sustainability in food service companies: the case of Latvia
2. Bell Quentin, Fer Istem, Nevalainen Olli, Varjonen Samu, Vira Julius, Höckerstedt Layla, Tang Hui, Kajasilta Niemitalo Olli, Kunttu Iivari, Kukkamäki Joni, Saarinen Juuso, Rosenberg, Laura, Kulmala Liisa, Liski Jari. Two peas in a pod: a digital twin for climate smart agriculture
3. Bäck Sari, Pellinen Tiina, Päivärinta Essi, Rautio Petra, Isokangas Antti, Erkkola Maijaliisa Pajari, Anne-Maria. Gaps between adults' perceived and actual macronutrient intakes: self-assessment relative to nutrition recommendations is challenging
4. Forsman Laura, In search of business models for local and systemically sustainable food
5. Fu Yue, Irz Xavier. Optimizing sustainable diets with mycoprotein in Finland
6. Gaiani Silvia, Leppälä Johanna, Seehusen Till, Niemi Jarkko. Increasing resilience of Nordic food systems through agriculture
7. Järviö Natasha, Uusitalo Ville, Tuomisto Hanna, A Finnish database for biodiversity impacts of food items consumed in Finland
8. Kadulin Aki, Martinez Mylene, Melts Indrek, Viira Ants-Hannes Why farmers manage or abandon semi-natural grasslands: a systematic review of motivations and barriers
9. Tänavots Alo, Tepper Marek, Kerner Kristi Meat quality of forage-fed Hereford beef cattle in a coastal region on small-scale organic farm
10. Korhonen Kirsi, Konttinen Hanna, Vahvaselkä Marjatta, Perspectives on the potential of legume production and consumption from farm to fork
11. Kuoppala Kaisa, Kajava Sari, Sairanen Auvo, Niskanen Olli, Rinne Marketta, Resilience of the European dairy sector
12. Kähkönen Kaisa, Hirvonen Jade, Partanen Kati, Hoxha-Jahja Ardita, Transforming the Food System for Sustainability: The Role of Agri-Food Cluster in North Savo
13. Licite Ieva, Popluga Dina, Lazdiņš Andis, Mapping Research and Policy Processes for Latvia's Bioeconomy in the Context of the Carbon Market
14. Nurk Krista, Värnik Rando, Aleksandrova Olha, Viira Ants-Hannes, The perceived risk factors in Estonian agriculture
15. Paalanen Laura, Tapanainen Heli, Sares-Jäske Laura, Kaartinen Niina E, Differences in food consumption and macronutrient intake by diet-related green-house gas emission sums
16. Popluga Dina, Naglis-Liepa Kaspars, Lēnerts Arnis, Līcīte Ieva, Decarbonization Strategies in Agriculture: From Theory to Implementation
17. Savallampi Jasmine, Järviö Natasha, Dalmau Laia, Uusitalo Ville, Improving biodiversity impact assessment for regenerative agriculture in Finland using environmental DNA and LCA
18. Savikko Riitta, Rimhanen Karoliina, Himanen Sari, Nurmi Elina, Högnäsbacka Merja, Kuoppala Kaisa, Raiskio Sakari, Co-creating solutions for climate-smart and resilient agriculture in Finland
19. Stachnik Marta, Tarkkio Aino, Tuomasjukka Saska, Sustainability intervention's negative effect on the nutritional value of meals in cafeteria

20. Strøm-Andersen Nhat, Kvakkestad Valborg, Steinshamn Håvard, Bakken Anne Kjersti, Bonesmo Helge, Cultivating Sustainable Changes in Livestock Feed Production and Feeding Practices
21. Suikki Tiina, Maukonen Mirkka, Kaartinen Niina, Pajari Anne-Maria, Männistö Satu, The association between the Planetary Health Diet and body mass index in Finnish adults
22. Tavakoli Ali, Juva Katri, Ylinen Eeva, Lehmusvaara Jari, Latva Martti, Advancing sustainability and workforce development in Satakunta's food industry through technological innovation
23. Tarkkio Aino, Stachnik Marta, Tuomasjukka Saska, Meal pairing dynamics: the relationship between side dishes and main meal types

10 PhD events

The NFN2025 will feature two PhD networking events to increase interdisciplinary exchange, networking and collaboration among PhD students from various disciplines working on the broad field of food system research within the Baltic and Nordic countries.

This is a unique opportunity for early-career food system researchers to network, exchange ideas, and find solutions for sustainable future food systems together.

Creative networking session

Date: 26.5.2025

Time: 9-11:30

Place: Main building, Fabianinkatu 33, Helsinki F3010 (3rd floor)

A relaxed and creative gathering where Nordic and Baltic food system PhD researchers can meet and foster interdisciplinary dialogue.

Dinner with brainstorming

Date: 26.5.2025

Time: 19-21:00

Place: Green Hippo Punavuori, Punavuorenkatu 2, 00120, Helsinki

We will discuss the future of the PhD Network over dinner. What kind of educational and networking activities do you need as an early-career food system researcher? How should we proceed? Let's discuss and co-create our vision together. (The dinner is at own cost.)

11 Scientific committee and organisers

The conference is organized by the Nordic-Baltic network for transdisciplinary food systems research (NFN) with an aim to strengthen transdisciplinary research between the countries.

The network is a collaborative initiative between the Finnish Environment Institute, University of Helsinki, Swedish University of Agricultural Sciences, University of Copenhagen, University of Bergen, University of Iceland, Centre of Estonian Rural Research and Knowledge, Latvia University of Life Sciences and Technologies funded by the Nordic Joint Committee for Agricultural and Food Research (NKJ). The conference is part of Finland's presidency of the Nordic Council of Ministers.

The conference takes place in collaboration with

- The Nordic Council of Ministers
- University of Helsinki, Faculty of Agriculture and Forestry
- Strategic Research Council, Food Program
- Finnish Environment Institute
- Lund University, Bioeconomy Graduate Research School
- Mistra Food Futures -program
- Nordic Association of Agricultural research
- City of Helsinki

The conference is funded by

- Nordic Joint Committee for Agricultural and Food Research
- Strategic Research Council
- Lund University, Bioeconomy Graduate Research School
- EIT Food
- Finnish Food and Drink Industries' Federation
- Federation of Finnish Learned Societies



Scientific Committee

- Minna Kaljonen (chair), Finnish Environment Institute, Finland
- Juha Helenius (co-chair), University of Helsinki, Strategic Research Programme FOOD, Finland
- Mari Sandell, University of Helsinki, Faculty of Agriculture and Forestry, Finland
- Helena Hansson, Swedish University of agricultural sciences, Sweden
- Sinne Smed, University of Copenhagen, Denmark
- Birgit Kopainsky, University of Bergen, Norway
- Þórhallur Ingi Halldórsson, Faculty of Food Science and Nutrition at the University of Iceland, Iceland
- Ants-Hannes Viira the Centre of Estonian Rural Research and Knowledge, Estonia
- Kristine Valujeva Latvia University of Life Sciences and Technologies, Latvia
- Deniz Koca, Lund University (LU), Sweden
- Silvia Gaiani, University of Helsinki, Ruralia Institute, Finland

12 Extended paper abstracts

12.1 Ala-Karvia U. School meals in the Baltic Sea Region - different paths towards resilience and sustainability

Doctoral Researcher Urszula Ala-Karvia¹

¹University Of Helsinki Ruralia Institute

This working paper reviews recent developments in school meal provision in Estonia, Finland, and Poland, with a focus on progress towards sustainability. It draws on experience from the EU Interreg Baltic Sea program projects StratKIT and StratKIT+, along with insights from the Global Survey of School Meal Programs. As EU member states, all three countries follow EU laws on food hygiene, public procurement, and organic certification, yet they differ in their practices and pace of sustainability adoption.

Each country also participates in the EU School Fruit, Vegetables and Milk Scheme yet the level of the support is different. For the 2024/2025 school year, allocations are:

- Estonia: €0.41M (fruit/vegetables), €0.75M (milk)
- Finland: €1.76M (fruit/vegetables), €2.73M (milk)
- Poland: €12.56M (fruit/vegetables), €12.79M (milk)

Estonia - the organic boost

Since 2018, Estonia has provided subsidized hot lunches for all students in grades 1–12 in both public and private schools, with municipalities often topping up state funds to offer free meals. Nutrition and food safety standards are governed by the Ministry of Social Affairs and guided by health protection policies.

The use of organic and eco-labeled food is increasing. A government labeling system recognizes caterers based on the percentage of organic ingredients used, with 46 schools reporting organic use in 2021, up from just 3 in 2018.

Public catering is mostly in-house in rural areas, while cities outsource through public tenders. In some cases, centralized procurement is managed by municipalities; in others, school principals handle procurement individually—often without sufficient support.

Most schools use a “cook and serve” model, although some rely on central kitchens. The higher cost of organic food presents a challenge, especially where procurement decisions favor the lowest price. Local procurement is promoted through the EU School Scheme and national programs, which encourage the use of seasonal and locally grown food.

To minimize food waste, students self-serve milk, and school gardens contribute fresh produce. Increasing awareness around food waste and plant-based options is part of a broader sustainability effort.

Finland - the holistic example to follow

Finland has a legally mandated, nationally coordinated system of free school meals for all students. Municipalities manage implementation, with meals required to meet nutritional standards based on the Nordic Nutrition Recommendations. Menus are monitored for compliance, with a strong emphasis on documentation and quality.

Sustainability is integral to the system. Municipalities craft local environmental strategies that often include increasing organic and local food, offering more vegetarian options, and reducing meat and dairy consumption.

School catering is a mix of in-house and outsourced services. Recently, large-scale municipal catering services have been restructured into municipally owned companies with dedicated leadership in areas like nutrition, finance, and customer engagement. Central kitchens serve thousands of meals daily using “cook-chill” techniques, while smaller schools use traditional “cook and serve” models.

There is tension between promoting plant-based meals and maintaining ties with animal-product industries, as consumer demand still leans towards meat and dairy. Additionally, large-scale catering systems depend on uniform ingredients from industrial suppliers, making it difficult to include products from small local producers.

Students are involved in the food system—assisting in cafeterias and participating in food committees alongside staff and healthcare professionals. The entire school community, including teachers and parents, contributes to a positive food culture.

The National Nutrition Council guides menu planning, emphasizing variety, traditional foods, seasonal produce, and low-fat, low-salt unit foods. Many schools also offer environmental and sustainability education, such as food waste tracking and climate-conscious menu choices. Home economics classes teach skills like food reuse and reducing waste.

Ultimately, the Finnish model is a holistic ecosystem supporting health, education, and sustainability. The shared goal is that every child eats well at school every day.

Poland - the EU support follower

As of September 2022, primary schools in Poland must offer meals, though participation is voluntary. Meals follow national nutrition guidelines, and parents pay a portion of the cost, calculated based on ingredient prices. Government subsidies only partially cover meal expenses.

In-house catering dominates, with school-employed kitchen staff preparing meals. Studies show that on-site kitchens lead to higher participation and lower meal costs compared to outsourcing. Catering managers are responsible for menu development, procurement, and food safety.

However, many kitchen staff have limited training in sustainability and can be resistant to change due to long-established routines. Isolation from students and a lack of investment in kitchen infrastructure contribute to low morale. Equipment upgrades are often delayed due to low prioritization.

The Supreme Audit Office found that school-prepared meals were more affordable and preferred by parents. Larger and better-resourced schools generally offer healthier food environments, often supported by formal nutrition policies.

Poland’s “Meal at School and at Home” program (2019–2023) supported canteen development and meal provision. It also involved small-scale farmers in procurement and included family contributions. The private sector played a role in food logistics and services.

The EU School Scheme, by contrast, does not require competitive bidding or family contributions, but does involve the private sector in product delivery. Student preferences are considered in product selection.

Both programs integrate educational components. Food Bank educators teach students about food waste and sustainability. Lessons include seasonal eating, preservation methods, and the planetary health diet. Students complete related worksheets and eat produce from school gardens.

The EU School Scheme also promotes locally grown fruits and vegetables to reduce transport emissions. Garden produce is consumed and used in educational activities.

This summary highlights how Estonia, Finland, and Poland are evolving their school meal systems toward greater sustainability while facing unique structural, cultural, and financial challenges. These efforts are part of a broader move across Europe to make public meals more equitable, healthy, and environmentally responsible.

Source of information

- Ala-Karvia, U., Góralska-Walczak, R., Piirslau, E., Filippova, E., Kazimierczak, R., Post, A., Monakhov, V., & Mikkola, M. (2022). COVID-19 driven adaptations in the provision of school meals in the Baltic Sea Region. *Frontiers in sustainable food systems*, 5, Artikkel 750598. <https://doi.org/10.3389/fsufs.2021.750598>
- Mikkola, M., Ala-Karvia, U., & Stein, M. (2024). Public meal provision in the Baltic Sea Region: analysis of issues and challenges towards sustainable public food systems. teoksessa M. Stein, M. Mariani, R. Caranta, & Y. Polychronakis (Toimittajat), *Sustainable Food Procurement : Legal, Social and Organisational Challenges* (Sivut 62-82). Routledge. <https://doi.org/10.4324/9781003393023>
- Hamann, K., Mikkola, M., Ala-Karvia, U., Viitaharju, L., & Berges, R. (2021). StratKIT Sustainability Toolkit for greener public procurement and catering services in Baltic Sea Region and beyond. European regional development fund. https://www.stratkit.eu/documents/32/StratKIT_Sustainability_Toolkit_report.pdf
- Commission Implementing Decision (EU) 2024/845 of 12 March 2024 fixing the definitive allocation of Union aid to Member States for school fruit and vegetables and for school milk for the period from 1 August 2024 to 31 July 2025 and amending Implementing Decision (EU) 2023/655 <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32024D0845>
- Global Child Nutrition Foundation (GCNF). 2024. School Meal Programs Around the World: Results from the 2024 Global Survey of School Meal Programs ©. Accessed at <http://gcnf.org/global-reports/>. GCNF is a nonpolitical, non-profit entity.

12.2 Allievi, F. et al. Educating European chefs to bring sustainability to the table

Dr Francesca Allievi¹, Laura Salo¹, Karoliina Väisänen¹, Dr Sirpa Laitinen-Väänänen¹, Susanna Kanninen¹

¹Jyväskylä University of Applied Sciences

Introduction

Chefs have the potential to transform their businesses and the food system whilst providing people with healthy, low-impact and nutritious food. The focus the Climate Smart Chefs (CSC) project was to provide chefs with tools and education to act as changemakers in the food system.

This project was a partnership of Jamk University of Applied Sciences (Finland), Nutritics (Ireland), ENAIP (Italy), ALMA Culinary School (Italy) and Fondazione Barilla (Italy), had a budget of about 1,7 millions of euros and lasted from January 2022 to December 2024. It aimed at contributing to the EU Farm to Fork strategy through these activities: a) the implementation of a high-level training course for chefs; b) the development of a digital tool to design climate smart menus; c) the creation of an Award dedicated to climate smart chefs; d) the creation of a EU network of chefs associations. In this paper we focus on the impact of the first activity, including highlights on the Nordic participants (Climate Smart Chefs, 2024).

The high-level course

During the last three years, the high-level course developed within the LIFE Climate Smart Chefs project trained 164 chefs across all the EU 27 countries. Through 250+ hours of education on food sustainability, it supported chefs generating change in recipe design, menu planning and communication with customers, while also fostering their awareness on climate and environmental issues.

The training was structured as an online course including a 2-day session in a culinary school Italy. The convenience of online training is crucial for adult learners and professionals such as chefs, who may have time constraints. This can lead to increased learner satisfaction and engagement (Bernard et al., 2004). In addition, online training can reach a vast number of participants simultaneously without the limitations of physical space, which is particularly valuable for large-scale educational programs and corporate training initiatives as stated by Allen and Seaman (2017). Furthermore, online training supports the concept of lifelong learning by providing opportunities for continuous education and skill development, which is essential in rapidly evolving fields (World Economic Forum, 2020).

The course had 8 editions, each gathering 20-25 chefs from all over Europe, selected through an application process. In this project and in this paper, with the word “chef” we refer to a wide range of roles, including lunch chef, assistant cook and nutritionist working in different food services. This was necessary in order to include the variety of work titles used in Europe. There were 15 participants from the Nordic countries: 4 from Sweden, 2 from Denmark, 9 from Finland.

The course contained five modules: 1) “Introduction to food sustainability and sustainable diets”, which helped the chefs to identify and outline the main challenges for a sustainable food system along the food chain; 2) “Nordic perspectives to food sustainability”, in which the chefs learned about key principles of the Nordic diet, New Nordic Food Manifesto and the best practices related to Nordic diet applications and business concepts; 3) “Technology for food”, which instructed the chefs about the Foodprint tool for the creation of more sustainable menus; 4) “Food waste prevention”, in which the chefs got familiar with the precise actions to prevent and reduce waste in catering operations; and 5) “Sustainability and the Mediterranean Diets”, which informed the chefs about ingredients that are healthy and sustainable in the

Mediterranean Diet. Each partner was leading different modules, for example Jamk was in charge of the second module and Nutritics of the third. Study materials were available in the Hyperplanning online learning platform, and each module included recorded lectures and live kick-off and wrap-up sessions with different online tools, such as Microsoft Teams, Google Meet and Zoom. Starting from edition 3, also Q&A session in the beginning of each edition. At the end of each edition, a 2-day in-presence session in Colorno (Italy) was organized, which included a Sustainability and the Mediterranean Diets LAB and a Food waste LAB. Networking sessions were organized after each edition.

Nordic perspectives to food sustainability

The learning objectives of this module were to identify and outline the key principles of the Nordic diet; to review the key documents on sustainability in the Nordic diet (for example the Nordic Kitchen Manifesto, 2004); to review best practices related to Nordic diet applications; to review best practices in business concepts of the Nordic diet.

This allowed to present a Nordic perspective to food sustainability to chefs from all EU countries, which included also case studies from Finland (for example, restaurant Nolla, which was also showcased in one of the project's webinars).

Course assessment: understanding how chefs put sustainability knowledge into practice

Surveys were carried out in order to identify changes in the chef's knowledge and behavior related to sustainability. Applying the Kirkpatrick's four step tool (Smidt et al., 2009), prior to, at the end, and three months after each of the eight course editions, an online survey was sent to the participants.

Furthermore, interviews were conducted 3 months after the end of the course with a selection of the participants, these are also available on the Youtube channel of Fondazione Barilla. In this paper we focus on the results of the third survey, which presents the impact the high-level course had on the chefs.

Measuring the impact of the course: focus on the Nordic participants

The results of the third survey highlighted how the vast majority of the course participants implemented changes related to sustainability in their work, especially concerning menu planning (82 %), preparation (79 %) and food waste prevention (76 %).

In relation to the menu planning phase, significant changes occurred in the awareness of the elements supporting sustainability (+23%) and the use of smaller amounts of animal products (+20%). Avoiding food waste in every stage of production (+22%) increased the most in relation to the preparation phase. In terms of service and communication, 19% more chefs declared to create initiatives towards improving sustainability in their restaurant. Finally, 35% more chefs said that they compost organic waste at their workplace.

In this survey, participants from the Nordic countries also gave examples of how they implemented what they learned in the course:

"Measuring food waste, reducing portions, educating guests on food waste, leading by example and finding inspiration for unused produce."

"I try to use more plant bases ingredients than before."

The chefs were also asked to self-evaluate their sustainability skills on a scale from 1 to 10 before and after the course. The index that was calculated from the responses shows that the sustainability skills improved on average from 64 to 74 as a result of the high-level course.

In addition to the data previously gathered, the five chefs participating in the course from Finland were also interviewed in March 2024, after the end of the last edition of the course.

The interviewees felt that they gained new perspectives and inspiration for responsible actions and promoting sustainable development from the training; discussions and exchanges of ideas with European colleagues also encouraged them to try new things. They improved their skills in developing, planning, and naming vegetarian dishes, increasing their appeal, and favoring seasonal products.

They received tips for customer communication, with a focus on the attractiveness of the food. Participants' skills in calculating the carbon footprint also increased, as part of the training involved calculating the carbon footprint of their own recipes.

Discussion and implications for sustainability and highlight of role for Nordic countries

The assessment of the course, and the feedback received, suggest that there is a significant potential for chefs to bring sustainability issues to the table, but targeted education is needed.

The course presented both the Nordic diet and the Mediterranean diet as two valid alternatives for a sustainable approach to food, ensuring that participants would get familiar with the sustainability of a diet possibly already culturally relevant for them, while getting acquainted with an alternative. More research and projects could be developed in this sense, offering chances for mutual learning and cooperation between Nordic and Mediterranean countries, with the joint objective of bringing sustainability to all tables, in all European countries. The latest Nordic Nutrition Recommendations (Nordic Council of Ministers, 2023), and the ongoing update of the New Nordic Food movement (Nordic Council of Ministers, 2024), suggest that the New Nordic Food, and chefs familiar with it, could gain a central role in moving towards a more sustainable food system. While some fine-dining restaurants and chefs may be already on track, and present excellent examples of the New Nordic Food branding, action is still needed in public food services and other big caterers. The open answers in the survey analysed hint that chefs might learn better from other chefs, thus opening the way for new forms of professional education in this sense. When reflecting on the learning happened during the course, one participant said that the most important was "The belief that we can make a difference and it is encouraging that chefs all over Europe are working towards the same goal".

12.3 Bergman Lodin, J. & Ferrari, C. AgroDrive: a new center formation for the transition to fossil-free energy in Sweden's agri-food system

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Summary

“AgroDrive – the transition to fossil-free energy in Sweden’s agricultural and food systems, for improved competitiveness, higher resilience, and better climate” is a new Swedish center formation funded by the Swedish Research Council Formas 2024–2028. As such, it represents a unique and much-needed effort to catalyze this transition by 2050, with critical impact goals set for 2030 in line with the climate commitments of the sector itself.

The center employs a transdisciplinary, quadruple helix approach, bringing together a broad group of stakeholders to reduce fossil fuel dependency throughout the food value chain. By phasing out fossil energy, the climate impact is reduced, and preparedness is increased. AgroDrive will be at the forefront of innovative and effective green solutions, research and policy development.

Here, we present AgroDrive’s inclusive ambitions, technical innovation pathways, stakeholder engagement processes and foresight-based visioning as critical tools in overcoming entrenched system dependencies and facilitating a just green transition that leaves no one behind.

Introduction

Food and energy systems are inextricably linked. In Sweden, food production remains heavily dependent on fossil fuels. Despite advances in electrification and renewable energy uptake in heating and drying, core elements of the agri-food system, not least field operations and transports, continue to invariably rely on fossil fuel imports. This situation creates vulnerabilities for climate mitigation and national food security, particularly under geopolitical uncertainty (SOU, 2021). Between 1990 and 2020, emissions from Swedish agriculture fell by only 10%, primarily due to reductions in arable land and livestock (SEPA, 2024). Current trajectories are insufficient to meet the targets of the EU’s Fit-for-55 package or Agenda 2030.

AgroDrive addresses this shortfall by offering a platform to coordinate the systemic transition of Sweden’s agri-food sector towards fossil-free energy solutions, targeting technological substitution, policy coherence, and equitable change. It will work as an arena for fostering partnerships, collaborations and conversations among stakeholders to share knowledge, best practices and resources as well as co-create solutions related to cost distribution and transition processes, aiming for inclusivity and fairness across the system.

Vision and objectives

AgroDrive’s overarching vision is a fossil-free, just and sustainable food system that combines competitiveness in good times with resilience and food security in harsh times. The overarching impact goals are to (i) implement Sweden’s fossil-free food production roadmaps, (ii) build stakeholder capacity, (iii) ensure inclusive transition processes, (iv) support profitability and competitiveness, (v) reduce climate impacts, and (vi) increase emergency preparedness across the food system, all by 2030. To achieve these goals, AgroDrive has eight operational objectives:

1. Establish a national Transition Arena to connect stakeholders across the entire food value chain, identify barriers and co-create practical, coordinated solutions for fossil-free transformation.
2. Evaluate and demonstrate fossil-free technologies (including electrification, biogas, other biofuels and electrofuels) relevant to primary food production, with case studies and technical validation.
3. Map the sustainable supply potential for agricultural biomass, including availability of raw materials, suitable production processes, and the influence of policy and biomass competition.
4. Analyze material flows and fossil fuel use in food system transport, then develop and pilot sustainable logistics models to reduce transport demand and improve food distribution.
5. Examine existing policies and techno-economic drivers, identifying enabling or hindering factors for the green transition and proposing policy modifications to accelerate scalable change.
6. Investigate stakeholder attitudes, needs and preferences to foster multi-sector participation, promote social acceptance and support an inclusive and contextually adapted energy transition.
7. Co-create future visions of a fossil-free food system, combining foresight, artistic representation, and participatory workshops to inspire and mobilize people towards collective action.
8. Build academic capacity and public awareness, through the recruitment and support of PhD students, dissemination of peer-reviewed research, and extensive communication activities.

Transdisciplinary approach and contribution

AgroDrive is a cross-institutional collaboration between RISE – Research Institutes of Sweden, the Swedish University of Agricultural Sciences (SLU) and Lund University, alongside government and regional agencies, corporations such as Lantmännen, Arla, Axfood, GreenBay Development and Energifabriken, and civil society. It is structured around eight interconnected work packages (WPs), designed to integrate technical, economic, social, and governance perspectives:

1. WP1: Transition in reality
2. WP2: Green technology in food production
3. WP3: Sustainable bioresources and biofuels
4. WP4: Green logistics
5. WP5: Economic performance and policy analysis
6. WP6: Attitudes, needs and preferences
7. WP7: Visions for a fossil-free food system
8. WP8: Coordination and management

A quadruple helix model of collaboration ensures co-leadership between academic and non-academic partners in each WP. This model enables the co-creation of knowledge, co-design of research questions, and joint implementation of pilot and case studies. This embeddedness enhances relevance, practical utility, and uptake of outputs and findings.

Through the AgroDrive Academy, three PhD students will be recruited and benefit from interdisciplinary training, contributing future capacity in transdisciplinary research on sustainable food systems in Sweden and beyond.

AgroDrive contributes methodologically to transdisciplinary food systems research in several distinctive ways, including through:

- I. Living Labs and Policy Labs: AgroDrive's methodological core includes two regional Living Labs (East and West) and a national Policy Lab in WP6. These serve as participatory platforms where stakeholders collaboratively identify challenges and co-create new knowledge and cross-sectorial solutions. Labs will be designed to build trust, enable mutual learning, and ensure diverse representation while shedding light on social preferences and contributing behavioral insights.

- II. Foresight, Normative Visioning and Artistic Representations: WP7 employs scenario-based foresight methods and artistic representations to craft multiple visions of a fossil-free food future. These visions facilitate the identification and communication of pathways, synergies, and trade-offs against which policy and business models can be tested, empowering stakeholders to align short-term action with long-term aspirations.
- III. Youth Engagement and Early Education: AgroDrive introduces youth engagement as a deliberate methodological strategy in WP6 to foster long-term sustainability mindsets and build future capacity. Through collaboration with upper secondary schools in natural resource use and transport, the project will host workshops designed to train and inspire the next generation of farmers, transport operators, and sustainability professionals.
- IV. Mixed Methods Research, Multi-Scale Analysis and Iterative Feedback: AgroDrive relies on mixed-methods research, combining e.g. interviews, surveys, discrete choice experiments, cost-and-benefit modeling, green technology assessments, and GIS-based transport optimization. This allows AgroDrive to address the system at multiple scales, from farm-level practices to national biomass policy, and capture the complex interplay of behavioral, regulatory, and technical dynamics. Moreover, an iterative feedback model underpins all WPs, allowing learnings from pilot and case studies, stakeholder engagements, and scenario analyses to continuously inform the direction of research and implementation.

Equality and inclusion

Another distinctive feature of AgroDrive is its explicit focus on gender dynamics and social inclusion. Agriculture and transport remain male-dominated sectors in Sweden, with only 15% of farms and 8% of trucking jobs held by women (EUROSTAT, 2016; 2022). AgroDrive explores how the green transition can serve as a lever for gender equality by designing energy solutions that accommodate diverse values, needs, and technological affinities (Ball, 2020; Sachs et al., 2016).

Research suggests that women in the Global North are more likely to adopt sustainable farming practices, while men show greater openness to new machinery technologies (Brandth, 2015; Dentzman et al., 2023). By integrating these insights, AgroDrive will promote interventions that bridge green values and green technologies, avoiding new exclusions while challenging old ones.

By including young people in visioning processes and co-creation activities, AgroDrive not only strengthens democratic participation but also ensures that future food system actors are better equipped to navigate and lead the green transition. This engagement method reflects a commitment to intergenerational justice and knowledge continuity, and helps seed long-term cultural shifts within food and energy domains.

Conclusion

AgroDrive offers a novel, transdisciplinary approach to addressing the pressing challenge of decarbonizing food systems. By integrating technical, economic, and social innovations within a participatory governance framework, the center will not only advance research but also enable real-world change. In doing so, it will exemplify how food system transformation can be both scientifically robust and socially just.

AgroDrive's transdisciplinary design, inclusion commitment, and strategic alignment with national and EU goals position it as a flagship initiative in Sweden's green transition. As a model of how to conduct transdisciplinary food systems research, AgroDrive will generate insights and methods of value to the broader sustainability science and policy communities.

The outputs and findings can inform policy development, especially on state aid, biomass prioritization, and incentives for fossil-free investments. The center's impact will extend beyond the four year period by providing foundations for long-term innovation, investment, and educational reform.

References

- Ball, J., 2020. Women farmers in developed countries: a literature review. *Agric & Hum Values* 37:147-160
- Brandth, B., 2015. Rural masculinity in transition: gender images in tractor advertisements. *J of Rural Studies* 11(2):123-33
- Dentzman, K. et al., 2023. Applying the feminist agrifood systems theory (fast) to U.S. organic, value-added, and non-organic non-value-added farms. *Agric & Hum Values* 40:1185–204
- EUROSTAT 2016, 2022. <https://ec.europa.eu/eurostat>
- Sachs, CE. et al., 2016. *The rise of women farmers and sustainable agriculture*. University of Iowa Press
- SOU, 2021. *Vägen mot fossiloberoende jordbruk*. SOU 2021:67.
- Swedish Environmental Protection Agency (SEPA), 2024. Sweden's emissions of greenhouse gases. <https://www.naturvardsverket.se/data-och-statistik/klimat/sveriges-utslapp-och-upptagav-vaxthusgaser>

12.4 Bunge, A. Fika in the anthropocene- leveraging food systems transformations through food cultures

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Abstract

The role of food cultures in food systems transformations is gaining prominence in scholarly discourse. However, several food cultures rely on products with substantial environmental and socio-economic impacts and risks, raising questions about their potential role in transformation processes towards more sustainable food systems. One such example constitutes the Swedish Fika, the daily practice of having coffee and pastries in company as an important social care institution. Based on ingredients like coffee, cocoa, and palm oil, it relies on products associated with high environmental and socio-economic impacts and risks.

This paper draws on resilience theory and uses pathways as a conceptual approach to explore how Fika as an illustrative food culture can be adapted to societal targets and anthropogenic challenges in order to preserve its deeper social value in the long term. We first outline the interlinked environmental and socio-economic impacts and threats associated with Fika ingredients. We then develop two distinct exemplary pathways - “less but better” and “innovated” Fika to illustrate potential strategies that could mitigate adverse impacts while enhancing its resilience to anthropogenic challenges. Finally, we discuss the potential of these pathways to leverage wider dietary transitions by permeating throughout the food system.

We propose that viewing individual food products within their cultural context (the food cultural lens) provides the opportunity for a paradigm shift, using food cultures as strategic entry points and levers for wider food system transformation. Further multi- and transdisciplinary research is required to evaluate the effectiveness of these pathways as well as the broader potential of food cultures to leverage food system change.

Introduction

The current discourse on food systems transformations has been criticised for lacking a deeper focus on cultural-explicit needs and the appreciation of cultural values (Tulloch m.fl. 2023). Scholars increasingly advocate for more context-specific solutions for transforming food systems, based on local cultures and views.

However, some food cultures drive demand for unhealthy and unsustainable foods (The Food Culture Alliance 2023), and are vulnerable to current and future environmental changes. They depend on products with substantial anthropogenic impacts and risks, such as climate-change induced production declines. This raises the question of how these food cultures can be integrated into transformation processes towards more sustainable food systems.

In this paper, we aim to explore how such food cultures can be adapted to societal targets and anthropogenic challenges in order to preserve their deeper social value in the long term. We draw on resilience thinking (Folke 2006; Haider och Cleaver 2023) which suggests that systems facing disturbances need to undergo adaptations to maintain their overall identity (Cumming och Collier 2005; Rotarangi och Stephenson 2014), and develop two exemplary pathways to explore potential trajectories for the food culture to adapt.

As an illustrative example of food cultures, we utilise the Swedish tradition of Fika that constitutes a socio-cultural phenomenon and important social care institution, traditionally consisting of a cup of coffee accompanied by a sweet pastry. This case study is chosen for three main reasons: i) The food items that constitute Fika are linked to multiple adverse social and environmental impacts in producing countries, particularly the high coffee consumption contributes substantially to the environmental impact of the Swedish diet (Moberg m.fl. 2020); ii) the cumulating literature on sustainable dietary transformation predominantly focuses on main dishes and rarely on intermediate meals (Yngve, Scander, och Almroth 2023), albeit they can constitute a high percentage of the caloric intake and environmental impact of diets (Bunge m.fl. 2024); iii) a range of alternatives and strategies for more sustainable and climate-change resilient Fika product consumption are available or emerging and could mitigate the environmental and social impacts of current consumption patterns.

Findings

The environmental and socio-economic challenges of Fika ingredients

In summary, many ingredients central to the Fika culture are associated with adverse environmental and socio-economic impacts. They are also vulnerable to climate change, projected to experience reductions in agricultural yields, and thereby threatening future capacity to supply existing demand for conventional Fika ingredients. The published paper describes these impacts and threats detailed, but here Figure 2 exemplifies these impacts with coffee.

We argue that the multidimensional and interconnected impacts necessitate exploring pathways and underlying strategies to shift towards more sustainable and resilient ingredients for Fika, in order to preserve its social value as a food culture in the long term.

Pathways and strategies to transition towards a more sustainable and resilient Fika culture

In the main paper, we outline two distinct exemplary pathways and their underlying strategies for transitioning towards a more sustainable and resilient Fika: “less but better” and “innovated”. In Figure 3, we present their potential to mitigate current environmental and socio-economic impacts from prevailing consumption patterns in Sweden. The “less but better” pathway employs established low-tech strategies, such as promoting the choice of more sustainable and ethically produced Fika products. In contrast, the “innovated” pathway focuses on emerging, tech-driven solutions to substitute conventional Fika products with food innovations.

Discussion

We titled this paper “Fika in the Anthropocene” to communicate both the current impacts and threats associated with the Fika culture, and also the adaptive capacity required to preserve its deeper social value in the long term. The Anthropocene concept provides an analytical framework to examine anthropogenic impacts across various sectors and encourages discussions on reversing unsustainable practices and advancing sustainable transformations (Olsson m.fl. 2017). As such, “Fika in the Anthropocene” intends to reflect both the anthropogenic impacts and challenges of the food products constituting this food culture, as well as its adaptive capacity to transition towards more sustainable products and practices to preserve its cultural significance.

By outlining two exemplary pathways- “less but better” and “innovated” Fika- we demonstrated that potential strategies exist that could mitigate the adverse environmental and socio-economic impacts of current consumption patterns and adapt them to anthropogenic risks, while preserving the social value of the Fika culture. These strategies illustrate the potential to transition towards more sustainable products

and practices, emphasizing the dynamic nature of food cultures and the possibility of adapting them to anthropogenic challenges.

Preserving by adapting food cultures in the Anthropocene

Integrating food cultures and social values into food systems transformation processes is a key principle (iPES Food 2021). Food cultures serve as a social identity that reach beyond the food products consumed and their potential nourishment. The cultural relevance extends the nutritional value of individual food products into identity by attributing important social values, thereby enhancing their overall value for consumers (Tellström 2011).

Recognising values as critical leverage points for sustainability transformations (Horcea-Milcu 2022), we propose that communicating the impacts and risks of individual food products through the lens of food cultures could leverage consumer acceptance of more sustainable products and practices (Fig. 4). We title this the “food cultural lens”, which frames food products within the context of food cultures rather than as individual ingredients.

We suggest that this food cultural lens could enable the pathways to take place and adapt Fika to anthropogenic challenges and societal goals. The enhanced social value of individual food products through the cultural lens can support shifting norms and values, fostering transitions from less sustainable to more sustainable practices, such as reducing coffee waste, consuming smaller portion sizes, and purchasing products certified with voluntary sustainability standards. This gives rise to the hypothesis that analysing the adaptations needed to preserve food cultures in the Anthropocene, rather than analysing how to reduce the impacts of individually-consumed food products, can serve as a strategic entry point to shift consumer behaviour towards more healthy and sustainable diets in general.

We therefore suggest that the proposed pathways could not only facilitate the transition to a Fika culture based on more sustainable and resilient products and practices, but thereby potentially leverage broader change across other parts of the food system (Fig. 4). The products consumed for Fika are not exclusively tied to, but consumed beyond the cultural context as part of other meals, such as the morning coffee. Raising awareness on the impact and threats of the products through the lens of a food culture, could therefore enhance consumer acceptance and adoption of more sustainable practices and products in general. For instance, increased awareness of the adverse impacts and risks associated with the Fika products could lead to behavioural changes towards greater attention to certificates, reduced waste behaviour, and a general acceptance of food innovations intended to compensate for the decreasing supply of the original commodity.

With the insights developed in this paper, we propose a paradigm shift regarding the role of food cultures in food systems transformation processes, suggesting that they could serve as strategic entry and leverage points instead of static parameters. We hope to inspire other food systems scholars to consider various food cultures in different geographical and cultural contexts and their potential as levers for transformation. We suggest to evaluate the environmental and socio-economic implications of the products constituting respective food cultures, exploring pathways and strategies to address or replace products with adverse impacts, and investigating the leverage potential for broader food systems transformation.

12.5 de Bauw, M. et al. From fragmentation to transformation: multi-level policy mixes for sustainable healthy food environments in Belgium

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Introduction

Affluent dietary patterns contribute to non-communicable diseases and environmental harm, requiring a transition towards healthier, environmentally responsible food environments (1–3). However, fragmented policies across competences, fields, and governance levels drive political inertia. This study aims to map, evaluate and suggest enhancements for a more transformative policy mix shaping Belgium's food environment.

Belgium presents a particularly complex case due to its multi-level governance system. The Belgian state is composed of three regions (Flemish, Walloon, and Brussels-Capital) and three communities (Flemish-, French-, and German-speaking), each with partially overlapping territories and competences. Regions manage land-based competences, such as agriculture and environment, while communities are responsible for people-oriented domains like health, education, and media. The federal government retains several residual competences in consumer protection, product regulation, fiscal policy, and social security.

Belgium mirrors many of the challenges observed in high-income countries more broadly. Approximately 49% of Belgian adults are overweight and 18% are obese. Dietary risks are among the top contributors to disease burden, and annual public health care costs attributable to diet-related diseases are estimated between €1.85 and €3.3 billion. In addition, Belgian dietary patterns contribute significantly to land use change, greenhouse gas emissions, and biodiversity pressures. Disparities in access to healthy food persist, with socioeconomic status strongly influencing diet quality and food security.

Analytical frameworks

A synergistic approach is being advanced here, by coupling two relatively disconnected literature strands. On the one hand, we build on the Healthy Food-Environment Policy Index (Food-EPI) as an internationally standardized tool and process to study food environment policies in the field of public health promotion (4,5). The policy mapping tool consists of 47 good practice indicators across 13 domains, divided into two components: policy - and infrastructure support domains. The process unfolds in three major phases: policy mapping, expert evaluation, and recommendation. On the other hand, this study applies the Six Policy Intervention Points (6IP) framework (6), which stems from transition studies and covers six points of interventions where policy can support sustainability transitions. These include stimulating the emergence of alternative products and practices (IP1), accelerating their uptake (IP2), destabilizing existing regimes (IP3), anticipating and mitigating adverse effects (IP4), enhancing coordination (IP5), and influencing broader societal direction of change (IP6).

Methods

The delineated focal policy mix covered public policies directly shaping food environments. Policies targeted more upstream the value chain, e.g. related to primary production, were out of scope. Eight

jurisdictions were focal to this study: the federal government, Flanders, Walloon Region, Brussels Capital Region, French Community, German Community, COCOF and VGC.

Within this delineated scope, a top-down policy mapping was conducted through desk research, complemented by interviews with public officials. A legal doctrinal analysis clarified the division of competences across jurisdictions.

Fifty-one experts from academia, public administration, and civil society rated the strength of policy implementation for each Food-EPI indicator. A five-point Likert scale was used, and inter-rater reliability was measured with Gwet's AC2.

Identified policy instruments were classified through triangulation into informational, regulatory, and economic instruments, and linked to one of the six intervention points defined in the 6IP framework. A Gini-Simpson Index was used to assess balance across these categories.

Three expert workshops with 47 participants were conducted to co-develop and prioritize targeted recommendations. For each recommendation, the potential impact, feasibility and jurisdictional competence were considered.

Results and discussion

The analysis of Belgium's food environment policies across eight jurisdictions revealed a generally low to moderate level of policy implementation strength. Among the evaluated policy domains, institutional food provision—particularly in schools and childcare—stood out as the most developed, especially in Flanders and Wallonia. In contrast, key areas such as zoning regulations, fiscal measures (e.g., taxes and subsidies), and the regulation of food marketing and retail environments remained significantly underdeveloped or absent. These gaps suggest a limited capacity to structurally influence food environments.

In terms of policy instruments, informational measures were overwhelmingly dominant. Out of 200 identified policy instruments, 168 were informational in nature, such as educational campaigns or voluntary guidelines. Only 25 were regulatory and 37 economic, indicating a narrow focus on non-coercive tools. The federal government showed the most balanced mix, integrating regulatory and fiscal strategies to some degree. However, community-level bodies relied almost entirely on informational measures, in some cases constrained by limited legislative authority.

When categorized using the Six Policy Intervention Points (6IP) framework, most policies were found to concentrate on stimulating (IP1) and accelerating (IP2) alternative products and practices, as well as improving multi-regime coordination (IP5). By contrast, very few policies aimed to destabilize existing unhealthy or unsustainable practices and products (IP3) or to anticipate and manage adverse side effects of transition (IP4), such as socio-economic inequalities or industry displacement. This imbalance suggests that while there is support for innovation, the necessary phase-down of harmful practices is still largely missing.

Legal analysis confirmed that more policy actions are technically feasible within Belgium's institutional framework, despite the fragmented competences often delaying or inhibiting implementation. For instance, the analysis concluded that efforts to regulate food advertising ultimately falls under federal competence, despite important competences at community- and regional levels. Similarly, the analysis demonstrated with the case of public procurement standards how very often, more than one single jurisdiction has legal ground to develop policies, an underutilized potential.

During the expert workshops, 158 recommended actions were formulated across jurisdictions. These offered a more balanced use of regulatory, economic, and informational instruments compared to current policies. Several addressed regime destabilisation (IP3), while IP4—anticipating socio-economic impacts—still remained underrepresented in these recommendations.

Conclusions

This study highlights how food environments have emerged as an increasingly topical concern in Belgium's public policy narratives on nutrition and sustainability. Increasingly, the focus has shifted away from individual-level interventions toward addressing the structural determinants of dietary behaviors. While some progress has been made—particularly in public procurement and normative standards—critical gaps remain in areas like zoning regulation and marketing controls. The predominance of informational and phase-in instruments continues to limit transformative potential, especially in the absence of regulatory and fiscal mechanisms that phase down unhealthy, unsustainable practices.

The study emphasizes the importance of building a more balanced and just policy mix. Legal analysis demonstrated that many actions are feasible within Belgium's institutional framework, especially when framed creatively within existing competences. This shifts the policy conversation from what is constitutionally possible to what is politically desirable and actionable. It also suggests that seemingly fragmented competences may hold latent potential for cross-jurisdictional alignment.

Notably, despite regional differences, the expert workshops revealed striking convergence in the types of actions recommended across governments. Shared priorities included advertising restrictions for unhealthy food, legal tools for local zoning, and eligibility criteria for subsidies. These cross-cutting recommendations offer valuable building blocks for a more integrated national vision for food environments.

However, individual instruments alone are insufficient. A transformative transition depends on well-aligned policy mixes and stronger vertical and horizontal coordination. Flanders has taken more structural steps, while Wallonia and Brussels require further institutional integration. A cohesive national strategy is needed, especially in light of the absence of EU-level direction on food environments.

Ultimately, addressing food environments is not merely a technical task—it is a political and ethical one. Reducing diet-related disease and environmental harm requires bold, systemic action. This study urges Belgian governments to adopt more far-reaching, coherent, and socially just policies to drive food system transformation.

References

- Clark M, Springmann M, Rayner M, Scarborough P, Hill J, Tilman D, et al. Estimating the environmental impacts of 57,000 food products. *Proc Natl Acad Sci U S A* [Internet]. 2022;119(33). Available from: <https://doi.org/10.1073/pnas.2120584119>
- Swinburn BA, Kraak VI, Allender S, Atkins VJ, Baker PI, Bogard JR, et al. The Global Syndemic of Obesity, Undernutrition, and Climate Change: The Lancet Commission report. Vol. 393, *The Lancet*. Lancet Publishing Group; 2019. p. 791–846.
- SAPEA. Towards sustainable food consumption: Evidence review report [Internet]. 2023 Jun. Available from: <https://zenodo.org/record/8031939>
- Pineda E, Poelman MP, Aasp A, Bica M, Bouzas C, Carrano E, et al. Policy implementation and priorities to create healthy food environments using the Healthy Food Environment Policy Index (Food-EPI): A pooled level analysis across eleven European countries. *www.thelancet.com* [Internet]. 2022; Available from: <https://doi.org/10.1016/j>.
- Swinburn B, Vandevijvere S, Kraak V, Sacks G, Snowdon W, Hawkes C, et al. Monitoring and benchmarking government policies and actions to improve the healthiness of food environments: A proposed government healthy food environment policy index. Vol. 14, *Obesity Reviews*. 2013. p. 24–37.
- Kanger L, Sovacool BK, Noorkõiv M. Six policy intervention points for sustainability transitions: A conceptual framework and a systematic literature review. *Res Policy*. 2020 Sep 1;49(7).

12.6 Eneroth, H. et al. Challenges and solutions for preparedness and sustainability in Swedish agriculture, a Q-methodology study of stakeholders

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Introduction

Recently, the COVID-19 pandemic, extreme weather events and geopolitical tensions have exposed vulnerabilities in global supply chains, highlighting the need for more resilient food systems to ensure food security during future crises. As a result, private food system actors, governmental organisations and civil society in Sweden have placed food preparedness higher on the agenda. At the same time, agriculture is also challenged by sustainability issues such as climate impact, pollution and negative effects on biodiversity, low profitability, and a range of socio-economic challenges.

Q-methodology allows for the investigation of patterns shared across individuals' perspectives and can be useful in problem identification, policy making and in policy implementation (Barry and Proops 1999). In the context of the current study, the stakeholders of interest are individuals involved in, or influencing the decision making about sustainability and preparedness in Swedish agriculture. The aim of this study is to identify different perspectives on food preparedness and the role of Swedish agriculture to supply food commodities to the population in times of crises, also considering the long-term sustainability of primary production.

Methods

Q-methodology is used to uncover and identify subjective perspectives of individuals by 1) collecting statements on the topic from literature 2) let respondents sort the statements 3) identify factors by factor analysis and 4) interpret the factors to find perspectives (Watts and Stenner 2012).

We identified three categories of relevance for the study: 1. Resources: inputs needed for agriculture; 2. Practices: Type and mode of primary production and food consumption 3. Governance: responsible actors and influencing factors. We collected 250 statements covering food preparedness, economic, environmental and social sustainability relating to the three categories. Sources were policy documents, popular media coverage of research and public debate. After piloting the statements and discussing them in the project group we narrowed our selection to 47 statements. In total 34 individuals were contacted by e-mail in January 2025 with an invitation to participate in the study. Respondents were from organisations representing producers, policy makers, academia and civil society.

A Q-sort is framed by a guiding question or statement that participants use to sort statements depending on how much they agree or disagree with each statement. In our study, the guiding question was: "What factors do you think are significant for the ability of Swedish agriculture to meet the need of food commodities for the population at times of crises?" The sorting grid looks like a pyramid where seven statements can be ranked 0 (neutral or neither agree or disagree), two statements can be put in the extremes ("agree most with my perception", ranked +5) and ("deviates most from my perception" ranked -5), four statements can be given the rank +4, five statements 3+ etcetera. Q-methodology software

(<https://qmethodsoftware.com/>) was used to collect and analyse the data. Seven semi-structured interviews focussing on the respondents' rationale for sorting of the statements were performed. A factor analysis gave us the mathematically most fitting number of factors from the Q-sets, and then we explored models of 3-5 factors using varimax rotation. Four factors were initially interpreted and finally five perspectives described. The perspectives that appeared from the interpretation of the study were discussed with stakeholders (n=10) in a digital workshop to validate the findings.

Results

In total, 26 respondents completed the Q-sort. In the interviews, respondents explained the rationale for their sorting. Several interviewees expressed their appreciation of the Q-sort as it made them reflect on their standpoint on these issues. We determined that a four factor-solution makes the most sense in terms of explained variance and distinct groups of statements to interpret. One factor was split into two (perspectives 2 and 3) due to both positive and negative loadings (bipolar factor). By looking into the highest and lowest rankings of factors on each of the 47 statements, and what ranks differed from other factors, we identified five different perspectives. These perspectives were recognized when presented to a group of stakeholders at a workshop. The five perspectives are summarised below.

Perspective 1: Ensure long-term solutions. A defining statement for this perspective is "The discussion on preparedness has too much focus on short term measures to handle a crisis within the current system, and too little focus on long term changes from a sustainability perspective". Respondents holding this perspective consider that both the private and governmental sectors will be important actors to drive solutions to food preparedness. In many other issues, this perspective can be interpreted as the moderate, or analytical perspective as suggested solutions have a neutral ranking. Respondents from all types of organisations represent this perspective.

Perspective 2: Act for a nature-based shift. Unique for respondents holding this perspective is the high ranking of the statement "By enhancing biodiversity, we can reduce the need for pesticides and mineral fertilizers in food production and in that way become less dependent on inputs". The emerging perspective here is that less dependence on inputs together with changes in consumption to adjust for needs in a crisis will make us less vulnerable to disturbances. Those holding this perspective were found in all types of organisations except producers.

Perspective 3: Preparedness by protecting current production. This perspective is defined by the statement: "The most important for food preparedness is a large production of milk and beef in Sweden". A large milk and meat production may be seen as safeguarding food security in a crisis, because it is currently a profitable type of farming. Those aligning to this perspective prioritize domestic production of input as a food preparedness solution over decreasing input use through changes involving nature-based solutions. They were from organisations representing producers.

Perspective 4: Contingency planning is pivotal. A defining statement for this perspective is: "Authorities should consider what temporary regulatory reliefs are needed for the food supply in the event of a crisis". Those aligned with this perspective have faith in companies' ability to plan for how to act in disturbances and they emphasise that the government should support these companies by providing regulatory reliefs. They prioritize the strategic storage of inputs higher than producing more inputs in Sweden or reducing the use of inputs. This perspective was found among producers, policy makers and civil society, but not academia.

Perspective 5: Keep up the trade and market. This perspective is highlighting the importance of trade by a high ranking of: "The most important measure to safeguard food supply at disruptions is to, as far as possible, maintain the EU inner market and trade". The perspective that emerges here is that of reliance on sustaining trade and for individual companies to plan for a crisis. Those with this perspective feel that

strategic storage of inputs and common planning in the Nordics are prioritised actions. Those holding this perspective were found in all types of organisations except academia.

Overall, there was consensus on the statement “Municipalities must have resources secured to be able to take the practical responsibility for the food supply in the event of a crisis” where all factors had given a neutral rank. A low rank was given to urban farming: “One solution is urban farming, areas in city environment intended for cultivation, or arable land adjacent to cities, that may supply city residents with food during a crisis and thus improve food security”. Overall, there was also a low ranking of emerging techniques: “The fast development of food production "beyond agriculture" (for example precision fermentation, cellular cultivation and mycoproteins) bring possibilities for resource-efficient food production”.

Discussion and conclusion

We found five distinct perspectives emerge in this study. An incremental or “wait-and see” perspective such as “Ensure long-term solutions” is valid as preparedness has emerged recently as a high-priority topic in agriculture, and solutions are not yet in place. “Act for a nature-based shift” is a perspective leaning on principles of environmental sustainability with an emphasis on agri-ecological and low-input solutions. In opposition to the nature-based shift, there is a perspective of “Preparedness by protecting current production” with an emphasis on domestic inputs. Two of the perspectives: “Contingency planning is pivotal” and “Keep up trade and market” come across as having a particular focus on food preparedness, with suggestions on solutions and actors. These two perspectives have a lot in common but differs mainly on the emphasis on trade in the latter, which interestingly is emphasized only in one of the perspectives.

Q-methodology is suitable to explore an emerging topic using a limited number of respondents. Results are not representative of any sector or the population as a whole but reflect the ongoing debate in Sweden. This study has given us insights on similarities and differences in perspectives that may help in formulating further research on the challenge of applying a long-term perspective on sustainable agriculture, while preparing for food security in a crisis.

References

- Barry, J., & Proops, J. (1999). Seeking sustainability discourses with Q methodology. *Ecological economics*, 28(3), 337-345.
- Watts, S., & Stenner, P. (2012). *Doing Q methodological research: Theory, method & interpretation*.

12.7 Frey, S. et al. The transformative potential of Swiss visions for sustainable food systems

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In Switzerland sustainable food system transformations have received much attention in recent years. Five actor groups worked on visions of such transformations: A citizen council, a science coalition, two government entities, and the biggest organic agriculture organization¹⁻⁶. The latter also assigns the most important organic certification in Switzerland. While the first four visions address the entire Swiss food system, the last one focuses more on reducing GHG emissions throughout the organisation's organic value chain, which includes its approximately 7500 members. However, the larger context and constraints of the Swiss food system play a significant role in their considerations.

It is unclear how impactful such visions and their proposed measures are⁷. This paper compares these five visions regarding their justice implications, their transformative potential and to what extent the proposed measures address the visions' objectives.

Methods and concepts: frame analysis, leverage points and justice

To engage with the five visions, we analysed them with a focus on the following four key research questions: 1) How are their objectives similar or different? 2) What variations appear between the measures designed to reach the objectives? 3) How suitable are the measures for achieving the suggested objectives and to drive structural change? 4) Which elements of transitional justice are considered in the visions?

We adopted a frame analysis methodology to examine the vision documents and supplementary data. We also conducted a workshop with the organic agriculture organization to gain deeper insight into their vision and planned measures.

Questions 1 and 2 were examined by using a thematically structured coding frame. To explore question 3, we adapted Donella Meadows leverage points⁸ concept to food systems. The concept proposes leverage points to intervene in a system and ranks these points according to their transformative potential (12 is least transformative, 1 most transformative), a few illustrative examples: Changes in “constants, parameters, numbers”⁸ (rank 12), “The structure of information flows (who does and does not have access to what kinds of information”⁸ (rank 6), “The rules of the system” (such as incentives, punishments, constraints)”⁸ (rank 5) “The mindset or paradigm out of which the system—its goals, structure, rules, delays, parameters—arises”⁸ (rank 2). However, the original concept doesn't consider everyday practices. These are essential in food consumption and production. Producing, processing, choosing, eating, preparing and sharing food are highly interlinked with identity, culture, social status and more. These social dimensions strongly influence the sustainability of food systems and justice aspects of proposed transition pathways. To address this limitation of the concept, we expanded the framework by adding ‘changing everyday practices’ as an additional leverage point.

To analyse the consideration of transitional justice (question 4) we used the framework developed by Tribaldos and Kortetmäki⁹.

Preliminary results: high levels of consensus and noteworthy omissions

Preliminary results answering question 1 indicate that different actors' objectives vary more in the timeline for achieving them than in the content. For example, there is consensus that changing diets has high

benefits for health and the environment. While a government publication sets the objective at one third of adults eating according to the Swiss dietary recommendations by 2030³, the publication of the science actor proposes more ambitious aims, such as a 50% reduction of meat consumption by 2030². GHG emission reduction targets vary from near net zero in the whole organic value chain by 2040⁶, to net 0 in consumption in 2045² to minus 60 % in consumption by 2050⁴. However, these examples also demonstrate the difficulty in comparing objectives as they are often framed differently. While the consensus between the objectives seems relatively high, the visions fail to specify the priority levels of these different objectives and rarely address the trade-offs between them. The past political positions of the actors publishing the visions suggest that their priorities differ considerably. Acknowledging trade-offs and establishing clear priorities is essential for a deliberately democratic and just transformation of the food system. For example, several visions highlight that prices should be affordable but also should represent environmental, health and production costs and provide fair incomes for farmers. While trade-offs between these two objectives seem likely, they are rarely addressed as such.

The suggested measures vary much more between the different actors than the objectives (question 2). Results also suggest that many of the proposed measures target low hanging fruit (such as developing guidelines for irrigation or providing advice for farmers concerning renewable energies⁵) rather than aiming at more transformative leverage points, such as goals, paradigms or system rules (e.g. change the power structure in markets, where large retailers or processors have important decision power compared to farmers¹⁰) (question 3). This is especially true for the governmental publications. Moreover, in the latter political settings and power dynamics are rarely discussed. In Meadows framework they are captured under rank “5. The rules of the system”⁸ (for example laws) and more importantly “4. The power to add, change, evolve, or self-organize system structure”⁸ (for example who can change laws through which processes).

The visions only rarely explicitly consider transitional justice (question 4). Implicitly the focus lies on distributional and ecological integrity justice principles. Particularly little attention is paid to recognition justice. Literature however shows that recognition is an important element for some Swiss farmers¹¹. Additionally, from a justice perspective the following issues deserve more consideration: The opportunities for livelihoods in rural areas, power distribution and price structures in value chains, the political representation of different types of farmers and different sizes of farms and the impacts food system activities have on distant people or future generations.

Limitations: ranking leverage

Meadows' concept is limited by having undergone comparatively little development or evidence-based testing since its inception in the 1990s¹². Especially, the hierarchy indicating the transformative potential of each point, has limitations. The leverage of the isolated points depends on various factors and the leverage points are interdependent. Nevertheless, the approach best allowed us to categorize and evaluate the proposed measures, providing preliminary insights into their potential suitability to reach the respective objectives.

Conclusion

Provisional results of our analysis show, that while on an abstract level there is relative consensus on the direction of the objectives, the proposed measure to reach them differ considerably. In most cases, trade-offs between and priorities of objectives remain unclear. Many measures seem to be harvesting rather low hanging fruit. Due to the above-mentioned limitations of the leverage point framework it is essential that further, more data driven research determines whether the proposed objectives and the respective measures are sufficient to maintain and regain a safe and just operating space for humanity⁷.

Trade-offs between objectives with their respective measures need to be researched and clarified. The priorities of different objectives need to be specified and made transparent by the respective actors. Without addressing the political mechanisms and power dynamics essential for change, the visions are incomplete. Finally, a holistic understanding of justice is crucial to ensure that no one is left behind.

References

- Bürger:innenrat für Ernährungspolitik. Empfehlungen für die Schweizer Ernährungspolitik. Stiftung Biovision, Verein Landwirtschaft mit Zukunft, SDSN Schweiz; 2023. https://www.buergerinnenrat.ch/wp-content/uploads/2023/01/230126_Empfehlungen_BuergerInnenrat_DE.pdf
- Fesenfeld L et al. Wege in die Ernährungszukunft der Schweiz - Leitfaden zu den grössten Hebeln und politischen Pfaden für ein nachhaltiges Ernährungssystem. Zenodo; 2023. <https://zenodo.org/record/7543576>
<https://doi.org/10.5281/zenodo.7543576>
- Der Bundesrat. Zukünftige Ausrichtung der Agrarpolitik Bericht des Bundesrates in Erfüllung der Postulate 20.3931 der WAK-S vom 20. August 2020 und 21.3015 der WAK-N vom 2. Februar 2021. Schweizerische Eidgenossenschaft; 2022.
- Bundesamt für Landwirtschaft BLW, Bundesamt für Umwelt BAFU, Bundesamt für Lebensmittelsicherheit und Veterinärwesen BLV. Klimastrategie Landwirtschaft und Ernährung 2050 Verminderung von Treibhausgasemissionen und Anpassung an die Folgen des Klimawandels für ein nachhaltiges Schweizer Ernährungssystem 1. Teil: Grundsätze, Ziele und Stossrichtungen. Schweizerische Eidgenossenschaft; 2023.
- Bundesamt für Landwirtschaft BLW, Bundesamt für Lebensmittelsicherheit und Veterinärwesen BLV, Bundesamt für Umwelt BAFU. Klimastrategie Landwirtschaft und Ernährung 2050 Verminderung von Treibhausgasemissionen und Anpassung an die Folgen des Klimawandels für ein nachhaltiges Schweizer Ernährungssystem 2. Teil: Massnahmenplan. Schweizerische Eidgenossenschaft; 2023. <https://backend.blw.admin.ch/fileservice/sdweb-docs-prod-blwch-files/files/2024/07/29/626ebd80-f58d-49be-af58-50aaa5deadeb.pdf>
- Bio Suisse. Bio Suisse will klimaneutrale Biolandwirtschaft in der Schweiz - Bio Suisse. Bio Suisse. 2022 Apr 13 [accessed 2023 Mar 27]. <https://www.bio-suisse.ch/de/unser-verband/medien/medienmitteilungen/detail/bio-suisse-will-klimaneutrale-biolandwirtschaft-in-der-schweiz.html>
- Richardson K et al. Earth beyond six of nine planetary boundaries. *Science Advances*. 2023;9(37):eadh2458. <https://doi.org/10.1126/sciadv.adh2458>
- Meadows D. Leverage Points Places to Intervene in a System. Sustainability Institute; 1999. https://1a0c26.p3cdn2.secureserver.net/wp-content/userfiles/Leverage_Points.pdf
- Tribaldos T, Kortetmäki T. Just transition principles and criteria for food systems and beyond. *Environmental Innovation and Societal Transitions*. 2022;43:244–256. <https://doi.org/10.1016/j.eist.2022.04.005>
- Scharrer B. Fördert die Schweizer Agrarpolitik die Entwicklung einer nachhaltigen und standortgerechten Landwirtschaft ausreichend? Eine Analyse der aktuellen Instrumente, Zielkonflikte und des Handlungsbedarfs. CDE, University of Bern; 2022. NRP 73 Project 'Sustainable Trade Relations for Diversified Food Systems Report No.: 04. <https://boris.unibe.ch/172674/>
- Contzen S, Häberli I. Exploring dairy farmers' quality of life perceptions – A Swiss case study. *Journal of Rural Studies*. 2021;88:227–238. <https://doi.org/10.1016/j.jrurstud.2021.11.007>
- Murphy R. Finding (a theory of) Leverage for Systemic Change: A systemic design research agenda. *Contexts – The Systemic Design Journal*. 2022 [accessed 2024 Nov 14];1. <https://systemic-design.org/contexts/vol1/ryan-murphy/v1004/>. <https://doi.org/10.58279/v1004>

12.8 Friman, A. & Hyytiä, N. Behavioural changes in households' efforts to reduce food waste in Finland, quantitative analysis

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Background aims

Food waste reduction became a specific policy objective at the EU from 2015 onwards, reflecting the EU's and its Member states commitments in the context of the UN Sustainable Development Goals framework (European Commission, 2015, 2019, 2020b, 2020a, 2023). In Finland, households account for nearly half of all discarded food (Eurostat, 2024), and one of the most common reasons for food waste are the deficiencies in household cooking skills and ability to estimate the right level of home-produced meals (Silvennoinen et al., 2014). The policy commitments have spurred several initiatives, both public and private (e.g., K Group, 2016, 2023; Kuluttajaliitto, 2024; Paulig Group, n.d.), aimed at reducing household food waste. Yet, household food waste in Finland has not decreased (Silvennoinen and Nisonen 2022; 2024).

Understanding food waste behaviour and economic effects of behavioural change is crucial to reduce food waste effectively. Previous literature has filled important research gaps on socio-cultural, psychological and material aspects related to food waste (Hebrok & Boks, 2017; Schanes et al., 2018), and on economic effects of food waste reduction (e.g., Bartelings & Philippidis, 2024; Britz et al., 2014, 2019; Campoy-Muñoz et al., 2017, 2021; Philippidis et al., 2019). However, time spent preparing food at home and its costs have often been omitted. In addition, analysis covering the interlinkages between market economy and household activities are lacking from the food waste literature. Thus, this study examines the economic effects of household food waste reduction in Finland. Specifically, in the context of the food waste reduction targets, this study shows how improvements in household meal production affects food waste, and further, economic welfare within the food system.

Methods

We apply a dynamic computable general equilibrium model GEM-Care (Lofgren & Cicowiez, 2021) to examine the economic effects of food waste reduction. With its economy-wide coverage of interdependencies between all the economic sectors, agents and markets simultaneously, such model is a well-functioning tool to analyse policy interventions and their effects on economic performance. Moreover, compared to a standard CGE model, GEM-Care has two distinguished features matching the key interests of our study: 1) it covers both GDP and non-GDP production, and 2) it includes a nested structure of household consumption to capture household choices between own production and market supplies. Consequently, the model captures time use relations between market work, household production and leisure, and the modelling results show both the direct and indirect effects of food waste reduction.

We use an extended social accounting matrix (SAM) with household production to cover the GDP and non-GDP activities in Finland. The base year for Finland SAM is 2019. With simulations, we analyse improvements in household meal production. We compare the results for a 2019-2035 base scenario to scenarios in which different shocks are introduced. Thus, the base scenario assumes no policy changes. The first scenario simulates an increase in cooking skills in household meal production. The size of a shock is set to level at which each household achieves a 30% reduction of food waste by 2035 compared to the baseline

in 2020. The second scenario departs from the first simulation in terms of the target. In the second scenario, the size of a shock is set to level at which each household achieves a 50% reduction of food waste by 2035.

The level of food waste is defined by the model. Following Lusk & Ellison (2017), the level of food waste is given by the ratio $FW = \text{Food inputs} / \text{Meals}$. Food waste in our study includes both edible and inedible parts. At the baseline, the levels of each households' food waste correspond to previous studies on food-waste-related lifestyles (Aschemann-Witzel et al., 2021) as well as on the importance of the household size (Katajajuuri et al., 2014).

We use the level of food waste also to calculate the amount of food in kilograms. Thus, the amount of food waste is calculated as a share of food inputs purchased from markets, $FWQ = FW \times \text{Food inputs}$. Since our model does not quantify food inputs in terms of kilograms, we monitor the total amount of household food waste against food waste estimates by Eurostat (2024) after the simulations.

Results and conclusions

Household food waste reduction is economically worthwhile in terms of investments and GDP at market prices. However, the gains were not attained without costs – neither in terms of time nor money. While improvements in household cooking skills reduced food waste, it also required more time spent preparing meals at home. These changes further reduced households' market work and incomes derived from it, and thus, the welfare of all households decreased. Furthermore, household food waste reduction decreased the demand for food products, generating economic trade-offs and welfare redistribution along the food supply chain: the value added of the agriculture and the food industry decreased.

In the context of policy targets (European Commission, 2023; United Nations, 2015), skills development is a promising avenue to reduce food waste. Yet, interventions that nudge consumers to improve their cooking skills require different levels of behavioural change depending on the initial levels of food waste and household's consumption structure. Albeit households save money in cutting their expenses on food, investing time on food waste reduction is costly. Such costs may give households a reason to sustain a certain level of food waste, even if they recognize the societal importance of reducing it.

It is reasonable to presume that the effects would be parallel in other EU member states. Thus, such changes in the economic welfare are worth considering also beyond Finland when implementing the reduction targets as proposed in the revision of the Waste Framework Directive.

References

- Aschemann-Witzel et al. (2021). My style, my food, my waste! Consumer food waste-related lifestyle segments. *Journal of Retailing and Consumer Services*, 59, 102353.
- Bartelings, H., & Philippidis, G. (2024). A novel macroeconomic modelling assessment of food loss and waste in the EU: An application to the sustainable development goal of halving household food waste. *Sustainable Production and Consumption*, 45, 567–581.
- Britz et al. (2014). Economy-wide Impacts of Food Waste Reduction: A General Equilibrium Approach. In *Proceedings of the EAAE 2014 Congress Agri-Food and Rural Innovations for Healthier Societies*.
- Britz et al. (2019). *Economy-Wide Analysis of Food Waste Reductions and Related Costs*. Publications Office of the European Union: Luxembourg.
- Campoy-Muñoz et al. (2017). Economic impact assessment of food waste reduction on European countries through social accounting matrices. *Resources, Conservation and Recycling*, 122, 202–209.
- Campoy-Muñoz et al. (2021). Food Losses and Waste: A Needed Assessment for Future Policies. *International Journal of Environmental Research and Public Health*, 18(21), 11586.
- European Commission. (2015). *Closing the loop – An EU action plan for the Circular Economy*. COM(2015) 614 final. .

- European Commission. (2019). The European Green Deal. COM(2019) 640 final.
- European Commission. (2020a). A Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system. COM(2020) 381 final.
- European Commission. (2020b). A new Circular Economy Action Plan For a cleaner and more competitive Europe. COM(2020) 98 final.
- European Commission. (2023). Proposal for a Directive of the European Parliament and of the Council amending Directive 2008/98/EC on waste. COM(2023) 420 final.
- Eurostat. (2024). Food waste and food waste prevention by NACE Rev. 2 activity - tonnes of fresh mass.
- Hebrok, M., & Boks, C. (2017). Household food waste: Drivers and potential intervention points for design – An extensive review. *Journal of Cleaner Production*, 151, 380–392.
- K Group. (2016, August 8). K-Food stores reduce wastage in many ways. <https://www.kesko.fi/en/media/news-and-releases/press-releases/2016/k-food-stores-reduce-wastage-in-many-ways/>
- K Group. (2023, January 5). K Group's grocery trade commits to reducing single-use plastics and food waste as part of its continued environmental work. . <https://www.kesko.fi/en/media/news-and-releases/news/2023/k-groups-grocery-trade-commits-to-reducing-single-use-plastics-and-food-wastage-as-part-of-its-continued-environmental-work/>
- Katajajuuri et al. (2014). Food waste in the Finnish food chain. *Journal of Cleaner Production*, 73, 322–329.
- Kuluttajaliitto. (2024). Hävikkifoorumi. <https://www.kuluttajaliitto.fi/hankkeet/kuluttajien-havikkifoorumi-hanke/>
- Lofgren, H., & Cicowiez, M. (2021). A Gendered Dynamic General Equilibrium Model for Analysis of Care. American University.
- Lusk, J. L., & Ellison, B. (2017). A note on modelling household food waste behaviour. *Applied Economics Letters*, 24(16), 1199–1202.
- Paulig Group. (n.d.). Time to cut food waste. Retrieved May 10, 2024, from <https://www.lessfoodwaste.fi/paulig/en/Home>
- Philippidis et al. (2019). Waste not, want not: A bio-economic impact assessment of household food waste reductions in the EU. *Resources, Conservation and Recycling*, 146, 514–522.
- Schanes, K., Dobernig, K., & Gözet, B. (2018). Food waste matters - A systematic review of household food waste practices and their policy implications. *Journal of Cleaner Production*, 182, 978–991.
- Silvennoinen et al. (2014). Food waste volume and composition in Finnish households. *British Food Journal*, 116(6), 1058–1068.
- Silvennoinen, K., & Nisonen, S. (2022). Kotitalouksien elintarvikejäte 2021: Seka- ja biojätteen lajittelututkimus Keski-Suomi ja Helsingin seutu.
- Silvennoinen, K., & Nisonen, S. (2024). Kotitalouksien elintarvikejäte 2023: Seka- ja biojätteen lajittelututkimus Pirkanmaa.
- United Nations. (2015). Transforming our World: the 2030 Agenda for Sustainable Development; United Nations: A/RES/70/1.

12.9 Gaiani, S. et al. White paper on Nordic sustainable food systems: pathways and intervention areas

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Why a white paper on nordic sustainable food systems?

Each Nordic country has a distinct food system, yet all Nordic countries share common strengths and challenges. Nordic food systems are embedded in societies with strong social and institutional foundations, with high levels of innovation and multi-sector cross border collaboration – for instance on food, energy, culture, the labour market and education - and people enjoy a stable and rich food supply.

Despite positive achievements, recent researches (1) prove that Nordic food systems are not sustainable as they have to cope with numerous threats including diet-related health problems, intensive agricultural production, biodiversity loss, greenhouse gas emissions partially connected to food waste, high consumption of meat and dairy products, and reliance on imported fertilizers and pesticides.

In such a complex framework, eight Nordic Universities (2) joined forces in 2022 to start the project “The role of Nordic research in promoting sustainable agro-marine food systems” financed by the Nordic Joint Committee for Food and Agriculture Research whose main aim was to develop recommendations for a just transition to more sustainable Nordic food systems. The White Paper on Nordic Sustainable Food Systems was created as final outcome of project’s activities and was officially launched in Copenhagen on the 12th of June 2024 at the presence of the representatives from the Nordic Council of Ministers, FAO, NordForsk.

The White Paper focuses on two key questions: Is a Nordic joint vision on sustainable food systems possible? And how can Nordic academic institutions support and facilitate the transition to sustainable food systems?

It builds upon data collected in existing reports and projects (3) and reflects on food systems related topics suggesting 12 intervention actions that should be prioritized in the Nordic political and institutional agenda. Main aims are to support food systems actors in reflecting on their roles in promoting action on sustainable solutions and to create a space for communication and negotiation among food systems stakeholders.

Limitations include the lack of the analysis regarding the role of diverse immigrant communities in shaping Nordic food systems and the lack of reference to the Common Agricultural Policy as it covers only part of the Nordic countries.

The intended audience are governments, food researchers, civil society organizations, and special interest groups looking for new ways to shape societal change through food.

12 Intervention areas to promote Nordic sustainable food systems

Nordic governance structure for food systems is fragmented, as it has grown over time in the absence of a systems lens. The future governance structure needs to be rethought to apply a food systems approach, as intervention points conducted in isolation have little potential to produce transformation.

The White Paper proposes 12 interconnected intervention areas which should support a fair transition to food systems transformations. These areas are:

1. Strengthen Nordic coordination to support national pathways for food systems transformation
2. Promote sustainable innovation in agriculture
3. Reflect on Nordic nutritional guidelines and explore the current incentives to follow them
4. Combine food traditions with sustainable diets while valuing Nordic food culture
5. Strengthen and invest in education on food and nutrition
6. Analyze deeper the connection between the role of consumption and behavioral change
7. Explore the connection between taste and place to valorize Nordic food
8. Emphasize the role of Indigenous communities in the Nordic food transition
9. Address power imbalances in the Nordic food supply chain
10. Focus on the Nordic blue economy
11. Consider the relationship between food self-sufficiency, food sovereignty and food waste in the Nordic countries
12. Improve cooperation across the Nordic Region in relation to emergency preparedness and crisis management

These 12 intervention areas recognize that:

- A critical part of planning pathways for sustainable food systems lies in understanding which stakeholders should be involved and their role in the food system. Good practices for multi-stakeholders' collaboration include the promotion of long-term visions for Nordic sustainable food systems, based on testing, learning processes, trust, and collaboration between all actors in the food system, coordination between government departments and meaningful participation of stakeholders who have often been excluded from policymaking processes, such as Indigenous people, youth, informal food systems workers.
- The extent to which Nordic companies leverage technology varies. Some large Nordic companies struggle to integrate innovation and digitalization into their business models, and are not investing enough in future-proofing their operations. To ensure long-term competitiveness, the agri-food industry needs to work on developing new knowledge, improving production systems, and supporting innovation.
- It is argued that reductions in consumption and production of meat and dairy products - as suggested in the Nordic Nutritional Recommendations- raise concerns about how to preserve local traditions (such as whale hunting in the Faroe Islands) and employment in the agri-food sector. The political decision to support a shift towards plant-based diets should be assessed against the backdrop of the economic viability to change production and consumption patterns.
- All Nordic countries (except the Faroe Islands and Greenland) have a dedicated food education curriculum. Despite this, there is no standardized Nordic approach to topics included in food education. Improving the competence levels in food education may professionalize the subject and raise its status to a level like subjects such as mathematics.
- A report from the Nordic Council of Ministers underscores the need for a proactive governmental action encompassing taxes, subsidies, directives for public procurement, public awareness campaigns, educational initiatives, and labelling regulations as instrumental interventions (4). Fiscal instruments when combined with a regulatory framework that bans marketing of unhealthy and unethical food, can increase the availability of sustainable food. (5)
- The main values of Nordic local food are good quality, fresh ingredients, simplicity, and ethics. Despite recent progress, the visibility and distribution of local food is still inefficient

in many Nordic regions and often regarded as a “niche” market. Commercialization and visibility of small-scale food production should be promoted and awareness of the importance of regional food culture should be raised.

- Indigenous People are facing new challenges associated with climate change and environmental degradation, market economies, globalization, and nutrition transition. Nordic and Arctic indigenous communities, whose food systems are multifunctional and holistic, should be preserved.
- In the Nordic countries increased concentration of companies at the manufacturing and retail level has led to the escalation in bargaining power for these companies and lower profit margins for farmers. It is important to recognize power imbalances and policy instruments are required so to enhance equity, diversity, and inclusion.
- Better utilization of fish resources and minimization of food loss throughout the value chain in the aquaculture sectors, should be promoted (6) while also keeping into consideration the impact of Nordic companies expanding their operations in developing countries.
- The Nordic nations have not yet achieved a circular economy, and their current food production systems rely heavily on the import of feed and fertilisers. New knowledge and approaches are needed to strive towards circular, waste free food systems.
- A Nordic joint approach should also be put in place with regards to crisis preparedness and security of supply. Currently the Nordic countries have all adopted different coping strategies creating disturbances in people’s work and private lives, especially in cross-border regions.

The transformation of Nordic food systems needs tools and above all a coordinated roadmap. The 12 intervention areas presented here all interconnected. When addressed properly, they can offer help create cross-cutting and complementary solutions for an improved Nordic food system.

References

The White Paper on Nordic Sustainable Food Systems is available at: <https://nordicagriresearch.org/wp-content/uploads/2024/11/2-White-Paper-on-Nordic-Sustainable-Food-Systems.pdf>

Nordic food systems for improved health and sustainability (2019). Baseline assessment to inform transformation. Available from: https://www.stockholmresilience.org/download/18.8620dc61698d96b1901719b/1618468598083/7017%200054%20SRC_Report%20Nordic%20Food%20Systems_webb%20new%20June%202019.pdf

Nordic Council of Ministers (2020). The Nordic Region – towards being the most sustainable and integrated region in the world. Action Plan for 2021 to 2024. Nutrition guidelines follow the Danish lead and add climate to the menu.

Nordic Council of Ministers (2020). The Nordic Region – towards being the most sustainable and integrated region in the world. Action Plan for 2021 to 2024. Nutrition guidelines follow the Danish lead and add climate to the menu.

Meltzer, H. M., Eneroth, H., Erkkola, M., Trolle, E., Fantke, P., Helenius, J., Olesen, J. E., Saarinen, M., Maage, A., & Ydersbond, T. A. (2024). Challenges and opportunities when moving food production and consumption toward sustainable diets in the Nordics: a scoping review for Nordic Nutrition Recommendations 2023. *Food & Nutrition Research*, 68, Article 10489 Available from: <https://doi.org/10.29219/fnr.v68.1048>

Jungsberg, L., Berlina, A., Vestergård, L. O., Guðmundsdóttir, H., & Ueland, Ø. (2024). Policy tools for sustainable and healthy eating: Enabling a food transition in the Nordic countries. N. C. o. Ministers. Available from: <https://pub.norden.org/nord2024-007/about-this-publication.html>

Vittersø, G. and U. Kjærnes (2015). “Kjøttets politiske økonomi – usynliggjøring av et betydelig miljø- og klimaproblem.” *Sosiologi i dag* 45(1): 74-97

Strand, A.V., Mehta, S., Myhre, M.S., Ólafsdóttir, G., Saviolidis, N.M. (2024). Can higher resource utilization be achieved in demersal fish supply chains? Status and challenges from Iceland and Norway. *Resources, Environment and Sustainability*, 100157, Available from: <https://doi.org/10.1016/j.resenv.2024.100157>

12.10 Heiska S. et al. Participatory and iterative process for creating model food products supporting change towards sustainable food system

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Future of food production in Eastern Finland

The significance of boreal food production is expected to increase due to abundant water resources and a clean environment that support sustainable agriculture. As climate change progresses, boreal regions may become more favorable for farming, compensating for deteriorating conditions elsewhere. Finland, the world's northernmost agricultural country, relies heavily on grasses and northern cereal varieties in Eastern Finland, primarily for livestock feed. However, the agricultural structure is changing.

Livestock production faces economic challenges, particularly for small farms, which struggle with profitability. Many farmers are abandoning livestock due to investment needs and risks, compounded by an aging rural population and difficulty in finding successors. Nordic and national dietary recommendations are steering consumers towards plant-based diets, potentially freeing up significant land currently used for feed production for crops suitable for human consumption.

Despite the short growing season and long winters, studies suggest several nutritionally valuable and high-yield alternatives, such as oats, buckwheat, peas, and faba beans. Vegetables and berries like strawberries, blackcurrants, and raspberries are also suitable for Eastern Finland, supported by the region's water resources for irrigation.

In forested Eastern Finland, the importance of non-timber forest products, such as berries, mushrooms, wild herbs, and spruce tips, may grow. Future advancements in technology and semi-cultivation methods could facilitate easier harvesting.

Challenges of transition

At the food system level, structural changes are necessary for sustainability transitions and crisis preparedness. Land freed from livestock feed production should remain cultivated, with new profitable crops providing sufficient income for the rural population. Boreal production may also need to compensate for yields lost in southern regions due to increased drought and heat.

For individual farmers, the transition is immense, requiring labor-intensive cultivation of special crops and a shift in roles from independent workers to team leaders. New production directions necessitate mastering new methods and significant investments in machinery, processing facilities, cold storage, and warehouses. Predicting market demand for specialty crops is challenging, and farmers often need to market their produce themselves.

In Eastern Finland, there are only a few food processing companies, making it difficult or unprofitable to transport small batches of primary products to distant processing facilities. Investing in processing facilities is risky in areas without sufficient raw material production. The desired food system change requires cooperation and joint planning among farmers, processors, and buyers. A planned and controlled transition could strengthen regional processing capabilities.

Drivers for sustainability transitions can also be seen on the latter steps of the food production chain. Developing products that utilize new raw materials and appeal to consumers strengthens raw material

demand. Research on raw materials and sensory evaluations of innovative product prototypes can support food product development, reduce risks, and speed up the process from idea to market.

Case: Unique food model products from Eastern Finland

We aimed to co-create delicious and healthy food model products using pure and distinctive local ingredients. Our goal was to develop products that could accelerate the transition to a sustainable food system.

During the initial phase of our co-creation process, we held open workshops with food chain stakeholders to envision which raw materials could be sustainably produced in Eastern Finland. We utilized existing vision papers and monitoring data, such as Luke's food vision, agricultural statistics, and Nordic nutrition recommendations.

The following raw materials were selected for the next phase of co-creation to create ideas for product types that support a healthier lifestyle and a more sustainable future, as well as unique high-end products with high nutritional value and minimal environmental impact.

- Oats (*Avena sativa*): A versatile plant protein source, oats contain beta-glucan, a soluble fiber that helps manage cholesterol and stabilize blood sugar levels. Oats are well-suited to Eastern Finland's conditions and improve soil health by adding organic matter.
- Buckwheat (*Fagopyrum esculentum*): Rich in essential amino acids, vitamins B1 and B2, calcium, and magnesium, buckwheat has a long cultivation history in Eastern Finland. Its long flowering period benefits pollinators like bees.
- Mushrooms: Cultivated and wild mushrooms, such as shiitake (*Lentinula edodes*), chanterelle (*Cantharellus cibarius*), and porcini (*Boletus edulis*), are excellent sources of protein, fiber, and vitamins. Shiitake mushrooms enhance flavors with their umami and are grown in controlled environments. Wild mushrooms are rich in vitamin D and other nutrients.
- Berries: Eastern Finland is a significant berry-growing region. Berries, like cultivated black currant (*Ribes nigrum*) are high in fiber and vitamins, supporting the immune system. As an example of wild berries, bilberries (*Vaccinium myrtillus*) contain anthocyanins, which help regulate blood sugar and reduce inflammation. Lingonberry (*Vaccinium vitis-idaea*) flavonols act as antioxidants, preventing oxidative reactions in cells.
- Spruce Tips (*Picea abies*): A valuable source of vitamin C, spruce tips also contain minerals like potassium, phosphorus, magnesium, and zinc. Harvesting spruce tips can provide significant income and has export potential.
- Honey: With a long history of use, honey has antibacterial properties and contains flavonoids and phenolic acids. Beekeeping supports biodiversity and enhances crop yields through pollination.
- Nettle (*Urtica* spp.): Rich in iron, vitamin C, and other essential vitamins and minerals, nettle is a wild vegetable that thrives in Eastern Finland. It offers significant nutritional benefits compared to spinach.

Ideas for food product types were developed in an open workshop attended by experts from across the entire food chain. A diverse group also participated in evaluating the ideas, from which the best ones were selected for further development by Luke's experts. After an initial feasibility study, three product types were chosen for further development: snacks, noodle-type pasta, and liquorice-type candy.

Extrusion was selected as the processing technology. Luke's experts created several recipes, which were tested in Luke's FoodPilot test environment. Based on the pilot, the most interesting products were

produced in test batches for sensory evaluation. Sensory evaluations were conducted in Luke's Sensory evaluation research environment with trained evaluators.

Example: berry liquorice

Three different berry liquorice recipes containing bilberry, cloudberry or lingonberry, were tested. Buckwheat and oat were used in the recipes to replace wheat, that is typically used as an ingredient of liquorice. Honey was also included in all the recipes to partly substitute imported syrups. The flavor of liquorice was obtained from liquorice powder. In lingonberry liquorice, spruce tips were also included in the recipe, to get stronger taste by using domestic ingredients.

List of ingredients

- Lingonberry liquorice: honey, buckwheat flours, syrup of spruce tips, lingonberry juice concentrate and lingonberry powder, liquorice powder, salt, xanthan gum and guar gum.
- Bilberry liquorice: honey, buckwheat and oat flours, agave syrup, bilberry powder, bilberry juice concentrate, liquorice powder and salt.
- Cloudberry liquorice: honey, buckwheat and oat flours, cloudberry powder and agave syrup.
- Bilberry and lingonberry liquorices were extruded with a round nozzle, while cloudberry liquorice was extruded with a flat nozzle.

The sensory quality of all the liquorice types were analysed by a trained panel with 22 evaluators. Overall, the evaluators' ratings were positive. The texture of the cloudberry liquorice was rated slightly more pleasant compared to the others. The taste of the bilberry liquorice was rated slightly more pleasant compared to the others. 35% of the evaluators responded that they would consider purchasing bilberry liquorice as is, and 22% would consider purchasing, if small improvements were made. Only 5% of the evaluators responded that they would consider purchasing lingonberry liquorice as is, but 32% would consider purchasing, if small improvements were made. 15% of the evaluators responded that they would consider purchasing cloud berry liquorice as is, and 42% would consider purchasing, if small improvements were made.

Collaboration

In the next phase, the results of the sensory evaluation will be published, and the sample products will be offered to companies for further development.

Benefits of Co-Creation

- Companies can enter new markets faster
- Product development accelerates
- New partnerships are formed
- Companies gain insights into new processing methods
- Companies' understanding of research possibilities increases
- The transition towards a sustainable food system accelerates

The developed co-creation process involves a multidisciplinary group of stakeholders, ensuring that perspectives from various dimensions of sustainability are included in ideation, further development, and evaluation of ideas. The collective thinking process generates high-quality ideas and engages participants

more strongly in taking actions to achieve a common future. The result is product concepts that are not only delicious and enhance well-being but also drive change towards sustainability.

12.11 Helenius, J. & Koppelmäki, K. Agroecological symbioses for food system transformation

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Abstract

We propose re-localizing food processing to proximity of primary production, and simultaneously, re-arranging the production and processing for plant nutrient cycling. This transformative model we call agroecological symbiosis (AES). As nodes in a network, the AESs form a Network of AES (NAES). These NAESs form the production & processing foundation of distributed food systems over scales from local to global. NAES is, specifically, a model for food chain transformation. At the same time, it results in, invites to, and calls for, sustainability transformation at the food system level. In this conference abstract, we argue for the transformative potential of NAES to deliver to biophysical, social and economic sustainability goals.

Agroecological symbiosis (AES)

Citing our definition(1): “Agroecological symbiosis – AES – is a form of food production and processing in which farms, food processors, and energy producers function locally and integrated. The operations are running in such spatial proximity to each other that it allows efficient material and energy integration. In an AES, nitrogen as plant nutrient for the primary production is biologically fixed. The main source of energy is renewable, generated from the biomasses produced within the AES in a biorefinery, such as a biogas plant, belonging to the AES. In case of a biogas plant, the biorefinery has the dual purpose of providing the energy, and in the form of the digestate, producing the organic fertilizer and soil-conditioner for recycling plant nutrients back to the farmland. An AES sells agricultural or horticultural products, food products, and if produced in excess, bioenergy. The volume of the production, and the reach to the surrounding farmland within the AES are limited by the biophysical potential of the specific agroecosystems without compromising the other ecosystem services. The spatial extent of the biophysical operations is limited to sustainable logistic efficiency for the transport of the feedstock and the recycling fertilizers. The AES strengthens the local socio-economic connections and diversifies the regional food culture.” (1)

An AES is nitrogen-efficient through biological fixation, and harvests all or more of its energy internally. Within an AES, the bioenergy production cycle includes leguminous leys as the “solar panel”, utilizing the ley biomass - with other recyclable biomasses from within the system - as feed to anaerobic digestion for biomethane, and use of digestate as recycling fertilizer. This forms the subsystem of bioenergy production and nutrient cycling. The leys and the digestate as organic recycling fertilizer ensure maintenance of soil fertility and soil carbon stocks.

An AES includes one or more farms, along with food processors processing the primary products to food products. These all operate with the bioenergy produced by the AES. Both agricultural and the food processing operations are scaled to meet the condition of nutrient recycling. The major parameter setting the scale is logistics of recycling nutrients in form of digestate. This results in radical re-localization in comparison to centralized food industries in current linear food chains.

Network of AES (NAES)

Network of AES – NAES - is a food chain ecosystem of businesses that link the AESs contributing to it. The AESs in an NAES can have variable roles to meet the food, feed, energy and plant nutrient functions at the network level. Ideally, local NAESs form geographically and culturally local food basket, a community shared food system. Such system facilitates not only consuming locally, but participating in, and acting for local food, i.e. food citizenship.

NAES forms the basic structure for resilient, distributed regional and national food systems. The re-localizing results in increased added value to rural regions which gain from return of food processing industries, and from the associated positive multiplier effects to rural livelihoods. The distributed structure of NEAS brings food system resilience against environmental and socio-economic disturbances.

Geographical scales of AES and NAES

At level of an AES, the scale is mainly determined by sustainable distances for transporting biomasses. Optimal solutions vary depending on agroecological context. In the pilot case we studied(2), the scale was within a radius of 20 km. If the AES does not have livestock, the nitrogen fixing biomasses are harvested and transported to biogas plant for energy extraction, and as digestate, back to the agricultural fields most in need of the recycling fertilizer. Including livestock, especially ruminants such as dairy, sacrifices some of the energy output, but may be optimal for ecosystem services and for balancing for food and energy production(3).

The food processing plants in an AES equally need to be in proximity of the farms. There are social benefits also, but biophysically, proximity is needed for transporting the primary products from the farms to the processors, and for recycling leftovers to, and getting the energy from, the biogas plant for the AES.

Scales of an NAES can vary from local to global. The condition of recycling can be met by arranging the NAESs for nested circularities(4). In arranging the food system for circular economy, nested circularity serves as a model in which nutrient, biomass and energy cycles are connected and closed across multiple spatial scales. "Achieving circularity in food systems at a global scale requires that these food systems are also compatible with circularity at national, regional, and farm level. In other words, circular food production at the regional scale requires the integration of farm scale cycles, circularity at the national scale requires the integration of regional cycles, while circularity at the global scale requires the integration of national and continental cycles."(4)

NAES delivering for sustainability goals

Currently increasingly concentrated, centralized, and socially distancing structure of the food system has evolved hand-in-hand with urbanization. We question sustainability of the deruralization trend, which is resulting in urbanization and decline of not only rural communities but also rural towns. Urbanization is a phenomena of fossil era. We argue that the future sustainable spatial structure of societies is "hybrid", a mosaic of ecologically localized rural towns and their surrounding rural communities(5). NAES is a food system structure fitting to this vision. NAES can even be used as a driver for revitalizing rural livelihoods and hence, for incentivizing the needed rural – or hybrid - economic growth(6).

In contrast to the centralized structure, the distributed structure of food processing industry of NAES is resilient, more food secure. NAES produces a network in which the revenues within the food chain are more transparent to the value chain actors, which facilitates economic fairness. NAES is a platform for

community shared food system, in which inclusive and fair access to food and good nutrition, food sovereignty can be arranged in a participatory manner.

NAES contributes to improved local and national food self-sufficiency, including reduced dependency in critical inputs for production, and creates new local and regional food culture. In largely relying on bioenergy produced within NAES, it is more energy secure than the current system. NAES meets with the goals of circular economy, through reliance on recycling fertilizers. It is by far more climate efficient than the current system, and by design, maintains soil fertility and carbon stocks. Through rotational diversity including nitrogen fixing leguminous lays, NAES contributes to biodiversity in farmland, and to securing of the associated ecosystem services.

Acknowledgement: The concept of AES was first published by us (in Finnish) in a research report for the Ministry of Environment(7): we share the idea with the authors of this report.

References

- Helenius, J., S.E. Hagolani-Albov & K. Koppelmäki 2020. Co-creating Agroecological Symbioses (AES) for sustainable food system networks. *Frontiers in Sustainable Food Systems* 4:588715.
<https://doi.org/10.3389/fsufs.2020.588715>
- Koppelmäki, K., T. Parviainen, E. Virkkunen, E. Winqvist, R.P.O. Schulte & J. Helenius 2019. Ecological intensification by integrating biogas production into nutrient cycling: Modeling the case of Agroecological Symbiosis. *Agricultural Systems* 170: 39-48. <https://doi.org/10.1016/j.agsy.2018.12.007>
- Koppelmäki, K., M. Lamminen, J. Helenius & R.P.O. Schulte 2021. Smart integration of food and bioenergy production delivers on multiple ecosystem services. *Food and Energy Security* 10 (2) / e279 / p. 351-367.
<https://doi.org/10.1002/fes3.279>
- Koppelmäki, K., J. Helenius & R.P.O. Schulte 2021. Nested circularity in food systems: a Nordic case study on connecting biomass, nutrient and energy flows from field scale to continent. *Resources, Conservation & Recycling* 164, 105218. <https://doi.org/10.1016/j.resconrec.2020.105218>
- Hyyryläinen, T., J. Helenius, K. Schmidt-Thomé, A. Jumppanen & M. Rantanen 2021. Maaseudun ja kaupungin vuorovaikutus osana kestävyysmuutosta. *Maaseutututkimus* 29: 165-177. (Teemanumerossa: T. Hyyryläinen & K. Schmidt-Thomé, Maaseudun ja kaupungin elävä suhde. ISSN 2670-2347.)
<https://doi.org/10.51807/maaseutututkimus.112891>
- Koppelmäki, K., M. Hendriks, J. Helenius, S. Kujala & R.P.O. Schulte 2022. Food-Energy Integration in Primary Production and Food Processing Results in a More Equal Distribution of Economic Value Across Regional Food Systems: Nordic Case Study from Circular Perspective. *Circular Economy and Sustainability*.
<https://doi.org/10.1007/s43615-022-00233-2>
- Helenius, J., K. Koppelmäki & E. Virkkunen (toim.) 2017. Agroekologinen symbioosi ravinne- ja energiaomavaraissa ruoantuotannossa. Ympäristöministeriön raportteja 18/2017. 66 s. (ISBN 978-952-11-4716-6)
<http://urn.fi/URN:ISBN:978-952-11-4716-6>

12.12 Herzon, I. et al. Sustainable niche for farmed animals in food systems: from principles to quantification

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Introduction

The current and projected impacts of the livestock sector are among the key drivers of humanity overshooting of several planetary boundaries (Bowels et al., 2019). However, animal-derived foods are an important part of most dietary traditions and livelihoods (Blomhoff et al., 2012). The sheer impact of global livestock production, on the one hand, and its celebrated role in economies and food cultures, on the other, have brought it to the forefront of debates on the sustainability of food systems (Herzon et al., 2024). Transforming systems towards sustainability requires identifying and addressing the root causes of unsustainability, namely the underlying values, goals and worldviews guiding the system, and social structures and institutions that manage the system (Abson et al., 2017). Integrating norms and values with biogeophysical limits translated into quantitative sustainability targets in a social deliberation process, is a major methodological challenge. We attempt this by conceptualising the sustainable niche for livestock (SNL) and quantifying it for food systems in Finland. We use the frameworks of the doughnut economy and consumption corridors, which balance human well-being with ecological constraints (Kendall et al. 2024, Cué Rio et al. 2022) in the safe and just operating space for humanity. This space is bounded by a social floor (human needs) and an ecological ceiling, above which human activities to satisfy needs would undermine ecological sustainability and intergenerational equity. A relevant example, applied to livestock in the EU, is that of the RISE Foundation (Buckwell and Nadeu 2018).

Our approach

We conceptualise the SNL for a food system in Finland through three inquiries. First, we investigate which of the possible boundary conditions in the sustainable niche can be regarded as non-negotiable, thus defining its primary boundaries, and which are subject to negotiated socio-economic arrangements and production and consumption designs. Second, we examine the consistency of the existing paradigms guiding the livestock production and consumption in the country with the SNL. Third, we assess the extent of livestock production and consumption that is likely to fit the SNL.

Defining boundaries for SNL

Our initial list of eight principles, according to which livestock production and consumption in Finland could be considered sustainable, relate to sufficiency in the production of food for domestic consumption and trade, efficient use of resources, consistency with other objectives such as environmental targets and animal welfare standards (Huber 2000). Two principles are emphasised as primary: the nutritional sufficiency of animal products in diets (the nutritional floor) and the level of impacts beyond irreversible levels (the ecological ceiling) (e.g. Kendall et al. 2024, Cué Rio et al. 2022). These boundary conditions in the

SNL are non-negotiable insofar as they are ultimately determined by the physiological needs of the human body and biophysical processes over which humanity has limited control. If the number of animals (and the amount of animal food) in the system falls below the nutritional floor, or if production exceeds the ecological ceiling, other parameters must be negotiated and adjusted.

These conditions can be quantified: the former by the aggregate amounts of nutritionally adequate food, taking into account the different physiological needs of different populations (e.g. Blomhoff, et al., 2023), and the latter by indicators, such as greenhouse gas emissions, biodiversity loss due to land use conversion to food production and intensification, or water footprints (Gough et al., 2020), taking into account impacts externalised through trade (Wang et al., 2018).

Several other principles, such as irreplaceable livelihoods or animal welfare, set additional limits within the SNL above the nutritional floor or below the ecological ceiling. They also have levels, below which the actors (human and non-human species) cannot satisfy their basic needs as in the case of subsistence farming involving livestock or basic needs of animal individuals used as livestock. Setting boundaries above these minima is highly context-specific and negotiable. For example, to what extent can livestock production be considered an irreplaceable livelihood in a particular context? What standards of animal welfare above the basic needs can be considered sustainable? The stringency of the latter may preclude the use of certain animals (e.g. broiler chickens) or production methods. If this reduces production below the nutritional floor - i.e. a basic requirement for human health and nutrition - then this constraint needs to be renegotiated to increase production of livestock or alternatives. Similarly, if livestock provides a livelihood for those without alternatives, production could be maintained above the nutritional floor, but not above the ecological ceiling. Otherwise, transition to other livelihoods is needed. Cultural preferences in lifestyle, dietary choices or economic models are not basic needs that justify such renegotiation, and, according to modern moral philosophy (Nussbaum 2007), secondary less vital interests of humans cannot override basic needs of non-human animals, or indeed other humans.

The other principles relate to production designs where livestock makes resource use more sustainable compared to alternatives without livestock: the use of grasslands and side streams, nutrient cycling, maintenance of pastoral biodiversity (e.g. van Zanten et al., 2016; Sandström et al., 2022). However, none of these justifies livestock production beyond the nutritious floor. Although the added value of livestock is considerable in some cases, it is not an essential part of the system (e.g. Torpman and Rööß 2024). There are alternative agronomic, social or economic arrangements (to the use of grasslands or side streams, and other organic fertilizers), which ideally need to be implemented in the process of just transition (Tribaldos and Kortetmäki 2022).

The role of current paradigms in the SNL

Between the floor and the ceiling lies the negotiation space for systemic restructuring, including economic structures and markets, sociocultural values, institutions and policies, technology and know-how. Such negotiations are strongly influenced by the paradigms held by food system actors (Lonkila et al., forthcoming). According to our results, the dominant paradigms of efficiency, individualism, exceptionalism and animal eating currently guide the structure and the feedback loops (Lonkila et al., 2025). None of these are aligned with the primary goal of the food system which is to provide healthy food in sufficient quantities within a safe and equitable operating space, making the SNL difficult to achieve. Recognising the primacy of two non-negotiable boundary conditions would require a new sustainability paradigm(s).

Such paradigm(s) need to be co-created in a way that gives room for manoeuvre to all actors in food systems. Some promising results lie in the flexibility of socio-cultural meanings attached to different foods and adequate diets, and in people's ability and willingness to renegotiate the role of animal products in diets (Kurki et al. 2025). However, individuals should not bear the sole responsibility for this renegotiation.

Preliminary findings on the sustainability paradigm(s) highlight the need to move from individualism to community, and to recognise animal ethics and multi-species relationships. The efficacy paradigm needs to take full account of externalities and focus more on viable farming and producers' livelihoods, while not violating the SNL floor and ceiling. New boundary conditions need to be negotiated for socio-cultural meanings, livelihoods, the environment and animal ethics.

Further work and lessons learnt so far

Our next step is to quantify both the non-negotiable floor and ceiling and the other boundary conditions specifically for Finland. Based on quantifications for other countries, regions and the world, we expect that significant reductions in per capita animal food production and consumption will be required. The global nature of some SNL boundary conditions (e.g. climate) indicates that if the national resources allow domestic livestock production above the domestic nutritional floor (e.g. Lehtikoinen et al. 2019), the surplus must be exported to places with the unmet nutritional floor, but not converted into consumption above the nutritional floor because of other socio-economic objectives.

A key lesson from our SNL work is the importance of a normative basis for defining the ceiling and the floor, i.e. the goals for livestock use. This is the most important deep leverage point for a sustainable transition. It is also the most ignored. In societal discussions, it can stimulate new imaginations for alternative paradigms, diets and livestock systems (Brand et al., 2021; Mazac et al. forthcoming; Koppelmäki et al. 2025; Kortetmäki et al. 2025). Another deep leverage point is the confusion between negotiable and non-negotiable boundary conditions, which is also reflected in the seemingly non-negotiable character of current paradigms (Lonkila et al. 2025). Quantifying SNL is difficult because of many assumptions, but not impossible, as they are determined by empirically measurable physiological needs and biophysical processes. Other limits are culturally determined: how we view animal welfare, cultural meanings we attach to food, extent to which we imagine and provide alternative livelihoods for people dependent on livestock and working in the livestock industry. This means that they are flexible and can be renegotiated in different combinations.

Work on sustainability of livestock systems is mostly based on the current paradigms and designs aiming to improve the baseline. Co-developing a sustainability paradigm that adheres to the key boundary conditions of sustainable globally operating livestock system could move us towards strong sustainability with the destination in a safe and just operating space for humanity.

12.13 Isaksson, K. & Bregman Lodin, J. Farmers' attitudes and conditions for implementing the energy transition in Sweden

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Background

Sweden's agricultural sector is undergoing a critical energy transition as part of industry, national and EU-level commitments to reduce greenhouse gas emissions and achieve net-zero emissions by 2045 (Klimatpolitiska rådet 2024). Currently, agriculture contributes around 14% of Sweden's territorial greenhouse gas emissions, with a large share resulting from fossil fuel use (Naturvårdsverket 2024). This energy transition refers specifically to the shift away from these fossil fuels towards renewable energy sources (renewables) and energy-efficient technologies on farms through the adoption of e.g. biogas, solar panels, drop in fuels (e.g., HVO, RME), electrofuels, hydrogen devices, electric tractors as well as through improved energy efficiency. While strides have been made in switching to renewables in heating and drying, the sector still heavily relies on diesel for mechanized farm operations.

Farmers are at the frontline of this transition. However, despite their strategic role, limited research has been conducted to explore their views and capacities for change. The ambition of this study is therefore to focus on farmers' perspectives, specifically taking into account gender dynamics, policy environments, and economic realities. Such insights can contribute a better understanding of what currently drives or hinders the energy transition on Swedish farms.

Aim

The aim of this study is to provide a snapshot of the structural and individual conditions that influence farmers' attitudes toward the energy transition in Sweden. The study specifically explores:

- What farmers think about the energy transition;
- The challenges and opportunities they perceive in adopting fossil-free energy technologies;
- The role of gender norms and practices in shaping engagement with the energy transition.

Methods

The study draws on qualitative, semi-structured interviews with nine farmers operating dairy or beef farms in the regions of Västergötland and Småland in southern Sweden. The sample includes four women and five men, allowing for an exploration of gendered attitudes toward energy innovation and sustainability.

The interview guide focused on perceptions of the energy transition, technologies already adopted, motivations and constraints regarding energy investments, and broader attitudes toward policy and sustainability. Interviewees were selected through snowball sampling, with a balance of ages, experience levels and herd sizes. Five interviews were conducted on-site, while four were held by phone.

Data were analyzed thematically, using a mixed inductive-deductive approach. The theoretical framework combined attitude theory (Ajzen & Fishbein, 1975; Nilsson & Martinsson 2012), diffusion of innovations (Rogers, 2003), and gender and social norm theory (Hirdman, 2001), enabling a nuanced interpretation of the personal, social, and institutional factors influencing farmers' decisions. While any far

reaching generalizations cannot be made based on this study, it nevertheless provide an illustrative snapshot of the realities and experiences of a group of farmers in Southern Sweden.

Results

All farmers expressed a positive attitude toward the energy transition and a willingness to contribute to climate goals. However, they also emphasized the financial barriers and political uncertainties that restrict what they can realistically do. Farmers reported feeling that there is a will and a drive, but the means are lacking. Several respondents pointed to unrealistic political expectations and a mismatch between policy ambition and practical farm-level support.

Despite these limitations, many farmers have taken initial steps toward adopting renewables. Solar panels were the most common technology already adopted, with more than half of the respondents having installed such. A few had access to or used biogas systems, either via partnerships or on-farm plants. Some also experimented with HVO (hydrotreated vegetable oil) and RME (rapeseed methyl ester) as partial diesel replacements. In short, most farms remain heavily diesel-dependent, particularly for heavy-duty machinery.

While only providing a snapshot, these findings nevertheless reveals that partial transition is underway, while pointing to that significant technological, economic, and policy support is still needed for a full shift to fossil-free energy systems.

Interestingly, the study revealed important gendered patterns in how farmers engage with the energy transition. Traditional gender norms persist: men farmers were more likely to highlight interest in new technology, innovation, and machinery, while women farmers were more likely to emphasize environmental ethics, sustainability, and long-term thinking. However, the transition appears to offer a platform for convergence. Regardless of gender, all participants expressed a shared commitment to change, with the traditionally male-coded interests in new technology and the traditionally female-coded interests in caring for the environment and sustainability aligning in a common goal. The energy transition thus served as a meeting ground for different motivations, breaking down stereotypical gender divides between “tech” and “care.”

This convergence has practical implications, since policies and communications that combine technical appeal with sustainability messaging are more likely to engage a broad spectrum of farmers.

The greatest barrier reported by farmers was financial risk. The upfront costs of new energy systems, especially for small or medium-sized farms, were viewed as too high, even with subsidies. Farmers cited volatile energy markets, a lack of long-term price predictability, and short-term political instruments that make it hard to plan or secure financing.

Many also noted bureaucratic complexity and a lack of coherent communication from authorities. Conflicting messages about diesel tax, electric transitions, and subsidy eligibility contributed to a general sense of confusion and caution. Some expressed skepticism about whether the state really understands how farms work.

Farmers with greater financial flexibility or personal interest in sustainability were more likely to act despite these constraints. Others were waiting for clearer incentives, more stable policy, or better technical information before taking the next step. Perhaps these farmers could have been earlier and more assertive in their investments in the energy transition if it had not been for the fact that farming demands relatively large investments compared to the earnings, and that there is often only a single or a few persons behind the business.

Despite the challenges, farmers who had taken steps toward the energy transition reported a strong sense of pride and independence. Installing solar panels, using drop-in fuels, or investing in efficiency

improvements helped them reduce vulnerability to external shocks, including fuel price fluctuations and grid outages.

Farmers viewed energy self-sufficiency as a resilience strategy, not just an environmental choice. Several framed their actions in terms of preparedness and food security, especially in a time of global instability.

This sense of pride, combined with peer influence and technical interest, was a powerful driver for change, even when financial returns were modest.

Conclusion

This study persuasively shows that the interviewed farmers, both women and men, are motivated and willing to participate in the energy transition. They see it as a necessary and desirable shift, aligned with both personal values and societal goals. While gender norms influence motivations, the transition offers a shared platform for sustainability-minded change.

However, farmers' ability to act is constrained by economic pressures, policy volatility, and a lack of long-term planning support. But farmers are not starting from zero. Many have already implemented solar panels and are exploring various renewables. Given that financial constraints are the primary barrier, this highlights the need for long-term investment frameworks. Also clearer policy signals and streamlined support systems are essential to increase adoption.

To scale up the transition, the study recommends that future strategies should:

- Recognize farmers as entrepreneurs and sustainability stewards;
- Design policy tools that balance financial support with technical simplicity;
- Address gendered engagement through diverse and inclusive communication strategies;
- Emphasize resilience, self-sufficiency, and future-proof farming in the case for energy innovation.

To conclude, farmers are not merely passive recipients of policy – they are active agents of transformation. By understanding their perspectives and supporting their efforts, Sweden can foster a more resilient, prepared, fossil-free, and future-ready food system.

References

- Ajzen, I., & Fishbein, M. (1975). *Belief, attitude, intention and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley
- Hirdman, Y. (2001). *Genus– om det stabila föränderliga normer* (1 uppl.). Malmö: Liber
- Klimatpolitiska rådet. (2024). 2024 Klimatpolitiska rådets rapport. <https://www.klimatpolitiskaradet.se/wp-content/uploads/2024/05/klimatpolitiskaradetsrapport2024.pdf>
- Naturvårdsverket. (2024). Jordbruk, utsläpp av växthusgaser. <https://www.naturvardsverket.se/data-och-statistik/klimat/vaxthusgaser-utslapp-fran-jordbruk/>
- Nilsson, A., & Martinsson, J. (2012). *Attityder till miljöfrågor: utveckling, betydelse och förklaringar*. Studentlitteratur.
- Rogers, M. E. (2003). *Diffusion of Innovations*. 5: e uppl., Free Press.

12.14 Jacobsen, M. et al. Fostering unsustainability? An analysis of 4-year-olds' dietary impacts in Sweden

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Introduction

The global food system is a major driver of environmental degradation, accounting for approximately one-third of global greenhouse gas emissions and contributing substantially to biodiversity loss, water stress, and nutrient pollution. Agriculture alone uses 75% of the world's ice-free land, 70% of blue water, and causes 78% of freshwater pollution. In response, policies like the EU Farm to Fork Strategy and the Nordic Nutrition Recommendations call for healthier, more sustainable diets.

High animal-based food consumption in high-income countries, including Sweden, threatens planetary boundaries. Swedes consume on average 79kg of meat and 358kg of milk-equivalents per person annually, exceeding sustainable levels. While the environmental impacts of adult and adolescent diets have been studied in Sweden, little is known about the sustainability of young children's diets. Since early childhood habits tend to persist, this life stage is crucial for establishing sustainable eating. Additionally, WHO highlights the importance of Early Childhood Education and Care settings in shaping diets. This is particularly important in Sweden, since 86% of children aged one to five attend preschool, receiving free meals aligned with national guidelines, and 77 municipalities have climate targets for public meals.

This study assessed the environmental and social impacts of Swedish four-year-olds' diets using nationally representative data. Objectives included evaluating diet performance against planetary boundaries, differences by demographic factors and setting, and indicator correlations.

Materials and methods

Study population

The study included 746 children aged four years, whose parents or caretakers completed food diaries and food-frequency questionnaires as part of the Riksmaten Young Children survey (2021–24). Participants were randomly selected from a national register to ensure representativeness regarding sex, geographical distribution, and family size, though the sample had a slight overrepresentation of higher parental education and urban areas.

Dietary assessment

Dietary intake was recorded using the web-based RiksmatenFlexDiet tool over two non-consecutive days. Parents or caretakers reported all foods and beverages consumed, while preschool staff contributed data for meals eaten at preschool. The tool allowed for detailed mapping of food types, portion sizes, meal times, and consumption settings.

Each food item reported was linked to the SAFAD tool, and impacts were calculated per 1000 kcal to standardize the results. Planetary boundary benchmarks were determined using global population size and a reference energy intake of 1828kcal per person per day.

Sustainability Indicators

Dietary impacts in this study were assessed using the Sustainability Assessment of Foods And Diets (SAFAD) tool (www.safad.se), which includes eight environmental and two social indicators. The environmental indicators cover carbon footprint, calculated using the GWP100 method and accounting for emissions throughout the food chain from farm to fork; cropland use, expressed in m²*years, indicating the land area required for food production; and blue water use, which reflects the consumption of surface and groundwater for irrigation. New inputs of nitrogen and phosphorus, including fertilizers and biologically fixed or mined nutrients, are used as proxies for disruptions to biogeochemical cycles. Additional indicators include ammonia emissions, a key driver of eutrophication and air pollution, and pesticide use, which represents chemical pollution linked to crop production. Biodiversity loss is assessed based on the effects of land management practices on species extinction risks. The two social indicators focus on animal welfare, which captures issues such as disease prevalence and restrictive living conditions in livestock production, and antibiotic use, which reflects the risk of antimicrobial resistance development from livestock practices.

Results

Performance against planetary boundaries

The mean dietary impacts for the children studied fell within or exceeded the uncertainty zone for five out of six planetary boundary indicators, with only blue water use remaining within the 'safe space'. Strikingly, not a single child's diet was below the uncertainty thresholds for all indicators.

Socio-demographic and setting differences

The study identified notable differences in dietary environmental impacts across socio-demographic groups and consumption settings. Boys generally exhibited higher dietary impacts than girls for most indicators, both in absolute terms and when adjusted for energy intake; however, girls showed higher impacts in terms of animal welfare, regardless of adjustment. Children living in rural areas tended to have higher overall environmental impacts compared to those in urban and metropolitan settings. These differences were primarily driven by higher consumption of red meat and meat dishes in rural areas, whereas children in larger cities and metropolitan regions consumed more poultry and seafood, which contributed to elevated animal welfare impacts in those areas. Parental education also played a role: children whose parents had lower educational attainment showed higher dietary impacts, with a particularly notable 28% increase in animal welfare impact, largely attributed to higher poultry consumption. Additionally, higher ammonia emissions in this group were linked to greater intake of meat-based dishes. When comparing dietary impacts between dietary patterns at home and in preschool, the study found no substantial difference in carbon footprint, despite statistical significance. Lower meat consumption in preschool meals was offset by higher intake of dairy and seafood, resulting in similar overall environmental impacts between the two settings.

Correlations among indicators

The study found that several environmental impact indicators—such as carbon footprint, cropland use, nitrogen input, and ammonia emissions—were strongly correlated, indicating that dietary patterns contributing to one type of environmental pressure often exacerbate others. This suggests that interventions or policies aimed at reducing climate impact may simultaneously yield co-benefits in related domains like land use and nutrient pollution. However, indicators such as animal welfare, pesticide use,

blue water use, and biodiversity loss showed weaker correlations with climate impact, highlighting the need for targeted strategies that address these dimensions specifically.

Discussion

This study provides the first comprehensive assessment of the sustainability of young children's diets in Sweden, using a broad set of environmental and social indicators. The findings reveal that the current dietary patterns of four-year-olds frequently exceed planetary boundaries, even in a country with a well-developed public food system and policy focus on sustainability. The persistence of high animal product consumption, both at home and in preschools, underscores the challenge of achieving dietary shifts at a population level.

While socio-demographic patterns in dietary impacts were observed, our findings suggest that these factors alone are insufficient predictors or targets for effective interventions. Dietary choices in early childhood are shaped by complex interplays of cultural norms, family routines, and individual preferences, making them difficult to modify through narrowly targeted strategies. Instead, the results highlight the need for broader, systemic approaches that consider the embedded nature of eating habits within everyday life contexts.

Conclusions

This study shows that the diets of Swedish four-year-olds frequently exceed planetary boundaries across multiple environmental indicators, with no child's diet remaining within safe limits for all dimensions. Boys, children in rural areas, and those with lower parental education levels generally exhibited higher impacts. Notably, there was no meaningful difference in carbon footprint between dietary patterns at home and in preschools, as reductions in meat intake were offset by higher dairy consumption—highlighting the limitations of current institutional strategies. Focusing on a core set of five indicators—carbon footprint, animal welfare, blue water use, pesticide use, and biodiversity loss—offers a balanced and actionable basis for governance and policy development. This approach enables interventions that are both practical and comprehensive, while recognizing important trade-offs and synergies in the transition toward more sustainable diets. Our findings underline the urgent need for system-level strategies that not only promote health and sustainability but also avoid reinforcing unsustainable patterns early in life. If left unaddressed, current food environments—including those in preschools—may risk fostering unsustainability rather than mitigating it.

Implications for the Nordic-Baltic region

The lack of difference in carbon footprint between home and preschool meals is noteworthy, especially given the strong policy focus on reducing the climate impact of public food provision in the Nordic region. While meat consumption is generally lower in preschools, this reduction appears to be offset by increased intake of dairy—likely influenced by nutritional guidelines and cultural norms—and to some extent seafood. This suggests that current institutional strategies, though well-intentioned, may be insufficient unless they adopt a more holistic approach that considers the full environmental footprint of all food groups, not just red meat.

Additionally, the use of a broad set of sustainability indicators—including animal welfare and antibiotic use—highlights the importance of multi-dimensional assessments in food systems governance. Narrow climate-focused approaches may overlook critical trade-offs or mask co-benefits across other domains such as biodiversity and animal welfare.

The findings provide essential evidence for policymakers, educators, and public health professionals seeking to design effective interventions and governance frameworks for sustainable nutrition in early childhood. Efforts should prioritize reducing the consumption of high-impact foods and addressing structural disparities in dietary patterns, all while safeguarding nutritional adequacy and long-term health. Crucially, institutional food environments—especially preschools—must not only support healthy growth but also avoid unintentionally reinforcing unsustainable dietary habits. Without deliberate, system-level action, there is a real risk that early childhood food provision may be fostering unsustainability, rather than challenging it.

12.15 Jansik, C. Protein production, consumption and self sufficiency of food in Finland

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Plant protein products are expected to be one of the most important expanding product groups in the food sector in the coming years. A significant proportion of plant protein crops, ingredients and plant protein products are imported into Finland from abroad. Self-sufficient food production plays an important role in the society as a means of ensuring security of supply.

Protein balance sheets calculated for the first time

The production, consumption, foreign trade and self-sufficiency of protein in foodstuffs were calculated the first time in Finland by product groups. The raw protein volumes were calculated from physical volumes of the major agricultural products. Consumer products protein content was calculated and expressed in the main source of respective raw material.

According to the calculations, the total protein consumption of the Finnish population reached 244.7 thousand tons in 2023. Domestic protein production amounted to 195.5 thousand tons, resulting in a high, almost 80% self-sufficiency rate of food protein in 2023. The weighted combined value consists of a self-sufficiency rate of 72 percent for plant-based protein and 84 percent for animal-based protein. The self-sufficiency rate is calculated by relating domestic production to domestic consumption, which is calculated as production + imports – exports.

The detailed analyses consists of 14 product categories, of which six are plant-based (cereals, potato, pulses, seeds and nuts, fruit and vegetables and cocoa), and eight are animal-based groups (beef, pork, poultry, eggs, fish, milk, cheese, other dairy products).

Cereals dominate the plant-based protein in foodstuffs

A wide discrepancy was found in the self-sufficiency rates of protein in plant-based products from 0% of nuts and seeds to 80% of cereal-based protein and potato protein. Within plant-based foodstuffs, 72% of protein was consumed in the form of cereal-based products. Half of the production of cereal protein and almost two-thirds of its consumption comes from wheat. The most significant product group for wheat is bakery products, which are also imported to Finland in significant quantities, both fresh and frozen.

Oats are the second most important source of cereal protein. Over 30% of cereal protein production and almost 17% of consumption come from oats. Oat products are increasingly exported from Finland, especially as semi-processed ingredients made by the milling industry.

The second most important source of plant protein in Finland is potatoes. Fresh potatoes contain only about 2%, but due to production and consumption volumes of over 300 thousand tons, the amount of protein obtained from potatoes has been 6–8 thousand tons. Similarly, protein content is marginal in fruits and vegetables but thanks to high overall volumes, the protein consumed in them is almost the same as in potatoes. Self-sufficiency of fruit, berry and vegetable protein is nearly 50%, while it is naturally very low or almost none in nuts, seeds and cocoa products.

Legumes and oilseeds are the most potential raw materials for increasing Finnish plant protein production. Peas and beans as well as oilseeds can be the main raw materials for new plant protein product value chains. They have high, 20–30% protein content and relatively low starting level of food use. Currently, among domestic legumes, peas account for the majority of the protein production and

consumption while beans are mainly used as feed. According to industry estimates, only 3% of the broad bean harvest is used as food. Hemp, an oil plant with a currently small but rapidly increasing production volume was also included in this product group. Although its current share of plant protein production is now below one percent, its potential is manifold.

Overall, only 7,3 thousand tons of protein is consumed in the form of legume-, pulses- or oilseed-based foodstuffs, a volume as low as the level of potato or fruit and vegetable protein. Besides the low volumes self-sufficiency rate is also very modest, only 54%. The protein concentrates or isolates used in the Finnish plant-protein products are currently imported from abroad. Legumes and oilseeds, however, represent the highest potential both to increase plant-based protein consumption and production. As most of these plants can be produced domestically, there is a realistic potential to improve their self-sufficiency at the same time with increasing volumes.

Animal-based food is the backbone of Finnish protein production and consumption

Animal-based food protein self-sufficiency rates were high ranging between 50-120%. Almost 43% of animal protein consumption comes from meat and 41% from milk and dairy products. In production, the distribution is more uneven: 49% of animal protein was produced in the meat sector and only about 38% in the dairy sector. This is explained by the high degree of self-sufficiency in meat, and correspondingly the low self-sufficiency of cheese.

In 2023, just under 16 million kg of fish protein was consumed, which was about 10% of the total consumption of animal protein. The self-sufficiency rate of fish is the lowest among animal products, at only 48%. The reason is the two-decade long shift in fish consumption to cultivated fish, which has been mainly covered by salmon imports from Norway. There is a strong commitment to increase domestic production of fish primarily by open water fish cultivation.

In 2023, just over 8 million kg of protein from eggs was consumed, which is 5% of all animal protein consumed. The self-sufficiency rate of the egg sector has been over 100% ever since Finland joined the EU and has fluctuated between 110 and 120% over the past two decades.

Plant-based protein has high growth potential by 2040

Plant-based protein production and consumption is currently at a rather low level and there is a high growth potential in both. In 2023 Finland's total plant protein production was 67 thousand tons. In 2040, up to 182 thousand tons of plant protein suitable for food production could be obtained from Finnish fields for the main protein crops, legumes and oilseeds. Taking all crops into account, the potential for overall plant protein production could rise to 228 thousand tons. This would allow an increase in the proportion of plant protein production within total protein consumption from the current 29 % to as high as 98 %.

A significant increase in plant protein production will require the cultivation of legumes and oilseeds to the maximum extent allowed by the crop rotation, thus tripling the cultivation area of these crops. The essential requirements are economic profitability, improved crop reliability, plant breeding, good farming practices and the use of current and emerging technologies.

Food industry will need to invest heavily in the processing of pulse-based protein concentrates. Furthermore, companies need to find innovative ways of utilisation of side streams generated during the process. Significant RDI efforts are also needed to bring new types of plant protein products to the market. The expansion of the sector also requires start-ups, which, with new ideas and innovations, will create the basis for growth. Increasing exports of plant protein products is a necessary requirement to ensure the profitability of the value chain and to reach critical mass.

The leap in plant-protein crop production would result in favourable implications

Plant protein production needs to be complemented by domestic livestock production and new production technologies. Only about half of Finland's protein crop meets the quality requirements of the food industry and no significant change in this share is expected. There must be a demand for non-food production, which will most naturally come from feed use in livestock production. Therefore, an increase in the production of plant protein crops would also significantly increase the domestic supply of protein feed supplement for livestock production. At present, the self-sufficiency of supplementary protein feed is as low as 27% and as a critical input in the food supply chain, its increase is a priority objective.

The growth of protein crop production is expected to have a positive impact on the profitability and growing conditions of crop farms in many ways. Shifting the focus of the agricultural sector to pulses and oilseeds would reduce the oversupply of grain and lead to an improved market situation for the farmers' point of view. Expanding the portfolio would reduce dependence on individual crops and diversify the price and market risks faced by crop farms. A more diverse crop rotation would bring economic benefits in the form of reducing plant diseases and higher yields. Increasing protein crops would also enable the versatile application of cultivation techniques, improve soil fertility and increase biodiversity.

Increased production of protein crops could, at best, increase food protein self-sufficiency to over 100%. Improving food security is considered essential in the geopolitical and security situation that has changed in recent years.

12.16 Järvinen, S. & Lindblom, T. The role of dairy and dairy alternatives in food preparation practice

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Dairy has a culturally and economically quintessential role in European countries while significantly contributing to GHG emissions. However, flexitarian dairy consumers are scarcely researched, especially in Finland, one of the world's most dairy-intensive countries (Autio et al., 2023). There is a rising need for comprehensive research on dairy consumption and the role of dairy in everyday life food consumption practices.

Many mundane food consumption patterns are widely considered fundamentally unsustainable, contributing significantly to the climate change challenges (Shove, 2010). Despite the awareness of food and sustainability, eating habits in Western countries have not drastically changed to be more environmentally friendly. Research on sustainable food consumption shows a remarkable gap between caring for the environment and changing one's consumption patterns accordingly toward more sustainable behaviour. (Connolly & Prothero, 2008; Halkier, 1999, 2001; Macnaghten, 2003) Hence, more research that addresses the materiality of food consumption rather than focuses on the meanings and aspirations of individuals is greatly needed.

This study aims to provide information about stability and change in dairy consumption by focusing on the fundamental factors that affect daily food consumption practices. Using a social practice theoretical approach, we study the role of dairy and dairy alternatives in food preparation practice of Finns in the North Ostrobothnia countryside, the location of most Finnish dairy farms. This study is a part of the SmartDairy project that assesses challenges, explores innovations and creates novel solutions to achieve a more sustainable dairy system in Europe. Contributing to the project's objective of analysing the current and potential future position of dairy and alternative products in Finnish food culture, we tackle the multisided and controversial topic of sustainable dairy consumption from the viewpoint of everyday life food preparation. Ultimately, the aim is to study the underlying factors in food preparation and provide signposts for policymakers, food producers, and future food consumption research. The study also provides valuable information about food consumption practices of millennials inhabiting the countryside of North Ostrobothnia and raising the next generation of Finns.

Food preparation practice and its performances can be defined as routine-like behaviour that consists of several interconnected elements: bodily and mental activities (competences), things and their use (materials), and background knowledge such as understanding, know-how and emotions (meanings) (Schatzki, 1996; 2002; Reckwitz, 2002; Shove, Pantzar & Watson, 2012). For example, when preparing breakfast, one engages in various physical and mental activities and uses different ingredients and kitchen tools in a specific locale. All these doings and sayings require an individual practitioner to have a certain amount of understanding and know-how to carry them out while also being affected by one's emotions and motivational engagements.

The study objective is divided into two research questions: a) what kinds of competences, materials and meanings support the use of dairy in people's daily food preparation practice, and b) what kinds of competences, materials and meanings promote a change in food preparation practice regarding the use of dairy alternatives. The data consisted of semi-structured interviews (n=11) gathered through discretionary chain-referral sampling. The inclusion criteria for the study participants were to be born between 1980 and 1996, live in the countryside of North Ostrobothnia and consume dairy products regularly. The transcribed data was analysed by structuring and coding it into themes formed by elements of competences, materials, and meanings and their interconnections.

The results show that dairy has a significant role in routinised food preparation practice. Interviewees engaged in familiarity and ease when using dairy products in food preparation, leaning on routinised food preparation methods, embedded know-how and embodied skills. They had a vast amount of knowledge and skills on using dairy products to achieve fulfilling and tasty meals approved by others around the same table. Interviewees were accustomed to using ingredients they often used alongside dairy, which led to the entrenchment of dairy products. Also, regularly used recipes that included some type of dairy product. The taste and texture of dairy were highly valued, having a strong cultural meaning: foods containing dairy were considered as 'proper' food; non-processed, natural, nutritious, high quality and tasty. Interviewees preferred domestically produced dairy products and found meaning in supporting local dairy farmers.

Dairy alternative use was associated with meanings such as sustainable and ethical issues, health-related concerns, pure curiosity, and taste. In food preparation, dairy alternatives were used in a similar manner to dairy products, which made them facile to use as new skills or know-how were not needed. In contrast, a lack of proven recipes and competences to prepare food from dairy alternatives also prevented interviewees from using them. Interviewees did not want to compromise the taste of everyday meals, and dairy alternatives were only used if they did not affect the taste or texture of the food.

The results indicate that the use of dairy has a habitual and cultural aspect grounded in food preparation practice and its performances as the practitioners are products of their environment and history. These familiar and routinised food preparation methods that include dairy can be seen as collective structures of knowledge that shape human action and understanding of the world as they are passed to the next generation. The countryside of North Ostrobothnia provides a social environment that supports the use of dairy products. Especially interviewees who had previously lived abroad and in bigger cities described how living in the countryside made consuming dairy products easier, as everybody else found it normal, and people were generally less judgmental about animal-based diets. At times, the social environment pushed the interviewees to consume dairy alternatives; for instance, when they had guests who did not consume dairy.

We argue that difficulties in reducing dairy consumption lie in the fact that people are required not only to change their routinised ways of purchasing, cooking, eating and socialising around food, but also the social norms of what is considered 'proper' or 'good taste' need to be challenged. Hence, the shift toward sustainable food culture concerning dairy consumption requires collectively challenging dairy-based diets and their position in current eating practices.

Attributes of culturally acceptable foods can change when the socially constructed requirements for good taste fluctuate, which can eventually lead to a change in eating practices on a larger scale. This study shows that oat drinks and plant-based sweet treats such as ice cream were accepted and even preferred over milk and other dairy products. Good taste was usually assessed in the product's capability of mimicking its dairy counterpart. Interviewees' broad acceptance of oat-based products is likely due to oat having a significant role in traditional Finnish cuisine and food culture, which makes them more readily accepted culturally.

Competences and materials, such as new recipes were required to prepare novel dishes and dishes with unknown ingredients. Findings show that open-mindedness is often not enough to change a practice: transforming performances in food preparation practice requires tremendous time and effort from the practitioners. Also, food preparation practice was intertwined with other food consumption practices, such as eating, grocery shopping, and avoiding food waste, which could be concentrated on in future research. Further research could concentrate on food consumption practices that affect the material elements of food preparation, such as attainable recipes or the availability of dairy alternatives at home. More research on how the social environment helps or hinders the use of dairy and dairy alternative products is also needed.

This study provides perceptions to the academic discussion about dairy use, sustainability and climate change that could also help in future policymaking. It offers insights into the use of dairy and dairy alternatives in food preparation that could be useful to the dairy and dairy alternative industry. A more comprehensive cultural change in food consumption practices is required to shift from dairy to plant-based alternatives.

References

- Autio, M., Sekki, S., Autio, J., Peltonen, K., & Niva, M. (2023). Towards de-dairification of the diet?—Consumers downshifting milk, yet justifying their dairy pleasures. *Frontiers in Sustainability*, 4.
- Connolly, J., & Prothero, A. (2008). Green consumption: life-politics, risk and contradictions. *Journal of Consumer Culture*, 8(1), 117-145.
- Halkier, B. (1999). Consequences of the politicization of consumption: the example of environmentally friendly consumption practices. *Journal of Environmental Policy and Planning*, 1, 25-41.
- Halkier, B. (2001). Consuming ambivalences: consumer handling of environmentally related risks in food. *Journal of Consumer Culture*, 1(2), 205-224.
- Macnaghten, P. (2003). Embodying the environment in everyday life practices. *The Sociological Review*, 51(1), 63-84.
- Reckwitz, A. (2002). Toward a theory of social practices: A development in culturalist theorizing. *European Journal of Social Theory*, 5, 243-263.
- Schatzki, T. (1996). *Social Practices: A Wittgensteinian Approach to Human Activity and the Social*. Cambridge: Cambridge University Press.
- Schatzki, T. (2002). *The Site of the Social: A philosophical account of the constitution of social life and change*. Pennsylvania: Pennsylvania State University Press.
- Shove, E. (2010). Social theory and climate change. *Theory, Culture & Society*, 27(2-3), 277-288.
- Shove, E., Pantzar, M., & Watson, M. (2012). *The dynamics of social practice: Everyday life and how it changes*. Los Angeles: SAGE.

12.17 Karlsson, A. & Bergman Lodin, J. The potential of farm-based biogas production in Sweden: farmer perspectives and experiences

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Background

The Swedish agricultural sector has a critical role to play in the green transition, yet remains heavily dependent on fossil fuels for machinery, heating, and transport. Farm-based biogas production offers a promising avenue for decarbonizing agriculture and enhancing energy security in line with EU, national and industry climate policies and targets. By converting manure and crop residues into biogas and digestate, farms can simultaneously produce renewable energy and nutrient-rich biofertilizer. This circular approach addresses a number of critical sustainability goals, such as reducing greenhouse gas emissions, improving nutrient management, as well as contributing to energy resilience on both farm and system level. However, despite state support schemes like Biogasstödet, Klimatklivet and tax exemptions, the adoption and expansion of biogas technologies in Sweden remain (s)low, leaving much of the sector's biogas potential untapped.

Understanding farmer perspectives is crucial to addressing this gap. Farmers operate under unique environmental, economic, and social conditions. Their lived experiences and attitudes shape the uptake and scalability of novel technologies like biogas. This study centers on the voices of farmers who have already invested in biogas systems, with the aim of informing future support strategies and biogas development.

Aim

The aim of this study is to investigate the attitudes of Swedish farmers who have established on-farm biogas facilities and to explore the opportunities and challenges they have faced throughout their biogas journey. The study also examines the role of interest in new technology and innovation in the decision-making process, as well as the structural and policy-related factors that influence the viability of biogas production on Swedish farms.

Through these lenses, the study contributes to a deeper understanding of the enabling and constraining conditions for biogas adoption and the potential of farm-based biogas as part of Sweden's green transition.

Methods

The study is based on qualitative, semi-structured interviews with nine farmers from southern Sweden who have built and operate on-farm biogas plants. All respondents use manure as the main substrate, and some supplement with other digestible materials like abattoir waste or food residues. The interviewees represent a range of production types (dairy and pig farms) and plant sizes, with varying levels of biogas sales and on-farm energy use.

Recruitment followed a snowball sampling method, beginning with farmers participating in study visits organized by the Swedish Board of Agriculture and expanding through industry contacts. The interviews were conducted primarily by phone following field visits to four biogas facilities. These initial observations enriched the understanding of plant design, operational routines, and context-specific challenges.

The interview data were analyzed thematically, guided by two theoretical frameworks: Attitude Theory, which examines how feelings, beliefs and values shape behavior (Angelöw, et al., 2015); and Diffusion of Innovation (Rogers, 2003), which explores how new technologies spread among adopters. Both frameworks helped contextualize farmers' experiences in relation to broader socio-technical dynamics and policy contexts.

Results

All nine farmers expressed a generally positive attitude toward biogas, emphasizing its benefits for energy self-sufficiency, cost control, and environmental performance. Several highlighted how biogas allowed them to reduce dependency on the electricity grid and fossil diesel, especially during energy price surges.

In addition to generating electricity and heat, all farmers praised the biofertilizer (digestate) produced through the biogas process. Compared to untreated manure, digestate was perceived as more manageable and contributing to nutrient recycling and odor reduction, particularly in residential areas. Yet, digestate is often undervalued in policy discussions.

Many described a strong sense of pride in producing both clean energy and sustainable fertilizers, and in contributing tangibly to climate and circularity goals. However, enthusiasm was tempered by the practical and economic realities of operating a biogas plant. Farmers described biogas as rewarding and climate smart, but technically and administratively demanding. Key challenges identified were:

- High investment costs, even with public support schemes.
- Complex regulations and permitting processes.
- Unpredictable policy environments, with short-termism in biogas support instruments and contradictory signals (e.g. reduced diesel taxes, the removal and re-approval of biogas tax exemption).
- Market uncertainty, especially due to price volatility and competitiveness of biogas relative to diesel.
- Maintenance burdens, especially for those lacking in-house technical expertise.

Some farmers reported operational issues early on that nearly caused them to abandon their projects. However, those with strong technical skills or social support networks were better able to troubleshoot and maintain continuous operation, which is critical since any interruptions in biogas production results in direct financial losses.

Interest in technology and innovation also played a major role in shaping decisions to invest. Several respondents can be seen as venturesome “early adopters” and “tinkerers”, expressing a natural curiosity toward new systems and a desire to improve farm sustainability. At the same time, farmers routinely handle technical, mechanical and troubleshooting tasks in their everyday work, which may explain why they did not believe it requires any specialized expertise to manage the demands of a biogas facility and did not find it particularly intimidating, although some of them highlighted the maintenance costs as a cause of concern.

The study also found that hands-on experience and peer-to-peer learning were vital in shaping perceptions of feasibility. Most farmers stressed the importance of seeing real-life examples and talking directly to other farmers before making investment decisions.

Discussion

Despite its technical feasibility and environmental benefits, the widespread adoption of farm-based biogas in Sweden remains constrained by a set of persistent systemic barriers. Profitability is often marginal,

particularly for small- and medium-sized plants reliant on manure as the primary substrate. Without targeted financial support schemes, many such operations would be economically unviable. Regulatory complexity and policy inconsistency further undermine confidence in the sector, as frequent changes to rules and administrative burdens create a high threshold for new entrants. In addition, limited access to gas infrastructure, especially in rural areas, hampers the potential for upgrading biogas for vehicle fuel or grid injection, reducing revenue opportunities. Underpinning these challenges is a perceived lack of long-term political commitment, which fosters uncertainty around reinvestment and scale-up. Overcoming these barriers will require coherent and durable policy frameworks, streamlined and simplified application processes, and improved cross-sectoral coordination to support the long-term viability and expansion of biogas in Sweden's agri-food system.

Conclusion

This study highlights the potential of farm-based biogas to contribute meaningfully to Sweden's green transition. From the perspective of farmers already operating biogas systems, the technology offers substantial environmental, economic, and energy-related benefits. Biogas strengthens farm resilience and preparedness, fosters circular nutrient use, and reduces dependency on fossil inputs, all of which are key elements in achieving sustainable and secure food systems.

However, realizing this potential at scale requires more than technical feasibility. Farmer experiences show that policy stability, financial support, and infrastructure development are essential enablers. The study underscores:

- I. Farmers are willing and capable partners in the green transition – but their involvement hinges on clear, long-term signals and practical support.
- II. Innovation is social as much as technical. Peer networks, experiential learning, and locally adapted information will likely shape farmer engagement with biogas.
- III. Trust and recognition matter. Many farmers expressed feeling unseen or deprioritized by policymakers, which may undermine not only trust in institutions but also confidence in the political commitment to support agriculture through the energy transition.
- IV. Policy must evolve from reactive subsidies to proactive systems planning, integrating biogas within broader strategies for rural development, energy security, and food system resilience.
- V. Biogas contributes to resilience and preparedness. In an era of increasing geopolitical instability, climatic events, and energy market volatility, farm-based biogas holds strategic value by enhancing energy autonomy at the farm level and strengthening national preparedness through decentralized, renewable energy production.

In conclusion, biogas is not just a novel technology – it is a strategic enabler of sustainability and preparedness across multiple sectors. Hence the values generated by biogas goes beyond the individual farm. By listening to farmers and learning from their experiences, Sweden can unlock the full potential of farm-based biogas in the national renewable energy mix and position itself as a leader in the transition towards fossil-free agri-food systems.

References

- Angelöw, B., Jonsson, T. & Stier, J. (2015). *Introduktion till socialpsykologi*. 3 uppl., Studentlitteratur.
- Rogers, E. (2003). *Diffusion of Innovation*. 5 uppl., Simon & Schuster International.

12.18 Karlsson, J. et al. Scenarios for long term conservation of Swedish semi-natural grasslands with limited climate impact

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Background aims

Grazing semi-natural grasslands is a key biodiversity conservation strategy in many temperate regions, including the Nordic-Baltic area (Shipley et al., 2024). In Sweden, most semi-natural grasslands have been lost since the early 20th century, and currently only 0.40 million hectares (Mha) are managed with agri-environmental support. Achieving a favourable conservation status for grassland habitats requires both an increase in their area and ecological quality (Swedish EPA, 2020), which in turn demands more livestock for grazing. However, agriculture is also expected to contribute to climate change mitigation, notably by reducing enteric methane emissions through lower ruminant numbers. This study explores scenarios for expanding the area of grazed semi-natural grasslands in Sweden while limiting climate impacts.

Methods

We modelled the maximum potential for grazing on semi-natural grasslands under enteric methane emissions capped at 70%, 100%, or 110% of current levels. The spatially disaggregated mass-flow model CIBUSmod (Karlsson et al., n.d.) was used. This model meets an exogenous demand for agricultural products by distributing crop and livestock production across 106 Swedish regions and calculates land use, energy consumption, nutrient (NPK) flows and fertiliser requirements, and greenhouse gas emissions from agriculture, including supply chain emissions from fertilisers and energy use. The model includes a baseline calibrated against national statistics and greenhouse gas inventories for the years 2016-2020.

Agronomic feasibility is ensured in the model by incorporating several constraints, including limits on land expansion, region-specific suitability for crops, regional availability of roughage feeds, and a maximum inclusion of certain crops in rotations.

In the model, demand for grazing and other feeds is calculated based on animal numbers and their energy requirements along with animal-category-specific feed rations. Grazing demand can be met either through grazing on arable land (i.e. ley pastures) or in semi-natural grasslands. As technical and biological constraints limit the share of grazing that can be obtained from semi-natural grasslands in different production systems, the model impose animal-category-specific constraints on this. Feed rations and the maximum share of grazing in semi-natural grasslands were based on previous studies of representative animal production systems in Sweden (e.g. Ahlgren et al. 2024).

The number and regional distribution of cattle and sheep were optimised to maximise biomass intake from semi-natural grasslands while remaining within the methane emission caps. This was done across several scenarios involving different interventions in animal production systems, aimed at increasing the area of grazed semi-natural grasslands:

- 1) No changes in animal production systems (MaxCur)
- 2) Raising all male calves as steers instead of intact bulls (Steers)
- 3) Keeping all dairy cows culled during the grazing season on pasture until slaughter in autumn (CulCows)

- 4) Extending the dry period for dairy cows to increase grazing time (DryCows)
- 5) Raising all lambs as 'winter lambs' (WinLamb)
- 6) Maximising grazing on semi-natural grasslands by the current horse population (RecHorses)

All scenarios were constrained to prevent any increase in cropland use in any region. The maximum area of semi-natural grassland per region was based on a dataset of potential pastures derived from historical land use maps (Swedish EPA, 2019). Baseline figures for semi-natural grassland area were drawn from national statistics, corrected for grasslands that are managed but not captured in agricultural statistics (Glimskär et al., 2023). Regional biomass productivity in semi-natural grasslands was estimated using the limited field measurements that have been conducted in Swedish semi-natural grasslands (Spörndly & Glimskär, 2018) along with remote sensing data on soil moisture and tree cover.

Results

After correcting for grasslands not represented in agricultural statistics, the baseline area of semi-natural grasslands was estimated at 0.52 Mha, with an average gross biomass productivity of 2.4 tonnes dry matter per hectare.

Under the strictest methane emissions cap (70% of current levels), it was still possible to graze up to 0.71 Mha of semi-natural grassland—a 36% increase from the baseline—when all interventions were applied. Without the interventions in animal production systems ('MaxCur') it was not possible to graze all currently managed semi-natural grasslands under this methane emissions cap, with a maximum of 0.48 Mha, representing a 7% reduction from the baseline.

Allowing a 10% increase in methane emissions enabled grazing on up to 1.1 Mha—effectively doubling the current area—when all interventions were combined. Even when emissions were capped at current levels and no changes were made to production systems ('MaxCur'), the area of semi-natural grasslands could still increase to 0.73 Mha, a 39% rise. This increase resulted from prioritising semi-natural grasslands over ley pastures for grazing, with livestock numbers and total grazing demand remaining close to baseline levels.

Among individual interventions, 'Steers' had the greatest potential to increase semi-natural grassland grazing, followed by 'RecHorses' and 'WinLamb'. Interventions focused on dairy cows ('DryCows' and 'CulCows') had relatively smaller effects. However, all interventions contributed to the overall effect when combined.

Comparing the climate impact per unit of protein produced (kg CO₂eq/kg protein) with the climate impact per unit area of grazed semi-natural grassland (kg CO₂eq/m²) across the scenarios revealed a negative correlation. In other words, scenarios with lower emissions per unit protein tended to have higher emissions per hectare of semi-natural grassland grazed, and vice versa.

Conclusions

This is the first study to explore scenarios of increased grazing in Swedish semi-natural grasslands using a spatially disaggregated agri-food systems modelling framework that considers regional land availability constraints, as well as other technical and agronomic limitations, while estimating agricultural greenhouse gas emissions.

Our results demonstrate that it is technically feasible to expand the area of grazed semi-natural grasslands in Sweden while reducing methane emissions and overall climate impacts—provided that production-side interventions supporting grazing are implemented and that semi-natural grasslands are

prioritised over ley pastures. However, achieving this will require improved economic and policy incentives for grassland-based production.

The comparison between climate impact per unit of food produced and per hectare of grazed grassland highlights a fundamental trade-off. Systems optimised for low climate impact per unit food produced may not be best suited to maintain semi-natural grasslands and their associated biodiversity. This suggests that climate-based incentive structures may unintentionally favour production systems that are less conducive to biodiversity conservation at low climate cost.

References

- Ahlgren, S., Wirsenius, S., Toräng, P., Carlsson, A., Seeman, A., Behaderovic, D., Kvarnbäck, O., Parvin, N. & Hessle, A. (2024). Climate and biodiversity impact of beef and lamb production – A case study in Sweden. *Agricultural Systems*, 219, 104047. <https://doi.org/10.1016/j.agsy.2024.104047>
- Glimskär, A., Hultgren, J., Hiron, M., Westin, R., Bokkers, E. A. M., & Keeling, L. J. (2023). Sustainable Grazing by Cattle and Sheep for Semi-Natural Grasslands in Sweden. *Agronomy*, 13(10), 2469. <https://doi.org/10.3390/agronomy13102469>
- Karlsson, J.O., Karlsson-Potter, H., Lagnelöv, O., Ericsson, N., Einarsson, R., Hansson, P-A (n.d.) CIBUSmod: A spatially disaggregated biophysical agri-food systems model for studying national-level demand- and production-side intervention scenarios. Unpublished manuscript
- Shipley, J.R., Frei, E.R., Bergamini, A., Boch, S., Schulz, T., Ginzler, C., Barandun, M., Bebi, P., Bolliger, J., Bollmann, K., Delpouve, N., Gossner, M.M., Graham, C., Krumm, F., Marty, M., Pichon, N., Rigling, A. & Rixen, C. (2024). Agricultural practices and biodiversity: Conservation policies for semi-natural grasslands in Europe. *Current Biology*, 34(16), R753-R761. <https://doi.org/10.1016/j.cub.2024.06.062>
- Spörndly, E. & Glimskär, A. (2018). Betesdjur och betestryck i naturbetesmarker. (Rapport 297). Uppsala: Sveriges lantbruksuniversitet. <https://pub.epsilon.slu.se/15649/>
- Swedish EPA. (2019). Mer naturbetesmarker och ekonomiskt bärkraftiga företag - Ett samverkansprojekt inom miljömålsrådets gemensamma åtgärdslista 2019.
- Swedish EPA. (2020). Sveriges arter och naturtyper i EU:s art- och habitatdirektiv - Resultat från rapportering 2019 till EU av bevarandestatus 2013-2018.

12.19 Krzywoszynska, A. & Kallio, G. In the shadow of carbon: the intersecting knowledge politics of carbon farming and regenerative agriculture

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A dramatic shift is underway in agriculture, where carbon, not just food, is becoming a key product of agricultural lands. Influential policy movements, such as the French-government backed “4 per 1000” initiative and the Horizon Europe mission “Soil Deal for Europe” assert that increasing the concentration of carbon in soils will significantly contribute to mitigating climate change (Vermeulen et al., 2019). These hopes driving policymakers, market actors, and scientists alike to advance knowledge practices and technologies which would make this project a reality through “carbon farming”. Thus, advancing carbon sequestration through agriculture is fast becoming an objective at the highest level of global, European, and Finnish governance strategies, including in the Soil Health Monitoring Law, due to be adopted by the European Commission within 2023. The push for carbon farming is also coming from other areas of industry: companies from various sectors are keen to buy soil-based carbon credits to meet their Net Zero targets, which is increasingly a requirement for trading under different certification schemes (Kaskeala, 2023).

In these framings, carbon farming is being positioned as naturally harmonious with a prosperous and environmentally sustainable farming sector; in other words, the interests of farming communities and of carbon policies and markets are seen as aligned. Consequently, carbon farming is in many ways becoming the instrument for agri-food system transformation. Notable are the words of the speech opening the European Carbon Farming Summit in 2024, a conference accelerating the aligning of scientific research with policy priorities in the interest of creating a unified, harmonized, and robust European carbon farming certification scheme. Christian Holzleitner, The Head of Unit for Land Economy and Carbon Removals at the European Commission's Directorate-General for Climate Action, argued that “voluntary carbon markets, regulated carbon markets – that can bring additional income to farmers (...) Carbon farming I think is about accompanying the farmer in their journey towards sustainability, doing the transition to more sustainable agriculture. (...) And with this certification framework, we want to accompany the farmer along this journey.” The second keynote speaker, Willem Ferwenda, Founder of Commonland in 2013, a landscape restoration platform involving farmers, landowners, business, conservation organisations, governments and investors, similarly positioned farmers’ interests as central to the success of carbon farming: “Carbon farming is not a panacea – it is part of a wider transformation, but only if you maximise the benefits to farmers, community, and ecology”.

However, that assuming that carbon farming can be or should be the primary mechanism for agri-food system transformation is highly problematic. A number of authors have raised concerns that carbon farming’s exclusive focus on carbon can have negative consequences on farming livelihoods and farming landscapes (Galvin and Silva Garzón 2023, Stanley 2024). In our current project, “In the shadow of carbon”, funded by the Kone Foundation, we seek to empirically ground and collectively evaluate these rather high-level and largely theoretical concerns about the impacts of soil carbon-related technologies and policies.

This requires, firstly, calling attention to the science-policy interface in carbon farming: the space which is largely kept out of the public eye, and yet one where the future shape of agriculture and rural land use is being decided. Scientific research is conceptualized here as not separate from, but acting in society, especially as concerns environmental issues (Turnhout et al., 2019). Currently, researchers across academic, state, and advisory institutions are increasingly engaged in making soil carbon governable by translating

(Latour, 2004) highly contested scientific concepts into objects manageable through governance instruments both public (e.g. legislation) and private (e.g. certification, carbon markets). Fundamental questions around the persistence and stabilization of carbon in soils are still hotly debated amongst scientists (Lehmann and Kleber, 2015; Rumpel et al., 2020); nonetheless, a large amount of public and private funding is being dedicated to creating actionable knowledge on soil carbon: forms of soil carbon land management, measurement, and reporting which would enable a governance of soil carbon. Scientific observation, measurement, and modelling plays a crucial role in constituting carbon realities; however, we have little understanding of how these processes are undertaken, how they are shaped relationally through institutional and cross-institutional situatedness, and how they link to market and policy instruments. Consequently, we propose a methodology of ‘following the carbon’ from field to market and policy. It is by tracing carbon’s changing translations through instruments, institutions, and policies that critical carbon scholarship can become both more specifically critical and constructive in relation to the role soil carbon techno-sciences play in agri-food system transformations.

Secondly, the political economy of carbon farming knowledge requires urgent investigation. Specifically, we draw attention to the interesting and potentially problematic relationship between carbon farming and regenerative farming. Our preliminary research indicates not only that there are multiple sites of cross-over between regen ag and carbon farming knowledge creation, but that, in Finland, the two are even treated as synonymous by some actors. However, as argued in previous research on regenerative landscapes (Kallio and LaFleur, 2023; Krzywoszynska, 2019), ways of knowing and acting in agricultural environments in regenerative agriculture (regenerative agriculture knowledges) are much broader than knowing carbon: they emerge in and through diverse more-than-human relations by which landscapes are improved, livelihoods enabled, and agri-food systems transformed. Regenerative agriculture conceptualizes farming as a multi-species achievement: an outcome of relations with the multiple non-human agents whose lives create fertile and healthy landscapes (Kallio & LaFleur 2023). It is important to investigate to what extent the current research on carbon farming may leave unnoticed or even silence the kinds of relations that are significant for the multispecies wellbeing and livelihoods, such as the inter-linkages between animal, human, and ecosystem health, landscape (bio)diversity and cultural heritage, community building and fair income, knowledge sharing and learning for new skills (for examples of such omissions see Mattila et al., 2022; Mills et al., 2019). It is therefore urgent to understand how soil carbon farming knowledges seek to act ‘on the ground’, how they intersect with other land-based knowledges and values, and how land managers assess the benefits and risks of managing land for carbon in agriculture. It is also important to understand how regenerative agriculture knowledges could ‘speak back’ to and engage productively with the emerging carbon farming paradigm.

References

- Galvin, S. S., & Silva Garzón, D. (2023). The political life of mitigation: from carbon accounting to agrarian counter-accounts. *The Journal of Peasant Studies*, 50(6), 2259-2282.
- Kallio G and LaFleur W (2023) Ways of (un)knowing landscapes: Tracing more-than-human relations in regenerative agriculture. *Journal of Rural studies* 101: 103059.
- Kaskeala N (2023) Comment: Carbon market company perspective. Northern Europe “4 per 1000” Regional Meeting. Helsinki.
- Krzywoszynska A (2019) Caring for soil life in the Anthropocene: The role of attentiveness in more-than-human ethics. *Transactions of the Institute of British Geographers* 44(4): 661-675.
- Latour B (2004) *Politics of nature*. Harvard University Press.
- Lehmann J and Kleber M (2015) The contentious nature of soil organic matter. *Nature* 528(7580): 60-68.

- Mattila TJ, Hagelberg E, Söderlund S, et al. (2022) How farmers approach soil carbon sequestration? Lessons learned from 105 carbon-farming plans. *Soil and Tillage Research* 215: 105204.
- Mills J, Ingram J, Dibari C, et al. (2019) Barriers to and opportunities for the uptake of soil carbon management practices in European sustainable agricultural production. *Agroecology and Sustainable Food Systems*. DOI: 10.1080/21683565.2019.1680476.
- Raworth K (2017) *Doughnut economics: seven ways to think like a 21st-century economist*. London: Chelsea Green Publishing.
- Rumpel C, Amiraslani F, Chenu C, et al. (2020) The 4p1000 initiative: Opportunities, limitations and challenges for implementing soil organic carbon sequestration as a sustainable development strategy. *Ambio* 49(1): 350-360.
- Stanley, T. (2024). Carbon ‘known not grown’: Reforesting Scotland, advanced measurement technologies, and a new frontier of mitigation deterrence. *Environmental Science & Policy*, 151, 103636.
- Turnhout E, Tuinstra W and Halffman W (2019) *Environmental expertise: connecting science, policy and society*. Cambridge: Cambridge University Press.
- Vermeulen S, Bossio D, Lehmann J, et al. (2019) A global agenda for collective action on soil carbon. *Nature Sustainability* 2(1): 2-4.

12.20 Kuhmonen, I. et al. Deconstructing the deep roots of vulnerabilities in the Finnish food system

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Resilience of the contemporary food system is a paradox. Food systems exhibit high levels of both systemic and structural resilience – meaning that especially in developed economies their capacity to feed the people reliant on them is high, and that their structures are resistant to any attempts to change them. At the same time, food systems are plagued by creeping vulnerabilities that arise from the way they are organised: the reasons for their success also give rise to vulnerabilities that have the potential to turn into seeds of their own destruction.

Achieving transformational changes in the food systems has proved extremely difficult due to the institutionalised vested interests, power constellations, norms and habits that maintain path-dependencies and lock-ins. The research stream aiming to make sense of and foster transformational changes can be labelled as the study of transition pathways. By and large, this research stream is devoted to addressing the ‘how’ of sustainability transitions: the needed means and social dynamics related to achieving desired, sustainable future states.

In this research, we asked how a more resilient food system could be built by deconstructing the paradigmatic vulnerabilities that threaten the resilience of the contemporary food system. Our focus is thus on resilience as a property of the food system, not of a specific system state, i.e., regime. Such an understanding about resilience leads to two important notions. First, resilience is a relational systemic property that is not predefined, subordinate or conditional to a specific system structure. Second, the resilience concept can be helpful in operationalising systemic transitions: to remain resilient, the food system sometimes needs to transform and effectively abandon the current structures that risk fulfilling its purpose of existence.

Transition pathways to maintain or enhance the resilience of the food system requires addressing three features of the system: 1) identification of root causes that keep the vulnerabilities alive, 2) design of means and strategies to enact transformative change and 3) definition of desired future states (or alternative regimes) for the food system. With our study, we contribute to deeper integration of transition and resilience research as well as to holistic understanding of transition pathways.

Our investigation into these dimensions of transition pathways took place in Finland. Our research design is built on mixed methods and triangulation. Specifically, it entails a review of literature, stakeholder workshop, causal mapping co-created in expert interviews and a stakeholder survey. Literature review, workshop and interviews served identification of the vulnerabilities and their root causes as well as design of alternative futures images, while the data collected from the stakeholder survey was used to identify the transition pathways.

In total, 10 vulnerabilities and 14 root causes of the vulnerabilities were identified. The vulnerabilities were as listed in the following.

1. Concentration of power within the food system
2. Weak profitability of primary production
3. Agriculture’s strong dependence on subsidies
4. Plant and animal diseases
5. Loss of biodiversity
6. Climate change
7. Variability in the availability of production inputs

8. Cyber risks
9. Lack of systemic understanding concerning food systems
10. Lack of policy coherence

Vulnerabilities were related to a set of four paradigmatic root causes, listed in the order of the frequencies: paradigm of centralisation, paradigm of detachment, cheap food paradigm and the paradigm of a well-functioning world.

The survey yielded 167 responses from food system experts, who were asked to provide descriptions of how to remove the root causes of the vulnerabilities. The analysis of the open-ended responses yielded four groups informed by previous research on transition processes: endogenous renewal of the contemporary regime (25% of responses), establishment of a new ruleset (13%), destabilisation of the contemporary regime (11%) and support for niche phenomena (8%). Depending on the nature of the vulnerabilities to be tackled, different combinations of transition pathways proved out to be useful.

Endogenous renewal of the regime means that the transition takes place 'from within'. These proposals aim especially at tackling the paradigmatic root cause of detachment, wherein consumers are alienated from the food system, where lack of systems thinking prevails, agriculture is not appreciated in the society and the public food discourses are superficial and segregated. Especially the means related to strengthening the agency of various food system actors were prevalent in this pathway.

Building a new ruleset is focused on creating the institutional conditions for the preferable future food system via redirection of the policy framework, through building a shared future vision and through internalisation of the (negative) externalities in the prices of food products. This pathway of building new rules can be applied especially to tackle the paradigm of cheap food.

The pathway of destabilisation was evaluated as the most difficult to realise. This pathway was built on the idea that transformative change can happen through redistribution of power. Ideas related to destabilisation were present in all the paradigmatic root causes.

Supporting niche phenomena proposed that the transformative potential lays in sustainable alternatives beyond the mainstream regime, which do not have a competitive edge in it. The respondents considered that supporting niche phenomena can be an efficient way to address especially the vulnerabilities caused by centralisation.

However, not all the identified root causes of vulnerabilities were considered as threats, which indicates that the vulnerabilities are deeply embedded in the cultural-cognitive dimension of the contemporary regime. Some of the root causes took the label of 'paradigm of a well-functioning world', and in this group the majority of respondents either could not identify a solution for removing the vulnerability's root cause or did not think the identified root cause was a problem whatsoever.

As the last step in the survey, the respondents were given three alternative future states for the food system for evaluation. Specifically, the respondents were asked to indicate which future state they would prefer and why. The options were the contemporary regime with improvements, agroecological regime and high-tech regime. The contemporary regime is characterised by its current features with incremental (but not specified) improvements. The agroecological regime would solve the resilience and sustainability problems by localising the food system, whereas the high-tech regime would solve them with an opposite strategy by detaching food production from land, intensifying the centralisation development on the way. The respondents preferred equally the contemporary system with improvements (48%, n=79) and the agroecological regime (48%, n=79), whereas the high-tech regime was the least popular option (6%, n=9). The pathways differed slightly between these futures. Those respondents who were in favour of the agroecological regime least frequently had the opinion that the presented root cause would not be a problem. In contrast, those respondents favouring the high-tech regime most frequently could not indicate

the means to remove the root cause. Promoting niche activities was most frequently mentioned by those favouring the agroecological regime.

In conclusion, our findings indicate that food system stakeholders do not share a consensus about the need for and direction of a fundamental transformation of the food system. The vulnerabilities are embedded in the regime structure – they are part of how the system functions. To tackle the root causes of the problems it would be necessary to shift towards another form of organisation – a new regime. While the surveyed food system stakeholders lack a shared vision of the food system's future, the results do provide support for a variety of transition pathways and concrete policies. For example, redistributing power within the food system, strengthening the agency of food system actors and supporting niche innovations as new sustainable modes of operations were frequently mentioned means to tackle the root causes of vulnerabilities. While promoting the agency of the food system actors was the single most frequently mentioned means to remove the vulnerabilities and thus improve resilience, one can argue that such means are the low-hanging fruits that need to be packed up with more transformative policies that go beyond awareness-raising. Further, the contents for such policies can vary widely, depending on what is targeted with them, which again highlights the importance of vision building. Visions should help various actors in the food system to direct their activities, but at the same time, it is important to retain a decent level of ambition – if aiming for a widely shared vision, it is likely to end up reinforcing the status quo. The most impactful transformative potential probably lays in destabilising the contemporary structure on one hand, and supporting the niche actors and activities on the other, complemented with an understanding about the desired future direction. Clearly the tools offered by contemporary policies, for example the Common Agricultural Policy, are not enough to meet the needs of deconstructing the deep roots of vulnerabilities in the Finnish food system.

12.21 Kāle, M. et al. Transferability of seed-saving practices: Insights from Latvia's and Ghana's agrifood systems' collaboration

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Introduction

Indigenous Local Knowledge (ILK) of agricultural practices is crucial for sustaining agricultural development, particularly in Northern Ghana. These knowledge systems, embedded in local traditions, customs, and experiences, offer valuable insights into sustainable farming, environmental management, and community resilience (File et al., 2022). In Northern Ghana, ILK plays a vital role in overcoming climate change, soil degradation, and food insecurity challenges (Filho et al., 2023). However, the limited documentation and declining transmission of this knowledge across generations risk its preservation. Traditional farming practices, such as seed saving and crop selection based on resilience to abiotic and biotic stresses, have been pivotal for maintaining food security (Poku et al., 2018). These traditional practices have appeared to be valuable for sustaining smallholder farming systems and maintaining biodiversity. Indigenous seeds are critical for preserving these characteristics, especially in drought-prone regions (Ficiciyan et al., 2018). However, these traditions are under threat from modern approaches that favour mechanisation and commercial farming.

Latvia's "seed savers movement" focuses on preserving traditional knowledge and stories of inherited crops. In the LATDEV (Latvian development cooperation) supported project "Building Digital Education on Indigenous/Heritage Crops for the Resilience of African Food Systems in the Context of the Climate Crisis," Latvia and Ghana collaborated to promote and preserve indigenous seed-saving practices by blending Latvia's "living seed lab" model with Ghanaian agrifood systems. In Latvia digital tools are used for documentation —such as story-maps and digitized seed-saving lectures that preserve and share knowledge widely. These platforms allow for the recording of oral traditions and practices, making them accessible through various technologies. This Latvian-Ghanaian collaboration offers an opportunity to transfer seed-saving and ILK that addresses land tenure, gender equity, and social cohesion challenges, all critical to the adoption of indigenous farming practices by adjusting to technological landscape in Ghana that is primarily mobile-technology based.

Methodology

The knowledge transfer was based on the Latvian Permaculture Association sharing their experience with heirloom crop documentation and movement-building, focusing on the successes and challenges of these processes. The Latvian model, integrating community-based seed-saving practices with digital storytelling, provided a framework for preserving biodiversity and fostering resilience in food systems, and the Latvian Permaculture Association together with the project's team developed a 10-lecture series addressing regenerative agriculture, soil fertility, and permaculture principles for seed storage and crop production.

The rationale for knowledge sharing was based on the "living seed bank," a key concept of the Latvian model, where the community is actively involved in cultivating, selecting, and adapting seeds to address climate challenges and keep cultural heritage preserved.

As a result of the project implementation, more than 10,000 Ghanaian farmers received short audio messages containing the content developed by the project joint working group. The messages were disseminated by a Ghanaian social enterprise Farmerline, using mobile technology platforms. In addition, Council for Scientific and Industrial Research-Savanna Agriculture Research Institute (CSIR-SARI) gathered data through semi-structured interviews across three regions of Northern Ghana: Northern Region, North-East Region, and Upper East Region. A total of 74 respondents, 73% being women, were selected using a stratified and purposive sampling technique to ensure regional representation. The interviews gathered knowledge of ILK use in local communities, as well as barriers to the pursue of sustainable practices of food systems locally by farmers.

Results and discussion

Respondents in Ghana reported using traditional farming practices, with a strong focus on seed storage and soil fertility management. About 90% of respondents still use traditional farming practices, particularly for soil fertility management and seed storage. However, the loss of zero-tillage, a traditional method, highlights the impact of modernization on farming systems. Traditional soil fertility management methods such as organic manure and crop rotation, were common. Additionally, many farmers stored seeds using ash or hanging maize in kitchens to reduce insect damage.

Respondents noted the younger generation's increasing disinterest in farming, further exacerbating the risk of knowledge loss. The project team is addressing this issue by documenting indigenous farming knowledge using modern tools, such as smartphones with video recording functions, and involving younger generations in the learning process.

Additionally, the respondents emphasized the importance of oral tradition and mentorship in transferring indigenous knowledge. Most of the respondents reported passing down farming knowledge to the next generation through oral transmission (95%) and apprenticeship (64%). These methods have proven to be the most effective in preserving and passing traditional practices on to future generations.

One of the significant challenges identified by respondents was the lack of formal systems for documenting indigenous farming practices. While some respondents expressed interest in using local TV programs and school records to document knowledge, others highlighted the barriers posed by the commercialization of agriculture.

Conclusions and recommendations

The transferability of Latvia's "seed savers movement" and the sharing of traditional and indigenous seeds to Ghana is feasible and potentially transformative for local agricultural practices. Latvia's experience, focusing on preserving heirloom crops through community-driven initiatives, provides a model for improving food system resilience in Northern Ghana, where smallholder farmers heavily depend on indigenous farming knowledge. Several key factors contribute to the success of transferring this praxis.

While the crops and farming systems may differ between Latvia and Ghana, the principles of Latvia's seed-saving movement—community engagement, local knowledge preservation, and sustainable agricultural practices—are highly transferable. Ghana, like Latvia, has a history of using indigenous seeds, and many communities still rely on these crops for food security and cultural identity. Thus, the emphasis on conserving indigenous varieties and promoting biodiversity aligns with the values and practices of Ghanaian farmers.

Latvia's "living seed bank" model, actively involving communities in seed saving, ensures that seeds are not just stored but also cultivated and adapted to local environmental conditions. This participatory approach could be easily implemented in Ghana, where communities often possess extensive knowledge of

their local ecosystems. Through training farmers to save and share seeds within their communities, this model promotes local control over food systems and empowers farmers to maintain seed sovereignty, which is crucial in the face of climate change.

Latvia's emphasis on knowledge transfer through educational materials, such as lectures and story-maps, provides a framework for sharing traditional farming practices in Ghana. Adapting this model, the project in Ghana could develop training modules for seed storage, soil fertility management, and seed exchange networks.

This digital aspect of the movement offers an innovative way to preserve traditional knowledge for future generations and make it accessible to a broader audience. In Ghana, leveraging mobile technology, which is increasingly widespread, could enable farmers to document and share their indigenous seed-saving practices, ensuring that this knowledge is not lost. This could be particularly valuable for younger generations, who may be more attuned to digital tools but less interested in traditional farming practices.

The Latvian model of seed sharing, where farmers exchange different varieties of crops, can be applied in Ghana to promote genetic diversity and ensure that valuable indigenous seed varieties are preserved and accessible to all farmers and plant breeders.

In both Latvia and Ghana, agriculture is essential to rural livelihoods, and women play a central role in seed-saving and agricultural knowledge transmission. The Latvian model places significant emphasis on community-based involvement, which can be an opportunity to address gender inequities in Ghana. By fostering inclusive seed-saving practices, the project could empower women and ensure that their contributions to agricultural knowledge and seed storage are recognized and valued.

In conclusion, the principles of Latvia's seed-saving movement are applicable and transferable. With appropriate adjustments to local contexts, such as integrating traditional Ghanaian knowledge systems and utilizing mobile technology, Latvia's praxis could contribute significantly to improving the resilience of Ghanaian food systems, enhancing local food and nutrition security, and preserving indigenous agricultural practices in the face of climate change.

Acknowledgments

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References

- Ficiciyan, A., Loos, J., Sievers-Glotzbach, S., & Tschardtke, T. (2018). More than yield: Ecosystem services of traditional versus modern crop varieties revisited. *Sustainability*, 10(8), 2834.
- File, D. J. M. B., & Nhamo, G. (2022). Climate compatible agriculture: interfacing scientific, indigenous and local knowledge in the Upper West Region, Northern Ghana. University of South Africa.
- Filho, W. L., Wolf, F., Totin, E., Zvobgo, L., Simpson, N. P., Musiyiwa, K., ... & Ayal, D. Y. (2023). Is indigenous knowledge serving climate adaptation? Evidence from various African regions. *Development Policy Review*, 41(2), e12664.
- Poku, A.-G., Birner, R., & Gupta, S. (2018). Why do maize farmers in Ghana have a limited choice of improved seed varieties? An assessment of the governance challenges in seed supply. *Food Security*, 10(1), 27–46. doi:10.1007/s12571-017-0749-0

12.22 Lamminen, M. Efficiency, sufficiency and consistency: Strategic approaches for improving sustainability of animal production

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Introduction

Grasping the multifaceted sustainability dimensions of animal production is challenging. Current strategies for more sustainable animal production are mainly aiming at increasing the efficiency of production processes. Indeed, e.g. milk yields of Finnish dairy cows have three-folded and total CH₄ production decreased by 56% in last 60 years (Huhtanen et al., 2022). The growth of broilers has increased by 400% and feed conversion ratio (FCR) improved by 50% from 1957 to 2005 (Zuidhof et al., 2014). These are result of improved feeding, breeding and management of animals, leading to lower environmental emissions per kg of animal product. However, efficiency-based strategies are alone insufficient in response to the wide environmental and societal challenges. The current discourse related to the role of animal production in societies has also led more often to greater dispersion than consensus. In this paper three strategic approaches to sustainability are identified: efficiency, sufficiency, and consistency. The proposed concept builds upon the work of Huber (2000), and further incorporates insights from Garnett (2014), Allievi et al. (2015) and White et al. (2016).

Limitations of efficiency-based strategies to improve sustainability and resiliency of animal production

Efficiency-based metrics in animal production are crucial for evaluating how efficiently resources are converted into milk, meat, eggs or wool. Commonly used efficiency-based metrics include measures like FCR (feed intake (kg)/product output (kg)), economic efficiency (revenue from products/total production costs), efficiency of space use (product output (kg)/stall, pen or hectare), nitrogen (N) use efficiency (NUE; N in animal product (kg)/N intake (kg)), carbon footprint (greenhouse gas emissions (kg CO₂-eq)/product output (kg)), litter size (number of offspring/dam), and conception rate (dams conceived/dams bred). These help producers, industry, farm advisors and researchers to assess and develop the performance, profitability and sustainability of animal production systems.

However, relying solely on efficiency-based metrics is risky when evaluating sustainability. Efficiency-based strategies may prioritise maximum output in ideal conditions, reduce the adaptability of the production system and increase vulnerability to shocks. They do not consider ethical aspects, or the nutritional quality of feed consumed, i.e., contribution of animal production to food security. For example, compared to intensive animal production systems, the FCR of extensive pastoral systems may seem poor, while the ecological, cultural and food security impacts and susceptibility to market shocks can be very different between these systems.

Moreover, many efficiency-based metrics are based on input-output relations, which make them susceptible to purchase-resale bias. This is a mathematical phenomenon, where the output:input ratio (efficiency) changes when both numerator and denominator are increased with the same amount (Godinot et al., 2014). When input is larger than output (like in NUE), efficiency increases when both input and output is increased equally, and vice versa when output is larger than input (like in the ratio of energy-corrected milk yield to dry matter intake). This implies that a cow with 1 g/d higher production of milk N

and 1 g/d higher N intake has higher NUE than a cow with 1 g/d lower milk N production and 1 g/d lower N intake.

The sustainability gains of efficiency-based strategies may also be hindered or prevented by rebound effect. This refers to a situation when improvements in efficiency decrease the cost of production or consumption, which in turn increases production or consumption, leading to unrealised resource savings or environmental benefits (Berkhout et al., 2000).

Triple approach for sustainability: Efficiency, sufficiency and consistency

To address the shortcomings of efficiency-based strategies, a holistic approach is needed that captures simultaneously the production and consumption of animal-sourced foods and multiple sustainability dimensions of animal production systems. Huber (2000) suggested efficiency, sufficiency and consistency approaches as mutually complementary transformational strategies for sustainable development. While efficiency strategy focuses on improving and optimising existing production processes via technological solutions, sufficiency strategy pushes changes on consumption and asks, 'How much is enough?' (Huber, 2000). Consistency, on the other hand, aims at improving sustainability via better integrated and ecologically more sensible production processes – compared to sufficiency, the approach is more innovative and transformational; while sufficiency focuses on quantity, consistency focuses on quality (Huber, 2000). These three strategies resonate well with the discourse types identified in post-war environmental debate: 1) Free market prometheans, rational optimists and cornucopians (efficiency), 2) Nea-Malthusian pessimists and limits environmentalists (sufficiency), and 3) Social environmentalists and possibilists (consistency) (White et al., 2016). These discourse types differ in underlying ethics, political approaches, and underlying vision of nature and humans; they also see different primary dangers to the planet (White et al., 2016). The values and ethical perspectives people have influence both the evidence they use, and the solutions proposed to food-sustainability problem (Garnett, 2014). Understanding the different strategies and discourse types used by various stakeholders may help us better understand each other and work constructively together to tackle wicked problems, like climate change.

Efficiency, sufficiency and consistency strategies in animal production

Applying the efficiency, sufficiency and consistency framework to agricultural context opens fruitful opportunities for strategic planning of the future food production. Garnett (2014) characterised three perspectives for sustainable food production and food security (efficiency, demand restraint, and food system transformation), which align closely with Huber (2000) and White et al. (2016). Allievi et al. (2015) have further refined the work of Garnett by adapting concepts of efficiency, sufficiency and consistency from Huber (2000) to develop metrics to measure the sustainability of environment-economy (efficiency), environment-society (sufficiency) and environment-animal ethics (consistency) relationships of food production system. They suggested the following metrics in context of meat consumption and production: land requirement for animal products (efficiency), amount of meat consumed (sufficiency) and number of animals slaughtered (consistency) (Allievi et al., 2015).

A challenge with consistency strategy is that it can be understood in vastly different ways (Allievi et al., 2015), which would also influence the metrics chosen to measure success and solutions offered. Allievi et al. (2015) give very strong emphasis on animal ethics and welfare in their consistency approach, which would promote vegetarian diets in human nutrition. While ethics and animal welfare are crucially important factors to consider, the animal ethics approach to consistency leads to narrowed range of solutions to reorient animal production, as also sufficiency strategy promotes decreasing the consumption

of animal-derived foods. Therefore, agroecological approach to consistency was developed in Lamminen (2019) and Helenius et al. (2021), which both reflect industrial ecology as described in Huber (2000).

In the agroecological framing, consistency strategy in animal production would aim at separating human and livestock diets from each other by feeding animals with food-industry by-products, food waste and forage. Thus, ruminants (cows, sheep) over monogastric animals (poultry, pigs) would likely be preferred as ruminants are able to utilise feed materials not competing with human diets. In the case of N utilisation in dairy production, conversion of human-edible protein in feed into human-edible protein in milk are suggested as metrics for success (Lamminen, 2019).

The efficiency strategy, on the other hand, would prefer monogastrics over ruminants, because monogastrics are by nature more efficient in utilising nutrients, if the quality of feed is not considered. In the case of N utilisation in dairy production, efficiency strategy would aim at e.g., optimising the ratio dietary N to metabolisable energy and balancing dietary amino acid composition to maximise the conversion efficiency of feed N into milk protein. Metrics for success in this example would be N output in milk per N input in feed (NUE) (Lamminen, 2019).

The sufficiency strategy would lead to minimising animal production irrespective of the animal type. If animal production is practiced, the focus is to minimise resource use. In the case of N utilisation in dairy production, sufficiency strategy would aim at e.g., minimising the amount of protein fed to cows to decrease amount of N emitted to environment and metrics for success would be amount of N excreted in urine and faeces (Lamminen, 2019).

Conclusions

To successfully reorient animal production towards sustainable and resilient future consideration of the different sustainability strategies as mutually complementary to each other is needed. In this paper, metrics for evaluating the sustainability of protein nutrition of dairy cows and N utilisation in dairy production have been suggested. Further development of metrics for other animal production types and environmental impact categories, such as phosphorus utilisation, water use, land-use change, greenhouse gas emissions and ecological footprint from efficiency, sufficiency and consistency perspectives are needed.

References

- Allievi et al., 2015. *Journal of Cleaner production* 92, 142-151.
- Berkhout et al., 2000. *Energy Policy* 28: 425-432
- Garnett, 2014. *Journal of Cleaner Production* 73, 10-18.
- Godinot et al., 2014. *Agricultural Systems* 127:41-52.
- Helenius et al., 2021. *Finnish Journal of Rural Studies* 29, 84-105.
- Huber, 2000. *Journal of Environmental Policy and Planning* 2, 269-285.
- Huhtanen et al., 2022. *Agricultural and Food Science* 31, 1–11.
- Lamminen, 2019. Potential of microalgae to replace conventional protein feeds for sustainable dairy cow nutrition. Doctoral dissertation, University of Helsinki.
- White et al., 2016. *Environments, Natures and Social Theory: Towards a Critical Hybridity*.
- Zuidhof et al., 2014. *Poultry Science* 93, 2970-2982.

12.23 Lehtonen, H. Effects of healthy diets on Finnish agriculture and greenhouse gas emissions up to 2040

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The new Finnish national dietary guidelines published in 2024 recommend reducing the consumption of red meat and dairy products and increasing plant-based products. A shift towards plant-based diets is widely seen as a key - although not sufficient - solution to the sustainability challenges of reducing greenhouse gas emissions in international research literature. This study assessed the extent to which the recommendations could affect agricultural production and greenhouse gas emissions in Finland by 2040. The time span of the analysis needs to be long enough, at least up to 2040, as both diets and agricultural production take time to change.

The impacts on agricultural production were estimated up to 2040 using the DREMFI model, and also this analysis, focuses on so-called basic agriculture, which does not include horticulture, fishing, reindeer, game, sheep and horse farming. DREMFI includes milk production, beef, pork and poultry production, and the production of about 10 of the most common arable crops. These agricultural production sectors cover more than 95% of agricultural land use, as well as greenhouse gas emissions from agriculture and the number of farms.

The DREMFI model can be given an exogenous consumption change per person. In this case, the model produces a competitive market, assuming that supply mainly responds to demand changes, and supply can come from both the domestic and foreign countries, while many agricultural products are imported and exported simultaneously. The DREMFI model models endogenous investments, productivity and farm size growth in dairy farming, which is also connected to beef production, assuming that cattle can be raised to an economically optimal slaughter weight according to the price ratios (of products and inputs). Crop yield levels, fertilization and average cow output and feeding also respond to changes in price ratios.

The effects of different dietary options were compared to the so-called baseline scenario, which represents a very slow and moderate change in diets, prices and agricultural policy from 2020 to 2040. In the baseline scenario, diets change very slowly, such that the consumption of dairy products and red meat (beef, pork) decreases by about 10–15% by 2035 and by just under 20% by 2040. At the same time, poultry consumption increases by about 5% from the 2022 level and then remains at the level it rose to after 2030. The consumption of bread cereals increases very moderately, and the consumption of eggs remains unchanged. The baseline was defined in this way with various stakeholders in 2020, and also based on the development in 2020–2023.

The baseline and all diet options assume EU-level prices for key agricultural products as predicted by the OECD-FAO Agricultural Outlook in summer 2023 until 2032, after which prices are assumed to remain unchanged in real terms until 2040. Agricultural support and its conditions are expected to remain in line with the EU CAP programming period 2023–2027 until 2040.

The development of milk production is very stable in the baseline, where production will first slowly decrease from the level of just over 2.1 billion liters in 2023 to close to 2 billion liters by 2026. After this, production in the baseline will slowly begin to rise, reaching again approximately the level of 2023 by 2030. The development after 2030 will rise very slowly in the baseline, so that in 2040 we will be close to the level of 2.3 billion liters, as we were in 2020. The small increase is due to gradually improving productivity, as investments in large barns lead in particular to improved labor productivity. At the same time, the average yield of cows will increase moderately by just under one percent per year. Overall, the productivity and competitiveness of milk production will improve in the baseline.

A very similar development occurs in four different diet options, where total milk consumption per person decreases by about 6% in the period 2022–2040. This change therefore occurs very slowly. The dairy sector, which improves its productivity and competitiveness partly by taking advantage of stable domestic demand, increases its total exports in approximately the same amount as the decrease in domestic consumption, bringing the total production close to the base-career level.

A somewhat unexpected result, however, is that milk production in Finland does not decrease, even though total demand for milk in the domestic market decreases by 34% in two different diet options in the period 2022–2040. In this case, exports increase more than the decrease in domestic consumption up to 2040. This is mainly because of the fact that the demand for pork disappears completely in two diet options, and with it almost all domestic pork production. This frees up plenty of high-yielding arable land in the southern and western parts of the country for dairy production, which continues to have good operating conditions, especially since export prices for dairy products are assumed to remain stable and relatively higher than prices for pork and poultry. Some of the arable land freed up from pork and poultry meat production could also be diverted to egg production, which could potentially increase in late 2030s, as the modelling results show. However, this development is quite uncertain and depends on the development of export prices.

Based on the results, pig and poultry meat production does not have the same potential and possibility for improving productivity by increasing farm size as milk production. In this case, the arable land of pig and poultry farms and the crop farms producing feed grains for them is taken into use by dairy cattle farming. Decreasing pig and poultry production means less competition for arable land (the so-called shadow price of the regional land constraint is taken into account in the investment model of the DREMFA model) and a small reduction in production costs. This gradually leads to cumulatively larger investments in dairy cattle farming in the western and partly southern parts of the country, where production is increasing. Milk production, where about half of the feed consumption of cows is grain-based and protein supplement feed is therefore increasing as a result of internal optimization of the agricultural sector, whereby milk production also increases slightly in the northern parts of the country, as feed grains become relatively cheaper throughout the country as the feed requirement for pig and poultry meat production decreases.

In the baseline scenario, total agricultural greenhouse gas emissions (from agricultural sector and land use sector of agriculture) will remain fairly stable at around 15 MtCO₂ eq. A somewhat unexpected result is that agricultural emissions (not emissions from consumers' total diet) will decrease relatively little, less than 10% (maximum 1.2 Mt CO₂ eq./year), even if dietary changes are large. The reason for the slow and small reduction in GHG emissions is that no new policy incentives were assumed for the use of agricultural peatlands. In this case, for example, an increase in milk production and bread grain production and a decrease in the total number of cattle due to a decrease in suckler cow production, especially in the greater Ostrobothnia region, could lead to an increase in the production of annual crops and reduced areas of extensive grasslands, which, in turn imply high GHG emissions per ha on agricultural peatlands.

The results show that changing diets may lead to only moderate and slow changes in overall livestock production and greenhouse gas emissions if export prices realize as predicted and production-linked livestock subsidies are not reduced. In this case, exports of dairy products may increase, partly as subsidies enable investments in large and productive production units. There is still significant potential in dairy farming to increase labour productivity and reduce unit costs. There may be even increasing production in the long-term, especially if arable land is released from pig and poultry meat production and feed grain production. Assumed constant agricultural policy and subsidies is also one reason for the increase in milk production in the results. Subsidies paid per liter of milk in the central and northern parts of the country and dairy cow premiums in southern Finland remain unchanged and promote investments in dairy farming in all scenarios. In reality, however, coupled subsidies for milk and beef production may be reduced if domestic demand for them clearly decreases.

These results mainly show that diets do not alone determine agricultural production and land use, which are also affected by global demand, prices and agricultural subsidies. The importance of exports and the possibility of increasing them may lead to significantly less change in land use and total production than one would expect based on dietary changes alone. If the goal is to significantly change agricultural production and improve the state of the environment, incl. greenhouse gas emissions, targeted actions are needed because dietary changes alone will not necessarily lead to the desired results in Finland.

12.24 Lempa, K. et al. Urban agriculture for a resilient future: identifying weak signals in Nordic-Baltic food systems

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Introduction

The urgency to transform global food systems has become increasingly evident in the wake of multiple intersecting crises, including the escalating climate emergency, the Covid-19 pandemic, geopolitical conflicts such as the Russian invasion of Ukraine, and protectionist trade policies triggered by shifts in global leadership. These disruptions have underscored the vulnerability of existing food supply chains and emphasized the importance of investing in local, circular, and resilient systems capable of withstanding systemic shocks.

Within this context, urban agriculture initiatives have gained attention as innovative and localized responses to the global food crisis. This study focuses on several case studies in the Nordic-Baltic region, examining how they challenge dominant food production paradigms and offer glimpses of alternative futures. The examples are versatile, including Dodo's grassroots urban gardening movement across Finland; Campus Roslagen's pioneering role in aquaponics education in Sweden; Norwegian University of Life Science's (NMBU) master's programme in urban agriculture in Norway; Edible Park in Helsinki, Finland; Norwegian Urban Agriculture Strategy and Lastādija, a participatory neighborhood project in Latvia. Mostly local and often community-led, these projects may seem peripheral or unconventional, yet they carry the potential to signal broader societal shifts. These early, uncertain developments, referred to as weak signals, may reflect deeper undercurrents of change that are not yet fully visible or understood.

To frame this analysis, the study draws on the multi-level perspective (MLP) on sustainability transitions which distinguishes between three levels of socio-technical change: the landscape (macro trends and external pressures), the regime (established systems and norms), and niches (spaces for experimentation and innovation). While regimes tend to be stable and resistant to disruption, landscape pressures can destabilize them, creating openings for alternative practices. Niches, often small-scale and protected, serve as testing grounds for novel approaches. In this layered dynamic, weak signals may emerge from within niches, revealing "seeds of change" that challenge existing systems and potentially contribute to broader transformations. By identifying and interpreting these signals, this study aims to contribute to a deeper understanding of how localized innovation can influence systemic sustainability transitions in the food systems of the Nordic-Baltic region.

Methodology

Finland's innovation fund for the future – SITRA proposes a three-step guide to identifying weak signals in diverse contexts: preparation, scanning and interpretation.

Firstly, the preparation phase in our study was previously conducted through the exploration of case studies in the Nordic-Baltic regions.

Secondly, in the scanning phase, we used two approaches to identify weak signals related to urban agriculture. First, we conducted an AI-assisted review using Elicit, which uses the Semantic Scholar database and focuses on peer-reviewed articles. Elicit is a transparent tool that allows users to access original academic articles and verify the accuracy of their interpretations. Our prompt in Elicit underwent

several revisions, with the final version being "How can weak signals of urban agricultural transformation be systematically identified and analysed in different European urban contexts in the post-pandemic period?". The focus on European studies provided a relevant benchmark for our analysis of the Nordic-Baltic cases. We particularly emphasised the post-pandemic context, as the pandemic had a significant impact on urban activities. Elicit reviewed 498 papers relevant to our call for papers and selected 40 for closer examination of key patterns. Elicit identified four dimensions for identifying weak signals: business models and value propositions, spatial and institutional adaptations, socio-economic integration, and post-pandemic resilience mechanisms. We used the four dimensions to classify our cases as described in the webinars, presentations and documents of the Future of Urban Agriculture project. Elicit is an efficient and transparent tool for producing summaries of academic articles, but it has its limitations. It only uses peer-reviewed academic articles and does not include information from blogs or social media. Thus, our method includes the types of weak signals that are recognised by academic researchers.

Thirdly, we interpreted the Elicit results, taking into account our prior knowledge of the topic. Our interpretation also included an understanding of the limitations that AI-generated results entail, such as the lack of screening of those results that are not part of the Semantic Scholar publication platform.

Results and Discussion

Six cases of urban agriculture in the Nordic-Baltic region were examined, each illustrating a different approach to resilient urban food systems. The selected cases include:

- Dodo (Helsinki, Finland): A non-profit organization enabling inclusive community gardening and citizen participation.
- Edible Park (Helsinki, Finland): A youth-run public garden offering education programs and a summer café for the community.
- Campus Roslagen (Sweden): A vocational hub pioneering aquaponics for local food production and specialist training.
- M.Sc. Urban Agriculture Program (Ås, Norway): A university graduate program training specialists in sustainable urban food systems.
- Norwegian Urban Agriculture Strategy (Norway): A national policy integrating urban farming into sustainable development goals.
- Lastādija (Riga, Latvia): A participatory neighborhood project combining communal gardens with cultural and artistic activities.

Collectively, these initiatives span policy, community, and educational domains. They provide evidence of several weak signals – subtle early trends – of urban transformation in food systems. Four cross-cutting theme areas were identified: (1) novel business models, (2) spatial and institutional adaptations, (3) socio-economic inclusion, and (4) post-pandemic resilience.

Novel business models

One theme is the emergence of innovative business models for urban farming. Technology integration is evident at Campus Roslagen, where an aquaponics system exemplifies a tech-driven, circular approach to local food production. The rise of formal training (e.g. the Norwegian University of Life Sciences (NMBU) master's program in urban agriculture) signals the growing maturity of the sector, preparing entrepreneurs to launch urban farming ventures. Meanwhile, community initiatives like Dodo, while volunteer-driven, partner with municipalities and sponsors, hinting at hybrid social enterprise models. These new initiatives suggest that urban agriculture could be a feasible economic sector in towns and cities.

Spatial and institutional adaptations

Urban agriculture is also encouraging cities to change spatially and institutionally. Policy support for urban agriculture is growing, exemplified by Norway's national strategy that explicitly includes urban farming in development plans. At the local scale, projects are reimagining space: Lastādiņa turned an underutilized area of Riga into community gardens and gathering spots, and Helsinki's Edible Park repurposes parkland for food cultivation and learning. These projects often employ participatory governance; for instance, residents co-manage Lastādiņa alongside municipal support, which indicate a shift in urban planning, where food production is a natural part of city space.

Socio-economic inclusion

Urban agriculture in these cases serves as a tool for social inclusion and community well-being. In Helsinki, projects like Dodo and Edible Park invite people from all backgrounds, including youth and immigrants, to get involved in gardening. These initiatives help build knowledge about food and create social connections. In Riga, the Lastādiņa project also brings locals together to create green spaces and strengthen community ties. Meanwhile, integrating urban farming into formal education (school programs or university curriculum) empowers more people with skills for sustainable food production. Though modest in scale, these examples show urban agriculture's potential to reduce urban inequalities and foster a sense of community.

Post-pandemic resilience

The COVID-19 crisis underscored the importance of local food production and community networks for urban resilience. Urban farming offers one response: producing food closer to home (as with aquaponics or community gardens) reduces reliance on long supply chains. Initiatives like Lastādiņa and Edible Park also provided safe outdoor spaces for social connection and mental health during lockdowns. These weak signals suggest that post-pandemic cities may treat community gardens, and other urban agriculture projects as strategic assets against future crises.

Reflections on weak-signal methodology

Our results fit quite well with the MLP framework. Weak signals highlighted niche-level experimentation in urban agriculture and how such activities may interact with established regime structures and wider landscape trends. The AI-assisted literature scan revealed niche innovations (e.g., novel business models, community governance experiments) that might otherwise go unnoticed. These innovations linked abstract trends to concrete niche cases within the urban food regime. However, relying mainly on academic literature risked bypassing grassroots niches. Nevertheless, our approach provided a forward-looking view consistent with MLP, highlighting how emerging niche activities may respond to landscape pressures in cities and potentially influence established systems.

Implications for future research and practice

Future research should track how these pilot initiatives develop and influence wider urban policy and also broaden weak-signal scanning beyond academia to capture grassroots and global perspectives. For practitioners, supporting a diversity of small-scale experiments – from high-tech farms to community gardens – can spur innovation, and lessons from successful pilots can inform larger projects or policies. Cities are investing in urban agriculture, however, it is important to maintain the inclusive, community-driven spirit of these projects to achieve resilient, sustainable, and equitable urban food systems.

Major references

- Geels, F. W. (2006). Multi-level perspective on system innovation: Relevance for industrial transformation. In X. Olsthoorn & A. J. Wieczorek (Eds.), *Understanding industrial transformation: Views from different disciplines* (pp. 163-186). Springer.
- Borges, L., A., & Matthiesen, H. (2024). *Urban Agriculture for a Resilient Future*. Nordregio.
<https://nordregio.org/publications/urban-agriculture-for-a-resilient-future/>
<https://norden.lv/en/projects/sustainable-development/project-future-of-urban-agriculture>
- Poussa, L., & Ylikoski, T. (2025). *Weak Signals from Future—Guide to Detection and Interpretation*. SITRA.
https://www.sitra.fi/wp/wp-content/uploads/2025/01/heikot_signaalit_-opas_eng.pdf

12.25 Lillements, J. & Viira, A-H. Understanding farmers' perspectives on sustainable food production

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Introduction

Farmers' views and choices about farmland profoundly influence food production, with policy and governance playing pivotal roles in shaping those choices. To explore how farmers perceive land use, this study undertook a systematic literature review. In December 2024, a systematic search of the Scopus and Web of Science databases was performed to identify peer-reviewed studies. Queries were targeted to find titles containing terms such as perceptions, beliefs, mindsets, or attitudes of landowners, landholders, land users, farmers, tenants, or stakeholders, and required abstracts to address land use, land cover, land management, or landscape planning in agricultural, farming, agroecosystem or forestry contexts. The initial search returned 617 articles, which were then screened for any mention of farmers' perceptions in the title or abstract, yielding 32 publications. From these papers, several recurring themes emerged regarding farmers' perspectives. Given their central role as food producers, these insights are especially pertinent to food policy.

Direct involvement in farming leads farmers to develop unique perspectives on land use

Farmers' perspectives on land use are distinct from those of other stakeholder groups, shaped in large part by personal experience and practical involvement in agricultural systems. Farmers emphasize tangible, context-specific concerns that are often grounded in daily practices, local knowledge, and economic realities. In Germany and Austria, farmers differed markedly from scientists in their perceptions of biodiversity and agri-environmental measures, with farmers placing more trust in sector-specific information sources and exhibiting less idealistic expectations. Similar contrasts appeared in studies from Chile and Japan, where farmers' land use values diverged from those of experts, conservationists, and the public, particularly in their lower priorities for restoration, aesthetics, and ecosystem service management. Farmers' perspectives on landscape change not only diverge from those of other stakeholders but also vary widely among themselves; for example, in the United States and Hungary, their views are differently influenced by economic interests and distinct senses of local responsibility.

Moreover, sociodemographic factors such as age, gender, and education further nuance these views. Older farmers in Ethiopia and the United States tended to favor adaptive practices and free-market mechanisms, while younger and female farmers are more likely to support sustainable land use and biodiversity initiatives. Thus, farmers' land use perspectives are shaped by their social identities but also by lived experience and the practical demands of agriculture, which can diverge substantially from the priorities and frameworks used by scientists, policymakers, and conservationists

Farmers value sustainability, but it is productivity that shapes their farming decisions

While many farmers are aware of the environmental consequences of intensive farming, including soil degradation and biodiversity loss, their decision-making frequently reflects the primacy of economic

productivity and operational viability. In Ethiopia, farmers recognized the challenges of soil erosion and fertility loss but reported limited investment in remediation due to financial and informational constraints. Similar patterns emerged in Colombia and England, where farmers cited financial limitations and concerns over the practicality of agroforestry as key barriers to adopting more sustainable practices. In Germany, although the ecological merits of agroforestry were acknowledged, the lack of clear economic returns tempered farmers' willingness to implement such systems.

The prioritization of land as a productive resource also informs aesthetic preferences. In Germany, Scotland, and the Swiss lowlands, farmers consistently favored neat, intensively managed landscapes, often equating visual order with agricultural efficiency. Surveys from Norway and Germany further underscore this emphasis on income generation and food production over environmental or social outcomes. Even where farmers' land-use values overlap with those of conservationists or policymakers, key differences emerge in how these values are operationalized. Historical analyses from England and cross-national studies in Europe reveal that traditional farming norms and expectations continue to shape farmers' resistance to multifunctional land use and public good-oriented land management strategies.

Farmers see themselves as land stewards, balancing tradition and food production over ecological innovations

Rather than focusing solely on ecological or economic optimization, many farmers view themselves as stewards of the land, committed to sustaining agricultural productivity and preserving farming traditions. In Ireland, for example, farmers' decisions regarding land use were influenced not only by economics but also by their values and a strong sense of responsibility toward the land. Similarly, in Australia, landholders frequently planted trees for personal satisfaction and environmental stewardship rather than for profit, and pastoralists in northern Australia expressed deep intrinsic motivations for biodiversity conservation rooted in cultural ties to the land.

Yet, despite recognizing environmental benefits, farmers often resist land-use changes like agroforestry due to concerns over profitability, labor, and loss of land-use flexibility. In Switzerland and Ireland, surveys revealed that farmers prefer to maintain control over land decisions, valuing flexibility and continuity in land management over potentially more profitable but restrictive long-term changes. The preference for productivity-focused landscapes also reflects farmers' practical priorities and aversion to yield losses caused by tree shading or increased complexity. Moreover, longer-term exposure to sustainable practices, such as organic farming in New Zealand, has been shown to shift farmers' appreciation for ecosystem services, suggesting that experience and familiarity can reshape attitudes over time.

Knowledge gaps and regulatory burden prevent farmers from adopting sustainable land management practices

A key barrier to the adoption of sustainable land management practices lies in persistent knowledge gaps and insufficient access to information. Farmers consistently express interest in sustainability, yet their ability to implement environmentally sound practices is constrained by a lack of clarity regarding how these practices function. In Ethiopia, the absence of information on best management practices was a major obstacle to adaptation efforts. Similar patterns were observed in Uganda and Colombia, where insufficient knowledge and limited technical assistance hindered the successful implementation and scaling of agroforestry practices. In northern Australia, farmers demonstrated limited understanding of the ecological impact of grazing, which influenced their reluctance to engage in biodiversity-friendly actions. Furthermore, German farmers indicated they would forgo some financial incentives if provided with technical forest management support, highlighting the value they place on actionable knowledge.

Lack of technical knowledge is often compounded by issues such as financial insecurity and legal ambiguity, which disproportionately affect resource-limited farmers and reduce their capacity to engage with new land-use strategies. In Germany, guided interviews revealed that although farmers generally support greening measures, their acceptance wanes when specific practices appear too complex or bureaucratic. This suggests that complexity without accompanying educational outreach can reduce the effectiveness of even well-intentioned policy tools. Correspondingly, Australian workshops with landholders showed a clear preference for voluntary, education-based incentives over command-and-control regulations, suggesting that farmers are more willing to embrace innovations when they feel knowledgeable rather than coerced.

Conclusions

Farmers' land-use decisions involve negotiating among three primary objectives: economic productivity, preservation of historical traditions, and ecological sustainability. Evidence presented in this paper shows that they typically assign greater weight to economic and cultural considerations over environmental ones. This can undermine the long-term resilience and sustainability of food systems unless policy and governance mechanisms more effectively realign economic incentives and stewardship values with ecological outcomes.

Recognizing that farmers' context-specific expertise often diverges from expert assumptions, policies should embed participatory decision-making that co-design and monitor land-use interventions with farmers. Acknowledging that age, gender, and education influence farmers' openness to innovation, policies should tailor outreach and support and disaggregate evaluation by demographic to ensure equitable participation. Since economic productivity drives farmers' decisions even when they value sustainability, incentive schemes must reward quantifiable ecosystem services alongside yield metrics with flexible, tiered payments accessible to farms of all sizes. As knowledge gaps impede adoption despite farmer interest, extension services should offer modular, farm-specific training and technical assistance through field demonstrations, mentoring, and digital platforms tailored to diverse literacy and generational needs. Given that complex regulations deter farmer participation, policies should streamline application processes, clarify best-practice guidelines, and aim to reduce administrative burdens for farmers.

Key areas for future research include surveying farmers' attitudes toward emerging market-based instruments such as carbon credits and biodiversity offsets to gauge their feasibility and appeal. Studies could explore how digital decision-support tools and remote-sensing feedback influence land-use choices across different farming types and sociodemographic groups. Longitudinal research is needed to track whether sustained participation in land stewardship programs or regenerative-practice pilots shifts productivity mindsets over time. Finally, deeper analysis of administrative and legal barriers can inform the design of widely accessible governance models, especially for smaller or resource-constrained farmers.

References

Please contact authors for citations and a full list of references.

12.26 Lindblom, T. & Högnabba, F. Stereotyping, vilifying and silencing: the clashing discourses of plant-based meat sold at Provinssi Festival 2024

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Introduction

In February 2024, a Finnish pop music festival Provinssi announced sales-site rent reductions for vendors of plant-based foods during the festival. With this new food policy, the festival claimed to take steps to reduce their environmental impact. The announcement sparked extensive dialogue on festival's social media platform (Facebook). The festival site is located in the region most rich in meat production in Finland, and there is an evident tension between the livestock-rich, food-related culture of the region and the hardship of making more sustainable practices manifest, if they are not considered culturally appropriate amongst the relevant stakeholders of the festival.

Media and public discourse on food and eating forms and reshapes the food environment we live in. Accordingly, temporary events such as music festivals can be regarded as somewhat established and influential institutions in the food environment, that form a social network consisting of its consumers (festival goers), producers (the festival organization and the artists and the other relevant stakeholders such as food vendors) and the locale (e.g. residents and entrepreneurs of the region).

This paper aims to gain deeper understanding of sustainable-food-related views and behaviour in this particular context by analyzing social-media content and the discourse spurred by the announcement. Publicly accessible texts, e.g. discussions on social media platforms, can possess great power by constructing and reinforcing social norms (Van Dijk 2008), not least related to food consumption and eating and diet preferences. Focusing on the meanings and matters that dominate and the ones that are marginalised in the arisen discourse, the goal is to identify ideology-anchored values and norms on sustainable eating surfacing in a social-media context (Confetto et al 2023; Segovia-Villarreal and Rosa-Díaz 2022). Focusing on the ways the announcement is received and discussed in public domains considers the socio-cultural aspects that are relevant in understanding sustainable eating practices (Mason and Lang 2017).

Theoretical background

Sustainability research focusing on social-media conversations have found that e.g. food-waste issues are constructed by market actors' discourses that vary in focus, tone and potential (Sutinen and Närvänen 2022), and in food packaging discourses more scepticism about food companies prevails, with companies' sustainability-related messaging provoking less engagement than similar user messages, suggesting more faith in peers than larger entities (Ruiz-de-Maya and Ferrer-Bernal 2024). A study on plant-based eating campaign concluded that sustainability framing was perceived by consumers as highly motivating, with people seeing the campaign as an opportunity for political action and sharing experiences (Pohjolainen and Jokinen 2020). Similarly, environmental communication is reshaped by social-media practices and blogging, which authorizes anyone to speak on environmental issues with no exclusive legitimacy held by expert authorities or politicians, leaving both power balance and misinformation-risk in its wake (Joosse and Brydges 2018).

Materials and methods

We study discussion on social media platform using a data set consisting of 399 Facebook comments related to festival's posts about their new food policy. We employ Critical Discourse Analysis (CDA) in hopes to unravel how certain ideologies and values are established as norms while others are marginalized in the social media discussions. The analysis is guided by concepts that have been recognized by earlier CDA-informed research (e.g. Locke 2004, Eissa 2014, Yilmaz et al. 2023) to help identify the dominant narratives and the underlying ideological values within the discourse, namely of stereotyping, vilifying, silencing, marginalizing, and complexity.

Results

The proposed conceptual framework for CDA was applicable throughout the material, and the results show clashing viewpoints: the discourse was clearly polarized to those endorsing and those criticizing the festival's policy.

Policy endorsing discourse

Critics of the policy are stereotyped as climate-ignorant conservatives, particularly associated with the Finns Party. This reinforces the stereotype of the conservative, meat-eating individual who is opposed to progressive environmental policies.

Meat production is vilified for its environmental impact and health risks, with red meat associated with diseases. The discourse positions plant-based diets as environmentally and ethically superior.

The discourse largely ignores (silencing) the potential negative impact of the announcement on local meat producers and the origins of plant-based foods, focusing solely on the environmental benefits of reduced meat consumption.

Meat consumption and its proponents are marginalized, with plant-based eating positioned as the dominant, normative choice for environmental sustainability.

Some comments acknowledge the complexity of achieving zero emissions and support incremental steps toward sustainability, showing a less polarized view.

Policy criticizing discourse

The festival's leadership is stereotyped as hypocritical, greenwashing green-left activists, and plant-based consumers are seen as consuming foreign produce, reinforcing negative stereotypes.

The policy is viewed as discriminatory (vilified) against local meat producers and as an act of virtue signaling rather than genuine environmental concern.

The discourse dismisses (silencing) scientific evidence linking meat consumption to health risks and focuses on criticizing the environmental impact of imported plant-based foods.

The plant-based policy is marginalized as an ineffective environmental strategy, with local meat production positioned as the more sustainable choice.

Some comments acknowledge the complexity and highlight the need for social and economic sustainability alongside ecological efforts, advocating for support of local production.

Discussion and conclusions

The Provinssi festival's food policy announcement led to polarized social media discussions, reflecting broader debates on sustainable food practices.

Some applaud Provinssi for environmental care and vilify meat production as causing environmental degradation and ill health, with meat endorsers stereotyped as climate-ignorant conservatives. This discourse reinforces the environmentalist ideology. Others criticize Provinssi for discriminating against the local meat industry while supporting air travel by performers and imported foods, thereby marrying Provinssi with green-left greenwashing. This discourse interlinks with meat endorsement. However, multifaceted viewpoints surface, too, like omnivores acknowledging the necessity of reducing meat eating and policy critics highlighting local culture and economy as crucial within sustainability discussions. This shows that a discursive complexity exists alongside the polarized black-and-whiteness.

The endorsing discourse, where norms and values of the plant-based-food-related, environmentalist ideology dominate as the truth, while meat becomes the wrongful 'other', echoes previous research's findings regarding discourses on emissions and biodiversity concerns (Hoppe and Kleinen-von KönigsLöw 2023) and positive sentiments towards local and organic food (Vargas Meza and Yamanaka 2020). The discourse critical to the festival's new policy has some parallels with previous findings regarding e.g. resistance to alternative proteins (Matwick 2024; Guo 2024) and the debates around reducing of meat consumption as encompassing contestation (Maye et al 2021).

The arguments balancing between the polar opposites creep in too; from pro-policy, meat-eating festivalgoers who recognise needs to lessen meat intake – showcasing perplexity in relation to criticisms of the food policy's coexistence with air-travel-utilising artists – to anti-policy meat eaters who encourage the support of local meat production to nurture social and economic sustainability in Finland, as such feeding ecological sustainability.

The study shows how Facebook and other social media may stir emotions, fuel confrontation and provoke further polarisation within a discussion already polarised. However, social-media conversations such as studied here may also render positive outcomes, in terms of providing an overview of how sustainable food consumption and production is understood, and which types of realities exist around meat and plant-based foods within public consciousness in Finland. The study reinforces the claim that sociocultural and economic considerations are necessary in understanding and promoting sustainability in the context of eating (Mason and Lang 2017).

References

- Confetto M G, Covucci C, Addeo F, Normando M. Sustainability advocacy antecedents: how social media content influences sustainable behaviours among Generation Z. *The Journal of consumer marketing* 2023; 40(6): 758–74.
- Eissa M. Polarized Discourse in the News. *Procedia, social and behavioral sciences* 2014; 134: 70–91.
- Joose S, Brydges T. Blogging for Sustainability: The Intermediary Role of Personal Green Blogs in Promoting Sustainability. *Environmental communication* 2018; 12(5): 686–700.
- Gustavsson M. Examining the 'cultural Sustainability' of Two Different Ways of Governing Fishing Practices. *Marine policy* 2018; 97: 262–69.
- Hoppe I, Kleinen-von KönigsLöw K. "This is Part of Everything that is Wrong with the World" - A Comparative Analysis of Sustainability Framing in Social Media Discussions About Food in Five Countries. *Environmental communication* 2023; 17(8): 1020–38.
- Locke T. *Critical Discourse Analysis* 2004. London, New York; Continuum.
- Mason P, Lang T. *Sustainable diets. How ecological nutrition can transform consumption and the food system.* 2017. Milton Park, Abingdon, Oxon: Routledge.
- Pohjolainen P, Jokinen P. Meat Reduction Practices in the Context of a Social Media Grassroots Experiment Campaign. *Sustainability* 2020; 12(9): 3822.
- Segovia-Villarreal M, Rosa-Díaz I M. Promoting Sustainable Lifestyle Habits: "Real Food" and Social Media in Spain. *Foods* 2022; 11(2): 224.

- Sutinen U M, Närvänen E. Constructing the food waste issue on social media: a discursive social marketing approach. *Journal of marketing management* 2022; 38(3–4): 219–47.
- Ruiz-de-Maya S, Ferrer-Bernal E. Sustainable food packaging: engagement through the public discourse on social networks. *The journal of product & brand management* 2024.
- Van Dijk T A. *Discourse and Power* 2008. Basingstoke; Palgrave Macmillan.
- Vargas Meza X, Yamanaka T. Food Communication and its Related Sentiment in Local and Organic Food Videos on YouTube. *Journal of medical Internet research* 2020; 22(8): e16761

12.27 Lonkila, A. et al. Paradigms of Finnish livestock production and consumption

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Introduction

Perspectives on food system transformation often remain captive to underlying assumptions related to modernist and capitalist paradigms (cf. West et al. 2021), resulting in solutions aligned with green growth, sustainable intensification (cf. Asquith et al. 2022) and consumers' freedom of choice. We build on the leverage points framework (Meadows 1999, Abson et al. 2017), which turns critical attention to the shallow and incremental solutions that are often offered to accelerate transformation, without changes to the existing system structure or the values and mindsets underpinning it.

Based on the notion of paradigms as the deepest leverage point in a system, we present an empirical understanding of paradigms guiding livestock production and consumption in the Finnish food system and propose an analytical framework for teasing out system paradigms from qualitative data. In existing literature, empirical analyses of system paradigms have been rare. We propose a framework for a co-evolutionary analysis of system paradigms, combining tools from material discourse analysis with deep system understanding. Attention is based on the material characteristics of the Finnish food system and the key metaphors and core assumptions comprising system paradigms.

Theoretical framework

Applying the leverage points framework to sustainability transformation aims for intervening in the right places with maximum transformative impact (Abson et al., 2017; Bolton 2022; Fischer and Riechers, 2019). Shallow leverage points, with low potential for systemic change, include physical system characteristics, isolated system parameters, and feedback loops regulating the system. Deep leverage points, with more transformative power, include the structure of information flows, rules, goals, and paradigms of the system. They can change the system's core beliefs and business-as-usual objectives (Meadows, 2008; Northcott et al., 2023). In the framework, paradigms are understood in the Kuhnian sense (Kuhn 1970) as cognitive and discursive, mental model depicting the "hared idea in the minds of society (Meadows 2008). Systems transformation, thus, requires transforming individuals' values and worldviews (Meadows 1997).

Following relational theories emphasising systems as material-semiotically intertwined, we suggest that paradigms are more deeply implicated within material system configurations (West et al. 2022). Our view on paradigms is based on a coevolutionary understanding of system dynamics: system characteristics are constituted by dominant paradigms, but paradigms are also constituted by system characteristics. This perspective of paradigms better reflects institutional structures and power relations (Buch-Hansen & Carstensen 2021) and highlights paradigms' resistance to change. Research suggests that human cognition, as well as societal and economic structures and cultural practices, are locked-in to mechanisms of growth (Pesch 2018).

Previous research has identified some discursive elements of paradigms, such as 'stable core assumptions' (Pesch 2018) or 'core metaphors' (Davelaar 2022), but provided few guidelines for empirical analysis. In our analytical framework, we build on the leverage points framework as a heuristic for identifying and analysing system characteristics, combined with insights from material discourse analysis

(cf. Hardy & Thomas 2015), and the work on meta-discourses as the hegemonic and dominant constructs of meaning in society (Fairclough 2005, Simoens et al. 2022).

Data and methods

The data consists of agricultural and food policy documents spanning several decades, a literature review, 18 interviews with key food system actors, and four paradigm workshops. We first examined the goals and intents spelled out in policy documents and the company accounts. Past policy goals, measures and actions have material effects in the systems and may create a mismatch between current policy goals, values, and policy actions (e.g. Huttunen, 2015; Kern et al., 2017). We then scoped relevant grey and scientific literature (e.g. reports, reviews, and policy analyses) and interviewed key stakeholders with the objective of analysing tensions, dynamics, and hierarchies between declared goals and to tease out objectives and values not openly stated. Our analysis pointed towards the crucial role of institutions, power, practices, discourses, materialities, and the implicitly assumed and taken-for-granted presuppositions inherent in the system. The paradigm narratives were crafted based on iterative rounds of thematic coding by two researchers, where the whole dataset was reflected against the analytical framework. The paradigm narratives provide an understanding of the core assumptions and metaphors of the paradigm, the main goals of driving it, coupled with the key rules, actors, and practices, as well as materialities and feedback loops shaping it. We acknowledge that these narratives reduce complexities, and that other interpretations are possible.

Four paradigms of Finnish livestock production and consumption

The efficiency paradigm

A free market economy is the only realistic model for organising societal functions. Cost efficiency, resource optimization, and continuous growth are essential. Profitability and competitiveness of the food system enables the social benefits the system produces. Competition is healthy. Companies need to make a profit and grow, and market concentration is a natural consequence of growth. Centralised retail and industry operate efficiently and offer comprehensive services all over Finland. Food is primarily a market commodity, and price competition is a law of nature on the free market. Food must be produced as cheaply as possible to ensure efficiency. Price competition limits farmers' bargaining power, but alternative models for organizing economic activities are not realistic. Sustainability, profitability, and security of supply can best be maintained through resource-efficient and intensive agriculture. Regulation should support free market economy. Market actors will find best solutions to the sustainability crisis.

The paradigm of exceptionalism

Animal production, based on grazing livestock and fodder crop use, is suitable for Finland's climatic conditions and is a natural part of the Finnish food system. Due to Finland's challenging natural conditions, farming, retail and food industry have developed exceptionally efficient practices. By global standards, Finnish production is very clean, ethical, responsible and of high quality. Finnish system corresponds well to the ideal of sustainable livestock production, and Finland has the best expertise in the field. Finnish consumers have high trust in Finnish production. Finnish food system actors are honest and due to self-monitoring, there is no need for added regulation. Finnish farmers have high moral standards. Consumers on global markets would also prefer Finnish food.

Strong confrontation is not part of the operating culture in Finland. Striving for consensus is a key goal of the actors in the Finnish food system. To seek growth beyond small domestic markets, it is best to maintain

a coherent, high-quality image of all Finnish production. There is no need for value-added markets. Agricultural policy is best kept in the hands of farmers' interest groups and the animal industry.

The paradigm of individualism

Freedom of choice guides food consumption and should not be restricted in a free market economy. Food industry and retail provide a wide variety of products and monitor consumption changes. Gentle nudging is used to support more plant-based diets, but promoting a shift from animal-based foods is too political. The responsibility for dietary change is outsourced to consumers. With rising standards of living, food is no longer just a source of nutrition, but also of joy, welfare and a key building block for social identity. Right to food has transformed into right to self-expression and pleasure. Politicians are not willing to regulate consumer choices. Sustainable consumption policies concentrate upon persuasion, nudging and information guidance. Finnish consumers are very price-conscious, which means that markets for added-value sustainable products are limited.

The paradigm of eating animals

Animals should be eaten and produced for food. Meat and dairy are part of the natural human diet and important parts of Finnish food culture. Animal products are familiar everyday food, special festive food, good nutrition, and joy and enjoyment. Nutrition recommendations have long seen animal products as part of a complete Finnish diet. Chicken is an easy everyday food and the best protein for sustainable diets. The welfare of livestock animals is the best in the world, due to responsible industry actors and farmers. Animal health and productive capacity are the main components of animal welfare. Additional regulation is not needed: the industry ensures ethical practices independently. Guaranteeing farmer welfare best supports animal welfare. Animal products are too cheap, but price competition makes this difficult to change. Animal production also guarantees Finnish security of supply.

Discussion

We suggest that critical attention to system paradigms can unlock inertia in sustainability transformation in the food system. Paradigm narratives have power because paradigms are characterized by the status of common sense and appearing to be beyond politics (Machin 2019, (Sengul 2019). Further, as paradigms are not intuitively understood, their empirical portrayals can increase different actors' critical self-reflection and contribute towards inner transformation (Woivode et al. 2021) by opening space for challenging dominant worldviews. Social scientific research on food system change should thus offer platforms and methods for stakeholders to transcend existing paradigmatic thinking when designing more sustainable food systems. It is also critical to attend to how the discourses and practices related to sustainability are translated within paradigms in potential processes of co-optation (van Oers et al. 2021).

References

Reference list available upon request.

12.28 Lundholm, I. Pressures from above: Dairy farmers' motivation to reduce climate impact

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Background and aims

Dairy farmers face a variety of expectations and demands from different actors in the dairy industry to reduce the on-farm climate impact. As for the EU Green Deal Farm to Fork Strategy and the Global Methane Pledge farmers are pressured to reduce and mitigate GHG emissions, increase biodiversity, produce food and fibre at a low cost, and improve on-farm profits (FAO and Global Dairy Platform 2019; European Commission 2020; Beauchemin et al. 2022). As farmers are expected to be more motivated when practices are voluntary, rather than controlled by policies (Sok et al. 2021), understanding farmers' motivation for climate transitions is an important area of research.

Previous research has mainly focused on farmers' motivation to adopt on-farm climate action by studying their intentions (Wang et al. 2023; Swallow & Barkemeyer 2024), emphasising the role of farmers' behavioural factors in their adoption of environmentally friendly practices (Dessart et al. 2019). However, the broader social context and how it influences farmers' motivation to carry out such actions remains underexplored (Knook & Turner 2020). Institutional factors like market incentives, policy regulations, or local community norms are likely to shape farmers' motivation to implement on-farm climate action (Pedersen et al. 2024). Therefore, farmers' climate actions must be studied in the context of their underlying motivations and goals, which are influenced by their social environment (Greve & Teh 2018; Kotlar et al. 2018).

Previous research has shown that farmers continually evaluate which climate goals to prioritise, ensuring that these objectives do not come at the expense of other critical business goals, such as farm profitability (Kopetz et al. 2012; Wheeler et al. 2018). Likewise, it may be complicated for farmers to balance their inner motivation to achieve a desired end-state, goals, and actions with different, and sometimes conflicting, demands from stakeholders and society (Greenwood et al. 2011; Kotlar & De Massis 2013; Williams et al. 2018). This study aims to uncover farmers' underlying goals and actions, represented as goal systems (Kruglanski et al. 2002), to better understand how farmers' motivations are intertwined and shaped by their social contexts in different institutional logics (Friedland & Alford 1991).

Methods

Data was collected using semi-structured interviews with 15 Swedish dairy farmers. Each interview lasted between 1-2 hours. Interviews were conducted either in person at the farm-site or via telephone. The interviewed farmers were sampled purposefully to ensure diversity in herd size, farm location, production methods, as well as age and gender of the managing farmer. An interview guide was used with questions covering farmers' motivation, goals and specific climate actions on the farm.

Nvivo was used to support a thematic analysis of the collected data. In the first-round coding, an inductive approach was used to identify reoccurring themes and categories in respondents' stated activities, goals and shared thoughts (Christensen & Sundahl 2001). In the second-round coding, the study's conceptual framework was used to sort and revise the initial codes to create a set of theoretically anchored themes that identify important elements defining the research domain (Swedberg 2016). Finally, in an

abductive process, we considered the data as examples illustrating the conceptual framework (Siggelkow 2007), allowing us to refine conceptual understandings and resolve inconsistencies.

Results and conclusions

From the interviews we identified three main categories of institutional logics: business, stewardship, and climate logic, all of which shape farmers' goal systems. Business and stewardship logic are well integrated with farmers' inner motivation to achieve goals related to profitability and the responsible use and management of resources. Climate logic, on the other hand, appears to be more of an extrinsic motivation for farmers to reduce on-farm climate emissions.

Therefore, the business logic and stewardship logic dominate climate logic in farmers' goal systems. Where business logic implies that farmers are intrinsically motivated to act in a way that makes them achieve gain goals (to make money), while stewardship logic implies that farmers are motivated to act in a way that makes them achieve hedonic goals (to do what feels good) (Steg et al. 2016). This implies that farmers' climate actions are not generally implemented to achieve normative goals (to act appropriately according to other stakeholders and society), but rather, farmers' underlying motivation is to achieve gain goals and hedonic goals arising from the business and stewardship logics. This suggests that the climate logic may shape farmers' actions, but not their goals.

Researchers and other stakeholders in the dairy industry should not assume that farmers who apply on-farm climate actions are motivated by climate concerns per se (Farstad et al. 2022). Instead, our results suggest that farmers are guided by business and stewardship logics. Thus, dairy industry stakeholders should design climate incentives that take business and stewardship logic into account, as they shape farmers' inner motivation and goal systems.

References

- Beauchemin, K.A., Ungerfeld, E.M., Abdalla, A.L., Alvarez, C., Arndt, C., Becquet, P., Benchaar, C., Berndt, A., Mauricio, R.M., McAllister, T.A., Oyhantçabal, W., Salami, S.A., Shalloo, L., Sun, Y., Tricarico, J., Uwizye, A., De Camillis, C., Bernoux, M., Robinson, T. & Kebreab, E., 2022. Invited review: Current enteric methane mitigation options. *Journal of Dairy Science*, 105 (12). <https://doi.org/10.3168/jds.2022-22091>.
- Christensen, C.M. & Sundahl, D., 2001. The process of building theory. Harvard Business School Working Paper, No. 02-016.
- Dessart, F.J., Barreiro-Hurlé, J. & Bavel, R.V., 2019. Behavioural factors affecting the adoption of sustainable farming practices: A policy-oriented review. *European Review of Agricultural Economics*, 46 (3). <https://doi.org/10.1093/erae/jbz019>.
- European Commission, 2020. Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system. COM(2020) 381 final.
- FAO and Global Dairy Platform, 2019. Climate change and the global dairy cattle sector: The role of the dairy sector in a low-carbon future. FAO.
- Farstad, M., Melås, A.M. & Klerkx, L., 2022. Climate considerations aside: What really matters for farmers in their implementation of climate mitigation measures. *Journal of Rural Studies*, 96. <https://doi.org/10.1016/j.jrurstud.2022.11.003>.
- Friedland, R. & Alford, R., 1991. Bringing society back in: Symbols, practices, and institutional contradictions. University of Chicago Press.
- Greenwood, R., Raynard, M., Kodeih, F., Micelotta, E.R. & Lounsbury, M., 2011. Institutional complexity and organizational responses. *Academy of Management Annals*, 5 (1). <https://doi.org/10.5465/19416520.2011.590299>.
- Greve, H.R. & Teh, D., 2018. Goal selection internally and externally: A behavioral theory of institutionalization. *International Journal of Management Reviews*, 20 (S1). <https://doi.org/10.1111/ijmr.12138>.

- Knook, J. & Turner, J.A., 2020. Reshaping a farming culture through participatory extension: An institutional logics perspective. *Journal of Rural Studies*, 78. <https://doi.org/10.1016/j.jrurstud.2020.06.037>.
- Kopetz, C.E., Kruglanski, A.W., Arens, Z.G., Etkin, J. & Johnson, H.M., 2012. The dynamics of consumer behavior: A goal systemic perspective. *Journal of Consumer Psychology*, 22 (2). <https://doi.org/10.1016/j.jcps.2011.03.001>.
- Kotlar, J. & De Massis, A., 2013. Goal setting in family firms: Goal diversity, social interactions, and collective commitment to family-centered goals. *Entrepreneurship Theory and Practice*, 37 (6). <https://doi.org/10.1111/etap.12065>.
- Kotlar, J., De Massis, A., Wright, M. & Frattini, F., 2018. Organizational goals: Antecedents, formation processes and implications for firm behavior and performance. *International Journal of Management Reviews*, 20 (S1). <https://doi.org/10.1111/ijmr.12170>.
- Kruglanski, A., Shah, J., Fishbach, A., Friedman, R., Chun, W.Y. & Sleeth-Keppler, D., 2002. A theory of goal systems. *Advances in Experimental Social Psychology*, 34. [https://doi.org/10.1016/S0065-2601\(02\)80008-9](https://doi.org/10.1016/S0065-2601(02)80008-9).
- Pedersen, S.M., Erekalı, K.T., Christensen, T., Denver, S., Gemtou, M., Fountas, S., Isakhanyan, G., Rosemarin, A., Ekane, N., Puggaard, L., Nertinger, M., Brinks, H., Puško, D. & Adrián, J.B., 2024. Drivers and barriers to climate-smart agricultural practices and technologies adoption: Insights from stakeholders of five European food supply chains. *Smart Agricultural Technology*, 8. <https://doi.org/10.1016/j.atech.2024.100478>.
- Siggelkow, N., 2007. Persuasion with case studies. *Academy of Management Journal*, 50 (1). <https://doi.org/10.5465/amj.2007.24160882>.
- Sok, J., Borges, J.R., Schmidt, P. & Ajzen, I., 2021. Farmer behaviour as reasoned action: A critical review of research with the theory of planned behaviour. *Journal of Agricultural Economics*, 72 (2). <https://doi.org/10.1111/1477-9552.12408>.
- Steg, L., Lindenberg, S. & Keizer, K., 2016. Intrinsic motivation, norms and environmental behaviour: The dynamics of overarching goals. *International Review of Environmental and Resource Economics*, 9. <https://doi.org/10.1561/101.00000077>.
- Swallow, N. & Barkemeyer, R., 2024. Examining farmers' motivations to engage in low-carbon agricultural practices: A study of New Zealand dairy farmers. *Journal of Rural Studies*, 111. <https://doi.org/10.1016/j.jrurstud.2024.103440>.
- Swedberg, R., 2016. Before theory comes theorizing or how to make social science more interesting. *The British Journal of Sociology*, 67 (1). <https://doi.org/10.1111/1468-4446.12184>.
- Wang, S., Höhler, J., Ang, F. & Oude Lansink, A., 2023. Dutch dairy farmers' adoption of climate mitigation measures – The role of socio-psychological and socio-demographical factors. *Journal of Cleaner Production*, 427. <https://doi.org/10.1016/j.jclepro.2023.139187>.
- Wheeler, R., Lobley, M., Winter, M. & Morris, C., 2018. "The good guys are doing it anyway": The accommodation of environmental concern among English and Welsh farmers. *Environment and Planning E*, 1 (4). <https://doi.org/10.1177/2514848618817487>.
- Williams, R.I., Pieper, T.M., Kellermanns, F.W. & Astrachan, J.H., 2018. Family firm goals and their effects on strategy, family and organization behavior: A review and research agenda. *International Journal of Management Reviews*, 20 (S1). <https://doi.org/10.1111/ijmr.12167>.

12.29 Lähde, V. A New conceptual constellation of food systems and crises

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A New Conceptual Constellation of Food Systems and Crises

Ville Lähde, BIOS Research Unit (www.bios.fi) Note: This conference paper is based on the article “The crises inherent in the success of the global food system” (2023), published in *Ecology & Society*, Vol. 28, Issue 4, Article 16: <https://doi.org/10.5751/ES-14624-280416>

The original inspiration for writing our article on food systems and food crises was the COVID 19 pandemic, and the first Finnish draft was published in the BIOS Research unit blog in May 2020 (in Finnish). During the opening stages of the pandemic, food crises were discussed in public much more than for many years since the last global food crisis (or series of crises) during 2008–2011. The process of writing, and the long sequences of academic reviews, took us past the logistical crisis brought on by the ship *Ever Given*, and into the perfect storm raised by the Russian invasion of Ukraine and the contemporaneous weather-related production shocks in many areas. The topic became more pertinent by the day.

The resulting public discussion in Finland, and in Europe more generally, gave an additional impetus for our research. Ideas of national self-sufficiency, even autarky, were suddenly in vogue, and at the same time there was strong pressure for downgrading environmental policies “in order to safeguard food security”. (In Finnish discussion, the term “food security” was increasingly conflated with preparedness, security of supply or national self-sufficiency.) It seemed to us that instead of deepening public understanding about food systems and crises, this entanglement of war, pandemic, logistic choking and environmental changes was feeding simplistic ideas about national selfishness and beggar-thy-neighbor policies, some with clear racist overtones. New conceptual tools were needed to get a handle on the situation and to highlight recurring misconceptions.

Notes on methods: since the BIOS Research Unit is a small outfit, and as I am the only one of our 10 researchers with a food system focus, the work consisted of wide examination of literature, informal discussions with peers, synthesis of views from diverse fields and conceptual analysis and critique. We did not have resources for empirical work, nor was there any specific project funding. Work on this article took place alongside our other workload during 2020–2023. I was the main writer: other BIOS researchers offered targeted support in finding references and commenting on the manuscript.

Originally the focus of our work was on exploring views on food crises and relating that to critique of productionism. (I had been working for years on the latter issue, in connection with definitions and metrics of hunger and food insecurity. That article was published in Finnish: <https://aluejaymparisto.journal.fi/article/view/79663>) But as the work progressed, we ran into problems concerning the concept of food system. The core problem was that on the one hand one could argue that there is one, deeply and tightly intertwined global system. But on the other hand, it was clear that there was a legion of diverse local, national and regional food systems. Unity in diversity. There was “a system of systems”, or “a network of networks”, but such terminological wordplay would not get one very far.

It was evident to us that different conceptual tools would be needed to handle the unity and the diversity. The dominant conceptual model, that followed the path laid by the classic article by Ericksen (2008), was intra-system: it diagnosed the operating parts and key agents within a more or less clearly delineated single food system, looking also at inputs and outcomes. Such diagnostic conceptualization aimed at understanding the dynamics of a food system, of e.g. a country or a region. Diagnosing diverse food systems with such a conceptualization and comparing them could lead to typologies between types of food system (e.g. traditional, mixed, modern).

However, these intra-system conceptualizations necessitate delineating outside/inside: there are inputs and outcomes, and the food system is related to other socio-ecological systems (energy, logistics etc.). But what would the “outside” be for the global food system? Looking at the global food system with the same conceptualization did not seem to be a fruitful approach.

This in order to complement, not to replace, the Ericksenesque intra-system conceptualization we drafted an inter-system conceptualization. The first attempt would be a rough model, an attempt to show a direction of travel. We chose to look at national food systems as units within the larger whole, because food trade between nations has such a crucial role on the formation of the global food system, “the system of systems”.

[See Figure 1 in the original article]

"Global food system as a network of networks: the network of national food systems around the world forms a center–periphery constellation. The food systems of the center are tightly and multi-directionally connected (connecting lines). There are key export hubs (black), but the other central food systems (blue) are not exclusively dependent on them. The food systems of the periphery (red) are characterized by weak access to the center and even neighboring systems (dashed lines) and strong dependency on the main export hubs of the center (arrows from export hubs)."

Our tentative division of national food systems into center and periphery does not denote geographical distance rather than the economic and political status in the constellation of power formed by the global food system. Roughly: the countries of the periphery are often import-dependent or have vulnerable food systems, and they tend to have a narrow selection of trade partners and to be in a weak negotiating position. Lack of resilience is characteristic.

The food systems in the center are more diverse, ranging from export hubs to import–process–export countries and to import-dependent wealthy countries with the resources and the political wherewithal to negotiate alternative trading connections, if need should arise.

Using this conceptualization, we were able to differentiate between types of food crises and how they would affect national food systems, depending on their position in the network:

[See Figure 2 in the original article]

"Four types of food system crises. 1) Local production shock: adding imports to supplement lacking local production is easier for countries of the center than those of the periphery. 2) Disruption in an export hub: the effects travel in the network but are experienced differently. The countries of the center can find new pathways in the network, which is hard in the periphery. 3) Simultaneous disruptions in many export hubs: the crisis becomes widespread in the system and its effects are felt also in the food systems of the center. 4) Long-term, widespread degradation of production: the globalized food system becomes less tightly coupled, reducing resilience for all."

This conceptualization helped us to highlight the asymmetries of resilience vis-a-vis food crises: how increasing resilience for some might erode that of others, as the relationships in the network were altered. The beggar-thy-neighbor policies in fertilizer markets in recent years are a good example. For the countries of the periphery, transformative resilience is especially hard, meaning the ability to change the nature of one's food system to better handle crises. Their operating space is delimited by the dominant trade relations and lack of agency in international food policy. We developed a rough typology for strategies of reducing vulnerability (or increasing resilience).

[See Figure 3 in the original article]

"Strategies to reduce vulnerability of food systems. 1) Increase local production in order to decrease the need for imports. 2) Diversify importer portfolio in order to gain resilience against supply shocks and other disturbances. 3) Form regional coalitions in order to facilitate mid-distance trade."

Such strategies could not, however, change the fundamental inequalities of the global network of food systems, so we took some tentative steps in looking for transformative pathways. These do not fit the confines of a short presentation, but those interested can explore the original article.

Some concluding remarks

For me, perhaps the most interesting part of this work was how it showed a deep tension in the current food system paradigm. The tightly connected network, showing high degree or specialization and a lack of buffering and redundancy, has succeeded in growing aggregate production and decreasing certain kinds of localized food crises. But in the shadows of success, other kinds of vulnerability have emerged. These vulnerabilities result on the one hand on the complex structure of the network itself, and on the other hand, the increasing unpredictability of conditions resulting in mutually amplifying environmental problems – “multiple breadbasket failures” are exceedingly likely, for example.

Our proposal for a new conceptualization is clearly a rough draft at this stage, and to be truly useful it would have to be fleshed out with empirical details. Since I lack the organizational resources for such work, I am only happy if someone gets interested, picks up this idea and runs with it. Further steps in fleshing out this conceptualization would include for example:

- the role of corporations in food systems
- the internal diversity of national food systems (e.g. food insecurity amongst plenty, food deserts)
- the possibility of a meso-level in the model (e.g. processing and logistic hubs).

12.30 Mathjis, E. et al. Tipping the protein transition: a transdisciplinary case study from Flanders, Belgium

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Introduction

Affluent societies tend to overconsume animal-based foods, leading to adverse environmental and health outcomes. A protein transition —defined as a shift from animal-based proteins to plant-based or alternative protein sources — is underway in these societies, but its pace varies and remains insufficient. The protein transition requires both a consumption and a production shift. Consumers need to shift their food intake away from animal-based sources, which requires a shift in meal ingredients and meal composition supplied by producers and service providers. Pioneer consumers and products exist, but the size of the market is still relatively small, i.e., it is still a niche. To break out of the niche and upscale the protein transition requires a sufficient amount of consumers to make the shift in order for industry to develop economically feasible solutions, while government intervention is needed to break the stalemate at different levels.

Lenton et al. (2022) introduced the concept of "positive tipping points" as pivotal moments where small, intentional interventions can catalyze self-reinforcing feedback loops, leading to rapid and sustained transitions toward sustainability. Contrasting with negative tipping points—such as climate system collapses—positive tipping points are characterized by their potential to drive beneficial systemic changes across social, technological, and ecological domains. The authors identify several mechanisms to enable and trigger these tipping points. The framework emphasizes the importance of multi-actor engagement and coordinated actions to overcome inertia and complexity in systems, aiming for a just and equitable transformation toward global sustainability.

Aschemann-Witzel and Schulze (2023) explore the application of societal tipping points in the context of transitioning to plant-based diets. They argue that achieving widespread adoption of plant-based diets requires reaching a critical mass where small additional interventions can lead to large-scale change. They discuss how changes in social norms, consumer behaviour, and market dynamics can collectively contribute to such a tipping point. They emphasize the role of various actors, including policymakers, businesses, and civil society, in creating enabling conditions and implementing interventions that promote plant-based consumption. Further advancing this line of inquiry, Schulze et al. (2024) integrate models of behavior change, food consumption, and marketing into the framework of positive tipping points to understand transitions in sustainable food consumption. Through empirical analysis of four Danish case studies, they identify enabling conditions, interventions, and reinforcing feedback mechanisms that can lead to societal tipping points. They conclude that understanding and leveraging positive tipping points can provide a strategic approach to achieving large-scale shifts toward sustainable food systems.

This paper reports on a four-year transdisciplinary project “Green Deal: Protein Shift on our plate” (GDPS) initiated by the Flemish Government in 2021. The GDPS brings together relevant stakeholders—protein producers and processors, retailers, catering, NGOs, policymakers and knowledge institutes—on a voluntary basis to accelerate the transition towards more plant-based diets. A learning history (see Roth and Kleiner, 1995) was created to detail all activities of the GDPS and its pre-development based on an analysis of policy documents, GDPS documents, embedded action research and interviews with the project’s initiators. Activities carried out in the GDPS have been mapped using the Triggering Tipping Cascades Framework.

The green deal protein shift on our plate

In 2017, the Flemish government introduced a new policy initiative, called the Green Deals. Green Deals are three-to four-year collaborative projects that can be set up any organization, designed to facilitate the transition of sectors and organisations towards more sustainable practices. Organisations (government agencies, companies, civil society organisations, etc.) voluntarily sign Green Deal agreements with the Flemish Government, committing to take an effort for sustainable actions and engage in mutual exchange (Vlaamse Overheid, 2024). Specifically, the Green Deal ‘Protein Shift on our plate’ (GDPS) aimed at increasing Flemish consumption of plant-based food, from a animal-to-plant-based protein ratio of 60/40 to 40/60 in 2030, while reducing total protein intake. The GDPS was initiated by a consortium of three government agencies (environment, agriculture and health), two universities and 2 civil society organisations in April 2021 and is scheduled to run for four years. By the time of the launch 65 organisations signed the agreement as signatories of the GDPS (Vlaamse Overheid, 2021) increasing up to 84 in 2024 (Vlaamse Overheid, 2024). Signatories include all retailers, caterers, food manufacturers, local governments, NGOs, educational and research institutes, etc.

From food routines to triggering tipping points

Initially, the GDPS used a framework on food routines as socio-cultural routines developed by the Dutch Planning Agency for the Environment as a theory of change to help guide the GDPS (Planbureau voor de Leefomgeving, 2020). The framework allows to analyse food consumption habits in a systematic way and to change these habits effectively. Food routines are subdivided into three categories, called “building blocks”, that are interrelated, including (1) protein culture, (2) food skills and (3) a healthy, qualitative and safe food offer. While work was organised alongside these categories, participants increasingly voiced the need for a new theory of change to better capture the big picture. We introduced the Triggering Tipping Points framework developed in Food and Land Use Coalition & University of Exeter (2021) and later published as Lenton et al. (2022). Steering committee members used the framework to organise its final progress report detailing all GDPS activities thus better identifying possible trigger points. More specifically, the committee (1) defined the conditions for the protein shift to happen, (2) defined 15 clusters of actions taken in the GDPS and assigned these clusters to the types of intervention and (3) reflected to what extent the GDPS has contributed to the identified conditions, using three guiding questions: (i) which conditions were not or less targeted by the interventions from the GDPS, and are these addressed elsewhere or do they represent a gap, (ii) what actions are needed, by which actors and in which settings, to meet this condition, and (iii) if there are gaps, are these aspects we could focus on more in a follow-up to the GDPS? The reflection helped in shaping the extension of the project beyond its end.

Five conditions were identified:

1. Competitive prices: Consumers have sufficient choice in plant-based and novel protein sources at competitive prices compared to equivalent animal protein sources.
2. Performance and quality: Plant-based and novel protein sources are produced as locally as possible and are convincing in terms of taste, texture, and ease of preparation, whether or not compared to animal-based alternatives.
3. Accessibility: The range of plant-based and novel protein sources is broad and deep, and easily available in shops, (company or school) canteens, and from online providers (including food boxes and delivery platforms). They are offered in an appealing and accessible way. The food environment (choice architecture) is designed to encourage healthy and sustainable choices (as the most logical and easiest option) and to avoid an oversupply of unhealthy and less sustainable animal-based protein sources

4. Cultural and social norms: Consumers perceive plant-based and novel protein sources as self-evident and feel good about following a half-and-half diet. It is part of the Flemish food culture. It is the norm to be able to choose from an assortment that consists of at least half plant-based or novel protein sources in various settings (e.g. at home, at work/school, on the go, etc.). An offering that lacks sufficient high-quality plant-based and novel protein options does not meet expectations.
5. Food skills: consumers, as well as food providers (e.g. catering services, hospitality), understand why the half-and-half approach is a smart choice. They are inspired by dishes in which plant-based and novel proteins take center stage, know where to find them, and possess the knowledge and skills to prepare meals with these protein sources that are easy to cook and fit into daily routines.

The analysis of how the various activities reported under the GDPS highlighted that most of them have contributed to changing cultural and social norms, as most activities were communication actions. Actors instrumental for the other conditions were identified and will be targeted for the next iteration of the GDPS to be started in 2025. A critical success factor for carrying out this analysis has been the commitment of the non-academic GDPS participants of the steering committee, who pointed to the large time investment that is needed for carrying out these transdisciplinary activities.

References

- Aschemann-Witzel, J., Schulze, M., 2023. Transitions to plant-based diets: the role of societal tipping points. *Curr. Opin. Food Sci.* 51:101015
- Food and Land Use Coalition & University of Exeter, 2021. Accelerating the 10 Critical Transitions: Positive Tipping Points for Food and Land Use Systems Transformation
- Lenton et al., 2022. Operationalising positive tipping points towards global sustainability, *Global Sustainability*, 5, e1.
- Planbureau voor de Leefomgeving, 2020. Voedselconsumptie veranderen: bouwstenen voor beleid om verduurzaming van eetpatronen te stimuleren. Den Haag.
- Roth, G. and Kleiner, A. (1995). Creating a learning history. MIT, Cambridge.
- Schulze, M. et al., 2024. How to move the transition to sustainable food consumption towards a societal tipping point, *Technological Forecasting and Social Change*, 203, 123329.
- Vlaamse overheid, 2021. Green Deal Eiwitshift op ons bord Initiatierapport.
- Vlaamse Overheid, 2024. Green Deals in Vlaanderen. <https://omgeving.vlaanderen.be/nl/greendeal>

12.31 Milford, A. et al. System lock-ins and interventions for sustainable dietary transitions: comparative case study of Finland and Norway

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Introduction

Sustainable diets have been underlined in the political agenda as a part of the Farm to Fork strategy of the European Union that seeks to establish equitable, health-conscious, and environmentally sustainable food systems, guaranteeing widespread access to ample, safe, nutritious, and sustainable food systems [1]. Some of these suggestions for sustainable diets comprise opting for a predominantly plant-based diet, emphasizing seasonal and local foods. Boosting the production and consumption of fruits and vegetables (hereafter F&V) is acknowledged as a pivotal step toward realizing these goals and implementing policies to address F&V intake is critical [1, 2].

Finland and Norway are northern countries with challenging conditions for agriculture, yet both countries have available land to substantially increase F&V production [3]. It is a political aim in both Finland and Norway to increase F&V consumption, and different measures have been taken to achieve this aim. An increase in domestically produced F&V could retain agricultural employment and increase self-sufficiency levels.

In this study, we seek to learn about and compare strategies and intervention measures for increased F&V consumption in Finland and Norway, as well as system lock-ins that inhibit the implementation of these measures. Our research questions are:

- Which strategies have been implemented in Finland and Norway to increase the consumption of domestically produced F&V?
- What are the country-specific system lock-ins for implementing strategies for a transition towards more F&V consumption?

There is little previous research and analysis of concrete examples of intervention measures for increased F&V consumption, which studies the role of different food system actors and how they interact when implementing these measures [9]. Comparative studies of these aspects in different countries are also rare.

Theoretical approach and methods

The empirical data for this study were collected through document analysis of seven Finnish and nine Norwegian government white papers and strategies related to food and agriculture, dating from 2010 until present, as well as annual reports from the main retailers and wholesalers in Norway (10) and Finland (8). Interview guides were developed based on document analysis and research questions. Semi-structured in-depth interviews were conducted with 15 stakeholders from industry, public authorities and NGOs, all possessing expertise in the F&V sector in Norway and Finland. Data were analysed with NVivo.

We lean on system lock-ins in sustainability transitions literature, referring to structural, institutional, economic, or social factors that maintain the status quo and hinder the shift toward more sustainable practices and systems. These lock-ins create resistance to change, making it difficult to transition from unsustainable to sustainable paradigms [4].

Findings

Implemented measures

Finland and Norway have recently launched new food based dietary guidelines, and, in relation to this, healthy diet campaigns were organised. Norwegian Health Authorities have also had various information campaigns over the years, and actors from the private sector have signed an “intention agreement” with the Norwegian Directorate of Health to work for healthier diets. The horticultural sector in Norway is organised into a few large organisations (cooperatives and NGOs), and there is one large fruit and vegetable wholesaler, BAMA, catering for the majority of the retailers. The horticultural sector, including BAMA, provides, together with the government, funding to the “information office for fruits and vegetables” (OFG), which runs information activities for increasing F&V consumption. In Finland, cooperatives and NGOs are divided between different sectors (fruit and berries, greenhouses and field vegetables), and each of them takes responsibility for the promotion of F&V, with funding from producers.

Public authorities in Finland put more emphasis than Norway on providing education about healthy diets to children through the school curricula, for instance by implementing the “Tasty School” model. Finland has also sought to increase F&V intake through the free lunches they provide to all school children.

Retail chains in Norway and Finland have numerical goals of increasing sales of F&V and have implemented several measures that may influence consumer habits, such as placing the F&V section at the entrance of the shops and advertising for F&V with price incentives. An application by the K-group in Finland provides information about which monthly or yearly food purchases are in line with the national dietary guidelines.

System lock-ins

Finland and Norway have similar social and economic system lock-ins, as both countries, historically, due to natural conditions making horticulture challenging, have had relatively little production and consumption of F&V. In both countries, livestock producers have increasingly been protected with subsidies and import tariffs, which has created path-dependency, and a system locked into prioritising this sector. Horticultural producers have, to a larger extent, been expected to manage by themselves, including in competition against imports. Institutional lock-ins caused by the political power of actors with vested interests seem to be stronger in Norway. For instance, Finnish policy strategies express clear aims of reducing meat consumption, while the Norwegians don't.

Over the past few years, there seems to have been a change in attitudes towards a stronger emphasis on healthy diets, including F&V consumption, perhaps due to increased knowledge about the importance of this. In Norway, this seems to have led to a stronger prioritisation of the horticultural sector.

Discussion

Both Finland and Norway have implemented measures that theoretically should increase F&V consumption through improved food literacy and a more encouraging food environment, but the exact impact of these interventions is unclear. Finland has more emphasis than Norway on educating and influencing children's habits, which is considered a particularly important strategy [6]. Neither of the countries' public authorities has implemented market-based measures. One of the Finnish food policy strategies contained an aim to reduce the VAT for F&V, but this was never implemented. The retail sector has reduced price campaigns for F&V, but they also have this for other food products, including meat, sweets etc.

In Finland, public authorities within health, agriculture, environment and education collaborate and have successfully implemented policies directed towards encouraging healthy diets among school children. Policies in Norway are more siloed. However, Norway has a more coordinated horticultural sector comprising both public and private actors. Norway, which has large incomes from the export of petrol, also has more public funding for promotion campaigns.

In some studies on food system transformation, the private sector is considered an adversary as they are profit maximising and, presumably, sales of unhealthy foods are more income generating than healthy [7]. Our study shows that the private sector, which in this case implies producers and wholesalers of F&V, as well as retailers, can play an important role in dietary transitions. They have incentives to increase the consumption of F&V and funding opportunities to implement a range of different measures in areas where the public sector has little influence, such as in supermarkets. Furthermore, the private sector is not hindered by the same institutional lock-ins as the public sector.

Finland seems less locked into prioritising livestock than Norway. Explanations for this could be that in Finland, other agricultural sectors, including cereal and horticulture, are more economically important than in Norway, or that the agricultural sector in Finland has less influence on food policy than in Norway. Another explanation could be that food policy in Finland is more holistic. In line with recommendations from previous studies of food system transformation [8], Finland has a stronger integration of public authorities for health, agriculture, environment and education. Such a policy integration could help disrupt siloed decision-making processes.

Conclusion

A dietary change towards more F&V consumption requires addressing consumers and their food environments and food literacy. This has been accomplished to some extent by both the private and public sectors in Finland and Norway. However, such a dietary change has implications for producers and therefore also requires new visions for the different agricultural sectors, and the involvement of all stakeholders in a more fundamental food system transformation.

References

- European Commission. Sustainable food consumption and facilitating the shift towards healthy, sustainable diets. 2024 [19.02.2024]; Available from: https://food.ec.europa.eu/horizontal-topics/farm-fork-strategy/sustainable-food-consumption_en.
- FAO. Sustainable diets and biodiversity: Directions and solutions for policy, research and action. 2012 <https://www.fao.org/nutrition/education/food-dietary-guidelines/background/sustainable-dietary-guidelines/en/#:~:text=Sustainable%20diets%20are%20protective%20and,optimizing%20natural%20and%20human%20resources>.
- Harwatt, H., et al., Environmental sustainability of food production and consumption in the Nordic and Baltic region—a scoping review for Nordic Nutrition Recommendations 2023. *Food & Nutrition Research*, 2024. 68
- Eitan, A. and M.P. Hekkert, Locked in transition? Towards a conceptualization of path-dependence lock-ins in the renewable energy landscape. *Energy Research & Social Science*, 2023. 106
- Herrero, M., et al., A Shift to Healthy and Sustainable Consumption Patterns, in *Science and Innovations for Food Systems Transformation*, J. von Braun, et al., Editors. 2023: Cham (CH)
- Swinburn, B.A., et al., The Global Syndemic of Obesity, Undernutrition, and Climate Change: The Lancet Commission report. *Lancet*, 2019. 393(10173)
- Edwards, F., R. Sonnino, and M.L. Cifuentes, Connecting the dots: Integrating food policies towards food system transformation (vol 156 , 103735 , 2024). *Environmental Science & Policy*, 2024. 158.

Wolfenden, L., et al. (2021). Consolidating Evidence on the Effectiveness of Interventions Promoting Fruit and Vegetable Consumption: An Umbrella Review. *International Journal of Behavioral Nutrition and Physical Activity*, 18(1).

12.32 Niemi, J. et al. Regional economic impacts of climate change mitigation in Finnish agriculture

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A significant decrease of greenhouse gas (GHG) emissions from Finnish agriculture requires a considerable decrease in emissions from peat soils, a decrease in consumption of livestock products or changes in agricultural production methods. Because the largest share of agricultural peatlands is situated in Northern Finland and in Ostrobothnia, where also cattle production has a notable role and economically feasible alternatives for dairy and beef production are limited, regional justness comes into focus when designing policy measures. This far, there has been only very little analysis on the regional effects of the sustainability transition in the food system. This study utilises a sector level agricultural modelling and regional input-output modelling to examine how alternative scenarios for reducing agricultural GHG emissions would affect agriculture and other sectors in different regions of Finland. Regional economic impacts are assessed from the perspectives of economic output and employment.

In specifying alternative scenarios for reducing agricultural GHG emissions, we focus on different assumptions on two central factors – land-use and food consumption – and agricultural policy and agricultural practices related to them. The study first creates a baseline scenario, which is characterized by a continuation of current diet and current (2023-2027) agricultural policy over the study period, up to 2050, with no additional measures taken to reduce GHG emissions. The alternative scenarios contain (i) the land-use driven transition pathway based on current food consumption and (ii) two alternative transition pathways based on dietary change where the consumption of meat and dairy products decreases either by one third (–33%) or by two thirds (–67%) by the year 2050. In two the diet change scenarios, the livestock products are replaced by other sources of protein, such as plant-based food, including legumes, wholegrains and products processed from them, vegetables and exported plant-based proteins as well as fish in accordance with the Finnish nutritional balance recommendations (National Nutrition Council 2014).

In order to evaluate quantitative effects of these different scenarios on agricultural production and agricultural land use as well as farm income and use of workforce in different regions, we analysed the four above-mentioned scenarios first by the regional sector model of Finnish agriculture (Lehtonen et al. 2022). This dynamic model enables the studying of the effects of alternative market and policy scenarios on agricultural production, land use and farm income regionally until the end of the scenario period in the year of 2050. In the model, the Finnish agriculture is divided into four main regions: Southern Finland, Inner Finland, Ostrobothnia, and Northern Finland.

The regional results on agriculture in different scenarios are the starting point for the evaluation of the effects on regional economies. When a change occurs in agricultural production, its impacts have an effect, in addition to agriculture, on other industries in value chains through connections directed backwards (agricultural input demand) and forwards (agricultural raw material demand). The effects created by agriculture on other industries (processing, transport, trade, energy production, water and waste management etc.) are called multiplier effects or indirect effects to differentiate them from the direct effect that describes the output or employment of the examined industries themselves. The multiplier effects of production changes occurring in agriculture on other industries are calculated by means of a regional-economy input-output model (see the input-output model in e.g. Miller & Blair 2020). Agriculture acquires inputs required in production from the food industry e.g. as animal feeds, and the food industry acquires raw materials needed for the inputs from agriculture. When calculating indirect effects, the overlapping multiplier effects are removed in order not to calculate them twice.

The effects of different scenarios on the regional economies were examined in more detail for four example regions: Southwest Finland, South Ostrobothnia, North Savo, and Lapland. In the scenario based on the change in land use where farmers are paid remuneration of emission reductions, it is possible to preserve the quantity of the agricultural output almost the same as in the baseline pathway in different parts of the country. Then, the multiplier effects on the economy also remain quite small. The largest relative changes would occur due to the significant change in diet and changed food demand and the implied possible decrease of agriculture and food processing. According to this study, the change in diet would cut the economic output in South Ostrobothnia for 5–8 percentage points if the economy in the region was presumed to remain otherwise unchanged. In North Savo, the economic output would decrease by 2–4 percentage points. In Southwest Finland, where there are prerequisites and sufficient degree-days for expanding e.g. the production of bread cereals and challenging legumes, even a dramatic change in diet would not have a significant effect on the regional economy. Also in Lapland, where the significance of agriculture and food processing is the smallest of the regions studied, a change in diet would cut the economic output only one percentage point. An essentially important result is also that incentives that promote the change in land use, such as remuneration for reducing the GHG emissions of agricultural land, would not as such cause changes to agricultural production and regional economies in areas where there is a lot of farmlands on peat soil and bovines in relation to the total area under cultivation and agricultural production. This result, however, is based on the assumed swift re-allocation of livestock and other production from peat soils to mineral soils, while such re-allocations may be slow and imply adjustment costs not fully considered in the models. Still the results show the direction of change.

Overall, the results show that transition to a low-carbon food system would lead to rather different economic regional outcomes, and effects would be clearly negative in regions where agriculture is a large sector in the regional economy, especially if agriculture is dominated by beef and milk and few other types of agriculture is feasible in the region. This is a challenge for just transition.

References

- Lehtonen H., Huan-Niemi E. and Niemi J. (2022). The transition of agriculture to low carbon pathways with regional distributive impacts. *Environmental Innovation and Societal Transitions* 44(2022).
<https://doi.org/10.1016/j.eist.2022.05.002>
- Miller, R. E. & Blair, P. D. 2020. *Input-Output Analysis. Foundations and Extensions*. Cambridge University Press.
<https://doi.org/10.1017/CBO9780511626982>
- National Nutrition Council 2014. *Nutrition and food recommendations 2014*. The National Nutrition Council of Finland, Finnish Food Authority, Helsinki.

12.33 Niemi, T. & Kuhmonen, I. Imagining biodiversity-respectful food system: paradigms as drivers of transformation

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Background aims

Food systems are major drivers of biodiversity loss, but at the same time, biodiversity existing among food production areas is also declining. In Finland, this decline is largely driven by the intensification of production practices and the homogenisation of agricultural landscapes. Despite growing awareness of the need for change, the Finnish food system remains locked into existing structures, such as specialised production systems, fragmented governance and a persistent focus on efficiency over ecological sustainability. Turning these trends and achieving a biodiversity-respectful food system requires a profound systemic transformation.

Achieving this transformation is further complicated by the different narratives and pathways proposed for building a biodiversity-respectful food system. These divergent approaches often create friction in transition discourses between stakeholders. Sustainability itself is an empty concept without clearly defined content—what is prioritised and how it is framed varies significantly, shaping competing visions for the future. Exploring these future visions requires participatory approaches that bring multiple stakeholders together.

The paradigms of sharing and sparing provide two distinct yet overlapping frameworks for envisioning a biodiversity-respectful food system. Sharing emphasises integrating biodiversity within agricultural landscapes, while sparing focuses on separating intensive production areas from natural ecosystems. These paradigms reflect fundamental differences in mindsets influencing biodiversity policies related to food systems. They also offer distinct but at the same time in some dimensions overlapping alternatives for the organisation of food systems and the respective transformation pathways.

Food systems are complex adaptive systems, not governed by any single individual or entity. Conflicting or unclear visions for the future of the food system, coupled with unequal power dynamics, may reinforce existing structures and hinder transformation. Conversely, during times of system reconfiguration, future visions can play a pivotal role in steering large-scale transformations. Exploring the visions of key stakeholders can not only enhance understanding of the system's future but also support stakeholders in actively shaping and building that future.

Methods

The study employed future studies methodology to explore stakeholder perspectives on the future of food systems with thriving biodiversity. We organised eight workshops in 2024, engaging diverse stakeholder groups: farmers, researchers, non-governmental organisations, agricultural interest groups and extension services, environmental governance, Ministry of Agriculture and Forestry, retail and hospitality sectors and food industry. Each workshop lasted for three hours and followed a structured, yet flexible format designed to encourage open dialogue and the co-creation of future scenarios.

Discussions were guided by two paradigms—sharing and sparing—with participants selecting one as a framework for envisioning future biodiversity-respectful food systems. The workshops were divided into

two parts: the first focused on envisioning what a biodiversity-respectful food system could look like in 2050, and the second examined potential pathways to achieving that future. Key themes given to guide the discussion included diets, food distribution systems, the methods and locations of food production, energy and nutrient metabolism, cultural factors and the broader societal context. This research focuses on the preliminary results of the first parts of the workshops, i.e. future visions.

Results

Key findings include shared characteristics typical of sharing and sparing futures, alongside the recognition that the future is likely to encompass elements from both paradigms. All groups, despite the paradigms they worked with, anticipated a decline in meat consumption and a rise in the prevalence of plant-based diets. However, the extent and motivations for this transition varied among the groups. Some stakeholder groups perceived the shift in food consumption as gradual and consumer-driven, with current trends in reducing meat consumption continuing naturally. Conversely, others viewed the transition towards plant-based diets as more structural and intentional, involving more ambitious public policy measures, the integration of plant-based ingredients as staple foods, and the reduction of meat consumption to a rare luxury, enjoyed primarily during weekends or special occasions.

Recurring themes regarding future visions of diet composition included seasonality, locality, the diversity and healthiness of diets. Skills and the willingness to use raw materials more holistically, bringing along food waste reductions, were highlighted. Additionally, broader questions emerged regarding food culture, including the public's relationship with food, the role of affordability and appreciation for quality over quantity in driving consumption patterns and the balance of power and responsibility in driving the transition between consumers, policymakers and companies. Some participants pondered the balance of bringing back good practices from history and balancing them with new innovations to both production and processing. Many stakeholders indicated that appreciation for food and sufficiency—achieving more with less—would act both as a driver and a product of change.

Stakeholders broadly agreed on the shifting role of animals in the food system. The role of animals was discussed differently in different stakeholder groups, with nearly all recognising the instrumental value of grazing animals for nature and, consequently, for human well-being. For example, while some envisioned livestock as part of small-scale, integrated plant and animal production systems, there were differing opinions on the need for broiler production or the sustainability of fish as a protein source. In a few groups also the intrinsic value of nature and animals was acknowledged. Nevertheless, regardless of the paradigm in question, shifting production to grazing and biodiversity-respecting practices was emphasised.

Many participants highlighted shared challenges, such as bureaucratic structures and siloed governance, as barriers to change. Farmers were identified as particularly stretched under the current system, with several stakeholders stressing that any changes must be implemented in a way that supports farmers' capacities and enables them to adapt to the evolving food system. Divergent views arose regarding the scale of changes and the centralisation versus decentralisation of society. The role of rural areas, the importance of local food systems, and the role of trade in food distribution and market share were debated. These nuanced differences were emphasised according to the paradigm each group adhered to.

Regarding future visions of food production, many stakeholder groups emphasised localisation, collaboration and community. Grazing was included in nearly all visions. Production optimisation was considered especially in sparing visions, focusing it to areas where it is most sensible to produce. In some visions, the development of artisanal products (e.g. cheeses, breads) was noted, potentially indicating a focus on domestic processing. Climate change influencing and altering growing conditions in Finland, necessitating and enabling diversification of crop varieties, was mentioned in many groups. In some visions,

more commonly prevalent in groups working with the sharing paradigm, Finland becomes self-sufficient either on at farm or national level.

Discussions on nutrient use highlighted the importance of circular economy principles and localising nutrient cycles. Circular economy was emphasised in the use of fertilisers, with chemical and synthetic (including imported) fertilisers being replaced by circular solutions such as manure from grazing animals. In some visions, fertilisers sourced from the seabed and human sewage sludge were also considered.

The energy the food system would use was in most visions renewable—either entirely or predominantly. Energy sources mostly mentioned included solar, wind and bioenergy. Some envisioned Finland as a forerunner in hydrogen and emission-free energy as a significant contributor to Finland's international competitiveness.

For the future of international trade, stakeholders emphasised the need for rationalising the balance between domestic and international trade. Fairness and equilibrium were recurrent themes, with many advocating for a primary focus on domestic production, while exporting premium products abroad. Finland's unique conditions and specialties were highlighted, suggesting that the country should leverage its distinctive attributes compared to Southern Europe.

Some stakeholders proposed creating stricter, uniform global environmental standards for food and ensuring that only food produced with the same quality and respect for nature is imported into Finland. Berries and food produced with high environmental standards and biodiversity-respecting practices were identified as a key export advantage. Immigration evoked a range of perceptions, with internationalisation enriching the food culture both in terms of skills and content, contrasted against the challenges posed by immigration pressures.

Sharing futures were deemed more desirable by participants, while, with one exception, sparing futures were considered more likely under current trajectories of the Finnish food system.

Conclusions

The findings of this study suggest that there is potential to achieve consensus among stakeholders on key aspects of the future of food systems. The analysis also highlights the importance of transformation pathways and the agency required to pursue preferred futures. We argue that providing stakeholders with opportunities to envision desirable futures openly and without systemic constraints can help steer the system towards a biodiversity-respectful food system. This consensus can guide informed decision-making and enable stakeholders to actively shape a desired outcome, rather than passively drifting towards an uncertain future.

The workshop approach we adopted, which encouraged participants to articulate and discuss their visions for a biodiversity-respectful food system, supports our argument that open dialogue and the identification of common building blocks are critical. Such an approach could be replicated on a larger scale, crossing stakeholder boundaries and fostering transdisciplinary cooperation, to overcome current lock-ins and drive the systemic changes necessary to achieve a biodiversity-respectful food system.

12.34 Rimhanen, K. & Rikkonen, P. Building resilient food systems: a resilience assessment framework for food supply

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Introduction

Food systems are under growing pressure from climate change, economic instability, geopolitical tensions, natural disasters and health crisis (Béné 2020; Rimhanen et al. 2023; Rikkonen et al. 2024). Ensuring food availability requires enhanced resilience within food systems, and their interconnections with society. This, in turn, calls for monitoring of all aspect of the food system. Such monitoring improves the understanding of system dynamics and supports the development of strategies to enhance food security and resilience.

A resilience assessment framework offers a structured approach to evaluate and strengthen the capacity of food systems to buffer, recover, adapt, and transform in response to disruptions. This paper presents a draft framework designed to offer a systematic and practical tool for assessing food system resilience. The aim is to enable a holistic analysis of food system vulnerabilities and strengths, with a particular focus on the supply side of the food system.

Food system resilience refers to the capacity to provide sufficient, appropriate and accessible food for all over time, even under varying conditions and unexpected shocks (Tendall et al. 2015). It emphasizes adaptability and learning rather than simply maintaining the status quo.

The rationale for proposing a new framework lies in the need to bridge theoretical models of resilience with real-life applications. To achieve this, a practical and integrated assessment tool is needed.

Development of the resilience assessment framework

We propose an analytical method for evaluating food system resilience, structured around five distinct steps, each producing key outcomes:

Step 1: System characterization and identification of disruptions

The first step involves identifying the key components and actors within the food system under assessment, including producers, advisors, industry representatives, authorities, and consumers. The analysis includes mapping interactions and recognizing both external (e.g., climate variability, market fluctuations, policy changes) and internal disruptions (e.g., farm structure, economic status, technological access). Additionally, the time frame and geographic scope, ranging from local to national levels, are defined at this stage.

Step 2: Selection of key questions and indicators

This step focuses on defining key questions and selecting relevant indicators to evaluate the system's ability to buffer, recover, adapt, and transform. Both quantitative and qualitative indicators are considered, covering economic, environmental, and social dimensions of resilience. The indicators are grouped under three main themes:

1. Diverse and independent production systems:
 - Questions explore the diversity of production, farm sizes, methods, crops, and livestock. Quantitative data include the number of farms per sector, the share of organic farms, the

area under different crops, and the diversity of livestock species. Qualitative data include actor assessments of the current and future state, and open questions about factors that limit or enhance diversity. The spatial distribution of production and the degree of regional self-sufficiency are analyzed, along with the distance between production and consumption. Assessments also consider the state of transport infrastructure and the degree of independence from external inputs such as nutrients, energy, feed, and labor, including the impacts of input price volatility and the potential for using alternatives. Farm-level economic metrics like profitability, solvency, and liquidity are evaluated, along with subjective perceptions of entrepreneurial success.

2. System-level understanding and cooperation:

- This theme assesses the awareness of various actors (farmers, businesses, authorities) regarding the food system as a whole. It also evaluates how well consumers and policymakers understand food system vulnerabilities and resilience, accompanied by open questions about ways to improve awareness and understanding.

3. Preparedness and flexibility:

- Questions address the system's preparedness for unexpected shocks, such as extreme weather events, market disruptions, and pandemics. The effectiveness of monitoring and control systems (e.g., food safety, environmental regulations) is reviewed. The availability of critical resources (food, feed, etc.) in emergencies is considered, as well as the flexibility to increase production when demand grows. All aspects include qualitative input through actor assessments and suggestions for improvement.

Step 3: Assessment methods

A mix of methods is selected to analyze quantitative and qualitative data. Quantitative data, such as time-series statistics and national databases, provide objective insights into food system structure, production, and economic performance. Qualitative data are gathered through surveys, interviews, and focus groups, capturing expert and stakeholder perspectives.

Respondents evaluate resilience factors from three angles:

1. The current situation (rated on a scale from very weak to very good),
2. Their desired future direction (whether the factor should stay the same, increase, or decrease),
3. The most likely future development (predicted to stay the same, increase, or decrease).

Step 4: Identifying and exposing vulnerabilities

By combining quantitative metrics with qualitative feedback, the framework uncovers key vulnerabilities in the food system. Structural weaknesses are identified across economic, environmental, and social dimensions, such as yield instability, economic fragility, and gaps in stakeholder cooperation or preparedness.

Step 5: Recommendations and interventions

Based on the assessment, tailored recommendations are developed to strengthen resilience. These might include policy reforms, targeted training, better information dissemination, diversification strategies, and infrastructure upgrades. The goal is to enhance long-term sustainability and the system's ability to handle future disruptions.

Discussion

This study contributes to science, policy, and practice by offering a structured method to pinpoint resilience needs in the food system. Researchers can build on this framework in empirical studies. For policymakers, it serves as a practical tool for decision-making, and strategic planning. For practitioners, it introduces easy-to-use assessment methods that can enhance resilience to shocks and thus enhance preparedness and long-term sustainability across the sector.

Conclusions

This work advances resilience science in food systems by presenting a practical and multidimensional assessment framework. It supports practitioners, researchers, policymakers, and other food system actors in strengthening resilience and food security. The framework is adaptable to various contexts and food systems. As the next steps, the framework will be tested in real-world case studies and further refined based on stakeholder feedback to improve its applicability.

References

- Béné C (2020) Resilience of local food systems and links to food security – A review of some important concepts in the context of COVID-19 and other shocks. *Food Secur* 12:805–822. <https://doi.org/10.1007/s12571-020-01076-1>
- Rikkonen P, Rimhanen K, Aro K (2024) Food system futures in Finland: How do experts evaluate changes in resilience up to 2030? *Futures* 159:103364. <https://doi.org/10.1016/j.futures.2024.103364>
- Rimhanen K, Aakkula J, Aro K, Rikkonen P (2023) The elements of resilience in the food system and means to enhance the stability of the food supply. *Environ Syst Decis* 43:143–160. <https://doi.org/10.1007/s10669-022-09889-5>
- Tendall DM, Joerin J, Kopainsky B, et al (2015) Food system resilience: Defining the concept. *Glob Food Secur* 6:17–23. <https://doi.org/10.1016/j.gfs.2015.08.001>

12.35 Ritala, A. et al. Envisioning the 2040 circular food court: the role of cellular agriculture in future urban experiences

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Abstract

In our vision for 2040, the future food court is built upon a circular food system, integrating cellular agriculture to enhance organic streams and water flows within a closed ecosystem. This vision showcases a future where technology enables hyper-local food production in urban environments. To support this vision, we conducted experiments on producing fungal (*Paecilomyces variotii*, *Rhizopus oligosporus*, *Trichoderma reesei*) and arctic bramble cell culture biomass using side-streams from shopping centers, such as soft drink waste-mix, orange peels, expired bread, spent coffee grounds, and brewer's spent grain. Additionally, we included synthetic urine as a potential future feedstock, which would require efficient purification technologies. Among the tested side-streams, soft drink waste mix, orange peels, and expired bread demonstrated the highest potential as carbon sources for microbial cultivations. Through design of experiments, we identified optimal combinations of yeast extract (nitrogen) and pH to supplement the side-streams for maximum biomass yields. The soft drink waste mix stream and synthetic urine proved highly effective for arctic bramble, and the optimized culture medium reduced costs by 55% without compromising biomass yield. All microbial and plant cell biomasses grown on side-streams exhibited a balanced essential amino acid profile suitable for human consumption. The 2040 vision was presented to various stakeholders during experience workshops in a restaurant setting, where cellular agriculture-based imaginary foods were served. Participants found the future both probable and desirable but emphasized the need for significant attention to circularity. In addition to stakeholder acceptance, policy measures are essential to achieve this vision.

Introduction

The increasing urbanization and the consequent rise in food demand necessitate innovative solutions for sustainable food production. Addressing the planetary emergency related to our current food value chain requires socio-ecological-technological systems to be transformed. Such transformations are long-term, complex, and require political processes and changes.

This study explored the potential of utilizing side streams and waste materials from urban shopping centers as feedstocks for microbial and plant cell cultures. The focus was on the production of microbial proteins and plant cell biomass using various waste materials, including orange peels, soft drink waste mix, expired bread, spent coffee grounds, and artificial urine. The aim was to enhance the circular economy by converting waste into valuable food ingredients (1,2).

A future-oriented mindset is very important in addressing food sustainability challenges. The ability to adapt to new food production methods, driven by technological advancements and crises, is crucial. Acceptance of cellular agriculture-based foods and controlled-environment production must consider long-term safety and ethical implications to maintain consumer trust. Psychological factors play a significant role in sustainability efforts, with a strong belief in individual agency fostering proactive approaches. Embracing innovation and technology in food production strengthens resilience. Optimism in collective action and

policy influence drives systemic change. This study explored an experiential futures approach, and we presented our 2040 future food vision to various stakeholders during experience workshops in a restaurant setting, where cellular agriculture-based imaginary foods were served (3).

Methodology

Microbial Cultivation: The side streams were collected from local sources and pretreated to facilitate sugar release. Orange peels were minced and subjected to enzymatic sugar extraction. Spent coffee grounds were steam-exploded and enzymatically hydrolyzed. Expired bread was sorted, dried, and enzymatically treated. Soft drink waste mix was prepared by mixing various soft drinks and water. Artificial urine was prepared using a standard recipe. *Trichoderma reesei*, *Paecilomyces variotii*, and *Rhizopus oligosporus*, were grown on media containing the pretreated side streams. Flask cultivations were conducted to screen for suitable nutrient supplementations, and the most promising conditions were further optimized using design of experiments (DoE) methodology. Bioreactor cultivations were performed to validate the optimized conditions (1).

Plant Cell Cultures: The potential of using side streams from shopping centers as feedstocks also for plant cell cultures of arctic bramble (*Rubus arcticus* L.), barley (*Hordeum vulgare* L.), and tobacco BY-2 (*Nicotiana tabacum* L.) was explored. Preliminary screening experiments were conducted in shake flasks to evaluate the growth of plant cell cultures on media supplemented with side streams. The culture medium composition was optimized using DoE software to maximize biomass production and reduce costs (2).

Experiential futures approach: The "Future Food Court Workshops" were held in 2023 at Kämp, Helsinki, Finland. The restaurant was simulated as a 2040 food court, serving innovative imaginary food items, including cellular agriculture-produced wine and coffee. Initially piloted with VTT employees (n=20), the workshops included 18 tables with mixed Finnish participants from industry (13), the public sector (10), third-sector organizations (11), educational institutions (4), and consumers (14). In total, 70 participants (51 female and 19 male) engaged in the co-design sessions. While eating the four-course meal, a narrator playing a role of a butler guided the participants experiencing the future, and stakeholders were introduced to future-oriented food scenarios enhanced with AI-generated visuals and real-life videos. Facilitated focus group discussions ensured active discussion threads aligned with the predefined framework. At the end, participants were informed that the foods were prepared using ingredients currently available on the market, and a list of imaginary cellular agriculture companies was presented (3).

Results

Microbial Protein Production: The pretreatment of side streams resulted in suitable sugar concentrations for microbial growth. Flask cultivations showed that nitrogen supplementation, with yeast extract and artificial urine significantly increased fungal biomass production. The optimal conditions for biomass production were further examined using DoE methodology and validated in laboratory-scale bioreactor cultivations. The bioreactor cultivations of *T. reesei* and *P. variotii* with soft drink waste mix or orange peel juice supplemented with yeast extract resulted in good biomass production, with total protein contents of 22-35%. Amino acid analyses revealed balanced essential amino acid distributions for human consumption, confirming the potential of these by-products as substrates for sustainable fungal protein production (1).

Plant Cell Cultures: The results indicated that soft drink waste mix and artificial urine contributed to the highest biomass accumulation among the tested side streams. The culture medium composition was optimized using DoE software, resulting in notable cost reductions of 55%, 33%, and 45% for arctic bramble, tobacco BY-2, and barley cell lines, respectively, without compromising biomass yield. However,

the modified culture medium induced some changes in the amino acid composition of arctic bramble plant cell biomass, such as increased asparagine and decreased arginine, alanine, and tyrosine contents (2).

Experiential futures approach: The "Future Food Court Workshops" facilitated discussions on the impacts of food on sustainability, emphasizing the need for systemic changes. The insights collected from the group discussions stressed the importance of systemic strategies and collaborative innovation for a sustainable future. The study highlights the need for a future-oriented mindset in food sustainability, focusing on adaptability, health safety, and dietary evolution. Acceptance of cellular agriculture requires attention to safety and ethics to maintain consumer trust. In addition, generational shifts toward plant-based diets indicate broader sustainability trends, making equitable access to new food technologies essential (3).

Discussion

This study demonstrates the potential of utilizing side streams and waste materials from urban shopping centers as feedstocks for microbial and plant cell cultures. The results highlight the feasibility of producing microbial proteins and plant cell biomass using these waste materials, contributing to the circular economy and reducing the environmental impact of food production. Further research is needed to optimize the culture conditions and ensure the nutritional quality of the produced biomass.

A holistic approach to food sustainability is necessary, integrating psychological constructs and systemic thinking to drive meaningful change. Understanding global food supply chains can spur innovations in waste repurposing and alternative proteins. A diverse range of food production solutions is needed to address climate and geopolitical shifts. Our study highlights the interconnectedness of personal choices and systemic transformation. Increasing awareness of plant-based proteins and new cellular agriculture-based technologies helps consumers shift toward sustainable diets. Anticipated changes by 2040 suggest that dining experiences foster intergenerational connections while embracing food innovations. A growing openness to new food production methods, such as cellular agriculture, reflects increasing trust in technological advancements for food safety and security.

Conclusions

The 2040 vision for a circular food system integrates cellular agriculture to valorize organic side stream flows within a closed ecosystem. Experiments demonstrated the potential of using side-streams from shopping centers, such as soft drink waste mix, orange peels, and expired bread, as feedstocks for microbial and plant cell cultures. Optimized culture mediums reduced costs significantly without compromising biomass yield. All microbial and plant cell biomasses grown on side-streams had a balanced essential amino acid profile suitable for human consumption. Stakeholders found the 2040 vision both probable and desirable, emphasizing the need for circularity and policy measures to achieve this vision. These findings collectively emphasize the necessity of systemic strategies, collaborative innovation, and open-minded approaches to reshape food consumption and production for a more sustainable future.

References

- Viinikanoja (2025): Feasibility of using side streams from urban shopping centers as substrates for the cultivation of filamentous fungi. *New Biotechnology* (submitted).
- Lillberg (2025): Potential of using side streams from shopping centers as feedstocks for plant cell cultures. *Journal of Biotechnology* (submitted).
- Kymäläinen (2025): Towards 2040: Collaborative Approach in Finnish Food Systems Transition. *Futures* (submitted).

12.36 Salenius, F. & Irz, X. The economics of sustainable aquaculture in the Baltic Sea region: lessons from novel production systems

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Introduction

For decades, aquaculture has been the fastest growing food-producing sector in the world. As global demand for fish and seafood continues to grow, there is a need to ensure that aquaculture has the smallest possible impact on the environment. A potential way of improving the ecological and economic sustainability of the sector is the adoption to scale of integrated multi-trophic aquaculture (IMTA), which involves the joint production of species at different trophic levels, where lower trophic level organisms (mostly molluscs and algae) use energy and nutrient flows from species at higher trophic levels (usually fish). IMTA aims to reduce pollutions from fish farming and provide ecosystem services, while increasing economic benefits by improving productivity and generating new sources of income (Chopin et al., 2012; Knowler et al., 2020).

This review explores how the polyculture of fish and low trophic species could contribute to sustainable growth and value creation in the aquaculture sector of the Baltic Sea region. A condition for the broader uptake of IMTA production systems is the availability of robust evidence on their environmental and economic advantages over conventional aquaculture (i.e., monoculture of high-trophic fish). The review therefore presents the ongoing international research project BLUEBOOST, which aims to investigate the environmental and economic impacts of IMTA production in Europe and Brazil through six different case studies. Two case studies (Poland and Sardinia) are used to characterise relevant IMTA production systems for aquaculture in the Baltic Sea region that could serve as drivers of sustainable growth and value creation. The Finnish fish farming sector is used as an example of an industry that could use the knowledge generated by the study to achieve its strategic objectives.

Data and methods

The BLUEBOOST project (Aquaculture of low trophic species to boost sustainable production of blue foods and reduce environmental footprint) will provide new information on the practical performance of IMTA systems. At the heart of the project are six case studies in five countries (Spain, Portugal, Italy (Sardinia), Poland and Brazil), implemented by local project partners. Some of the studies will be carried out in the context of commercial aquaculture, which adds value to the IMTA literature, as most previous IMTA studies have been either theoretical or experimental. The case studies cover a wide range of species and farming methods, both marine and land based.

In each case study, the environmental and economic impacts of IMTA are compared with those of a carefully chosen local monoculture benchmark. In the case of Poland, this monoculture is the farming of common carp (*Cyprinus carpio*) in earthen ponds and in the case of Sardinia it is the farming of sea bass (*Dicentrarchus labrax*) and gilthead seabream (*Sparus aurata*) in cages in the open sea.

The environmental impacts will be assessed through a Life Cycle Assessment (LCA) carried out by the project's LCA experts in Sweden and Italy. The LCA will provide information on the impact of IMTA on nutrient and greenhouse gas emissions. The financial and economic impacts will be assessed through a cost-benefit analysis carried out by the authors of this review. The economic analysis includes a private

profitability calculation, which relates the revenues generated by IMTA to the fixed costs (e.g., investments) and variable costs (e.g., feeds, labour) of production over a multi-year time horizon. Where possible, the economic analysis will be extended into a broader social welfare analysis, which considers external impacts on actors other than the fish farmers, for instance the general population benefiting from the reduced environmental impact of aquaculture.

Results

The results of the BLUEBOOST project can inform aquaculture policy in the Baltic Sea region. There are two case studies of relevance to the region: fish farming in earthen ponds in Poland and net cage farming in the Mediterranean Sea in Sardinia. Both IMTA studies will be carried out under commercial conditions. In the Polish case, farming takes place in the northern part of the country near the shore of the Baltic Sea. The ponds are connected to natural water bodies, which means that eutrophying nutrients and solid matter from the farms are transported to the Baltic Sea by the water bodies. In IMTA, two species are added: native crayfish (*Pontastacus leptodactylus*) and watercress (*Nasturtium officinale*). Although the IMTA trial will only be carried out on a section of the commercial fish farm, it will nevertheless provide important information, notably on the costs and environmental impacts of farming. Crayfish will be reared in cages at the bottom of the ponds and watercress in the concrete channels connecting the ponds. The crayfish use solid matter and the plants absorb nutrients, so IMTA reduces the nutrient and organic load of fish farming. Both species are suitable for human consumption and can thus provide an additional revenue stream for producers.

The production system of the Sardinian case study, on the other hand, is similar to cage farming in the Baltic Sea, where pollutions from aquaculture have a negative impact on the seabed and also cause eutrophication. In IMTA, oysters are cultivated in connection with fish farming. The oysters are reared in nets and baskets which are placed around the ponds, so that IMTA can be implemented with very little additional investment. The oysters filter water near the ponds, which mitigates the negative environmental impacts. In addition, co-cultivation may stimulate the growth of oysters. Oyster shells also sequester carbon and can thus reduce the carbon footprint of fish farming. The oyster farming itself is experimental, but it will provide information on oyster growth, environmental impacts and the labour required, among other things. The oyster used in the study is the native flat oyster (*Ostrea edulis*)—a keystone species in the Mediterranean, which is not currently farmed on a large scale. Focusing on an indigenous production species may have positive effects on commercial success and on the attitude of regulators towards increasing cultivation capacity.

The key objective of the Finnish aquaculture strategy is to boost the sustainable growth of the sector, and one significant development has been the placement of fish farms in offshore areas (Valtioneuvosto, 2022). However, negative environmental impacts, such as nutrient emissions, can hinder the granting of new permits for open sea farming. Lessons from the Sardinian case study may be useful as Finland is exploring, for example, the cultivation of mussels in brackish water as part of so-called regenerative aquaculture. Cultivating mussels near fish cages could be worth exploring, as both the mussels and the aquatic environment can benefit from polyculture. In this way, IMTA would create growth in aquaculture by promoting the granting of environmental permits and diversifying the set of traditional species (i.e., rainbow trout and whitefish). IMTA would thus complement other environmentally friendly farming practices, such as recirculating aquaculture systems (RAS), which unfortunately has proven to be economically unviable (Laine et al., 2024). Measures to reduce the loading from inland flow-through facilities have also been investigated, but the cost-effectiveness of these measures has also proven questionable (Vielma et al., 2020). The joint farming of fish and other species with a positive impact on

water quality—following the Polish case—could therefore be worth exploring in the case of inland aquaculture.

Conclusions

This overview describes how the benefits of IMTA for producers and society can contribute to the sustainable growth of aquaculture. From the producer's perspective, financially sustainable growth is achieved by introducing new production species and, where possible, using existing farming capacity. In this way, the benefits of IMTA—ranging from additional income to better management of farming risks—can be achieved with moderate additional investment and labour. Socially sustainable growth is achieved by minimising adverse environmental impacts. Environmental benefits will increase the social acceptability of aquaculture, which in turn can contribute to an increase in farming capacity as policy makers become more willing to grant new farming licences. Social acceptability can also increase through a "cultural" channel. If farming promotes the wider use of native and local species, such as crayfish, oysters or mussels, this may well increase the acceptability of fish farming to consumers. New species, technologies and practices therefore play a key role in promoting the growth and value of aquaculture.

Literature

- Chopin, T., Cooper, J. A., Reid, G., Cross, S., & Moore, C. 2012. Open-water integrated multi-trophic aquaculture: environmental biomitigation and economic diversification of fed aquaculture by extractive aquaculture. *Rev. Aquac.* 4, 209-220.
- Knowler, D., Chopin, T., Martínez-Españeira, R., Neori, A., Nobre, A., Noce, A., & Reid, G. 2020. The economics of Integrated Multi-Trophic Aquaculture: where are we now and where do we need to go?. *Rev. Aquac.* 12, 1579-1594.
- Laine, C., Ollikainen, M., Kankainen, M., Setälä, J., & Vielma, J. 2024. Social net benefits from aquaculture production: a comparison of net cage cultivation and recirculating aquaculture systems. *Aquacult. Econ. Manag.* 28, 1-31.
- Government 2022. Government Decision of Principle. Aquaculture Strategy 2030 for Mainland Finland. 17.2.2022. 22 p. <https://mmm.fi/kalat/strategiat-ja-ohjelmat/vesivieljelystrategia>.
- Vielma, J., Naukkarinen, M., Myyrä, R., Pulkkinen, J. & Kiuru, T. 2020. Reducing nutrient loads from flow-through plants. *Natural Resources and Bioeconomy Research* 76/2020. Natural Resources Institute Finland. Helsinki. 38 s.

12.37 Salminen, J. et al. Environmentally-extended input-output modelling for food system sustainability studies

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Background and aims

Consumption and production of food are major contributors to the environmental problems the humanity is currently facing (Springmann et al., 2018). These problems include climate change, depletion of freshwater resources, deterioration of water quality and loss of biodiversity. At the same time, food system actors, primary producers in particular, are struggling globally with low profitability. As for humans, obesity and high consumption of animal-based foods prevail in many countries while populations in other regions suffer from poor nutrition.

Consequently, transition towards more sustainable food systems is a highly complex issue subject to potential trade-offs and injustices (Kalljonen et al. 2021). Sustainability transition can be pursued by actions targeting food production or food consumption. Recent studies demonstrate that goals for greenhouse gas emissions (GHGE) cannot be achieved by dietary changes alone when a relevant part of the emissions arise from agricultural land use (Virkkunen et al. 2025). Therefore, the intertwined nature on how the environmental burdens are dependent on both how we produce and how we consume different foods underlines the imminent need for methods that allow simultaneous sustainability analyses from the perspectives of both consumption and production.

This study presents a modelling approach that describes the Finnish food system in quantitative and highly disaggregated terms. The aim is to show how environmentally-extended input-output (EE-IO) modelling can be harnessed to food system studies so that a highly diverse sets of research questions can be answered and indicators and coefficients generated for assessing the present sustainability, trade-offs and policy options for more sustainable food systems.

Methods

In the present study, an existing EE-IO model for the Finnish economy (ENVIMAT) (Seppälä et al. 2011) was further developed to a highly specific and disaggregated food system model for Finland (ENVIMATfood). Both models the supply and use of goods and services in the economy in monetary terms as a snapshot of one year. Supply consists of products produced by domestic industries and imports. Products are used in the industries' production activities as intermediate products and as final products, which end up in domestic consumption and investments and exports. This is also how foreign trade flows are described in the model.

That said, the models describe the connections and interactions between production activities in euros. Using value chains, an EE-IO model enables, for example, the assessment of the direct and indirect effects of product groups, industries or end-use items in the economy. These are often referred to as life-cycle impacts. In the model, various environmental impacts can be linked to production activities, such as direct GHGE or direct land use by industries.

In ENVIMATfood, food-related industries and products have been considerably disaggregated compared to the ENVIMAT model (in parentheses). Agriculture is divided into 15 (4) lines of production, fishery into 4 (1), manufacturing of foods, feeds and drinks into 50 (10) industries. Industries providing food services are

also included in both models. As for commodities, ENVIMATfood contains over 500 product groups in comparison with roughly 35 in ENVIMAT. For the remaining industries, ENVIMATfood and ENVIMAT follow by and large the same structure of industries and commodities. In ENVIMATfood, following environmental impact categories are addressed: GHGE, use of land and water, eutrophying emissions to water, biodiversity.

Results and conclusions

The present work illustrates how EE-IO modelling can be harnessed to study the sustainability of food systems and to identify key points of action to make these systems more sustainable. First, ENVIMATfood generates environmental coefficients for all relevant crops, food groups and food-related industries (including primary production) in Finland. These coefficients are comparable with each other thus providing coherent sets of data and allow also concomitant analyses on different environmental burdens such as GHG and eutrophying emissions.

Second, ENVIMATfood helps to identify key points of action in terms of food production and consumption. In Finland, parallel actions targeting primary production and its land use in particular and food consumption are needed to substantially lower the GHGE of the domestic food system. Dietary shift towards lower consumption of red meat and dairy products help to reduce the need to cultivate fields on organic soils. However, as organic soils play a crucial role in the GHGE in Finland, dietary change towards plant-based foods is alone, without measures targeting fields on peat soils, a weak emission mitigation measure for the Finnish food system.

Third, ENVIMATfood allows making scenarios related not only to changes in diets or food production but also to other interlinked systems, such as energy system. This way, energy transitions, for instance, affecting the sustainability of food systems can be investigated in parallel with food system transitions.

Finally, construction of detailed EE-IO-based food system models may require large and diverse sets of data and related data analysis making the setup of such models a labour-intensive and demanding task.

References

- Kaljonen, M., Kortetmäki, T., Tribaldos, T., Huttunen, S., Karttunen, K., Maluf, R.S., Niemi, J., Saarinen, M., Salminen, J., Vaalavuo, M., Valsta, L. Justice in transitions: Widening considerations of justice in dietary transition. *Environmental Innovation and Societal Transitions*. 40 (2021), pp. 474-485.
- Seppälä, J., Mäenpää, I., Koskela, S., Mattila, T., Nissinen, A., Katajajuuri, J.-M., Härmä, T., Korhonen, M.-R., Saarinen, M., Virtanen, Y. An assessment of greenhouse gas emissions and material flows caused by the Finnish economy using the ENVIMAT model. *Journal of Cleaner Production*, 19 (2011), pp. 1833-1841.
<https://doi.org/10.1016/j.jclepro.2011.04.021>
- Springmann, M., Clark, D., Mason-D'Croz, K., Wiebe, B.L., Bodirsky, L., Lassaledda, W., De Vries, S.J., Vermeulen, M., Herrero, K.M., Carlson. Options for keeping the food system within environmental limits. *Nature*, 562 (2018), pp. 519-525.
<https://doi.org/10.1038/s41586-018-0594-0>
- Virkkunen, H., Riihimäki, J., Savolainen, H., Salminen, J. Framework for quantification of land use-based greenhouse gas emissions according to crop and farm type. *Journal of Cleaner Production*, 498 (2025), 145111.
<https://doi.org/10.1016/j.jclepro.2025.145111>

12.38 Sandström, V. et al. Global impacts of agricultural input shocks: insights into vulnerabilities and resilience in food systems

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Introduction

The industrialization of agriculture has increased the dependency on imported inputs such as synthetic fertilizers, pesticides and machinery, which are critical for sustaining high crop yields. Many of these inputs are imported, often from a very limited number of countries (Hebebrand & Laborder, 2022). Recent environmental changes and geopolitical events have highlighted the vulnerability of the food production systems to disruptions in their global markets and supply. Also, there is an increasing pressure to reduce the use of synthetic fertilizers and pesticides to reduce their environmental pressure (Beckman et al., 2020). Despite this, the impacts of agricultural input shocks to global food system remain understudied. This study will contribute to this discussion by putting together insights from two comprehensive studies (Ahvo et al., 2023 and Sandström et al., 2024) to analyze food systems' vulnerabilities against trade shocks and impacts to global food security.

Material and methods

We studied the temporal trends of agricultural input trade of 184 countries globally from 1991 to 2020 by applying statistics of the use and trade of synthetic fertilizers (N, P, and K) and pesticides (FAO, 2023). In addition, we assessed the effects of input shocks on the yields of 12 major crops worldwide with 5 arc-min resolution, by using a random forest machine learning model (Ahvo et al., 2023). We incorporated gridded climate, soil, and agricultural management data to predict yield changes under different shock scenarios (25%, 50% and 75% reduction in input availabilities). The model showed high accuracy (NSE > 0.75 for 79% of the crops), validated against FAOSTAT data (FAO, 2023).

Main findings

We found that the import dependency of agricultural inputs has increased over the past 30 years, but there is high variation between countries. The model simulations indicate that high-yielding 'breadbasket' areas are disproportionately affected by reductions in agricultural inputs. A 50% shock in all inputs reduced global production of maize and wheat by 26% and 21%, respectively, with severe impacts on high-yielding regions such as Central Europe and the United States. Fertilizer shocks, especially nitrogen, caused the largest yield declines across crops, while pesticide shocks had limited effects. Combined input shocks significantly affected multiple crops, with barley, potato, and rice yields declining heavily in key food producing regions like Argentina, Central Europe, and Southeast Asia. Countries with high import dependency combined with high use, such as many industrial agricultural producers in South America, Asia as well as Europe, show highest vulnerability to trade shocks. Also, our findings highlight that potential agricultural intensification in Sub-Saharan African countries—currently with low use of the inputs per cropland area but high import dependency—can lead to higher dependency on imported agricultural inputs.

Discussion and conclusions

The dependency on agricultural inputs for food production is a critical aspect of modern agriculture. This study underscores the varying impacts of input shocks across crops and regions, highlighting vulnerabilities in the global food system and the need for strategies to enhance resilience and food security. By understanding the vulnerabilities associated with agricultural input dependencies and identifying high-risk areas for yield reductions, different food system actors can better prepare for and mitigate the impacts of potential input supply disruptions. The regions relying heavily on imported inputs should explore strategies to diversify their input sources and invest in sustainable agricultural practices with reduced use of imported industrialized inputs, such as synthetic fertilizers and pesticides to enhance resilience. Additionally, policy interventions are needed to stabilize input markets and ensure the availability of critical inputs during disruptions.

References

- Ahvo, A., Heino, M., Sandström, V., Chrisendo, D., Jalava, M., & Kummu, M. (2023). Agricultural input shocks affect crop yields more in the high-yielding areas of the world. *Nature food*, 4(12), 1037-1046.
- Beckman, J., Ivanic, M., Jelliffe, J. L., Baquedano, F. G. & Scott, S. G. (2020) Economic and Food Security Impacts of Agricultural Input Reduction Under the European Union Green Deal's Farm to Fork and Biodiversity Strategies. Economic Brief No. 30, (USDA Economic Research Service, 2020).
- FAO (2023). FAOSTAT statistics division, food and agriculture organization of the United Nations (available at: www.faostat.org)
- Hebebrand, C. & Laborde, D. (2022) High fertilizer prices contribute to rising global food security concerns. IFPRI Blog <https://www.ifpri.org/blog/high-fertilizer-prices-contribute-rising-global-food-security-concerns>.
- Sandström, V., Huan-Niemi, E., Niemi, J., & Kummu, M. (2024). Dependency on imported agricultural inputs—global trade patterns and recent trends. *Environmental Research: Food Systems*, 1(1), 015002.

12.39 Seisto, A. et al. What kind of opportunities and future vision cellular agriculture could have for Finland?

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Background

Transitioning towards a sustainable food system requires both the advancement of existing food production methods and value chains, as well as the integration of novel approaches. Cellular agriculture presents a promising opportunity to accelerate Finland's transition toward a more sustainable and efficient food system (Seisto et al. 2025). This production method utilizes cells—such as microbes, algae, plant, insect, or animal cells—with bioreactors playing a key role in production. In practice, cells are cultivated in large steel tanks, similar to those used in fermentation processes in breweries. Instead of producing beer or other fermented goods, the end products of cellular agriculture are the cells themselves, which serve as valuable ingredients in the food industry. Additionally, cellular agriculture enables the production of key components such as proteins and fats, where these elements are extracted from cultivated cells rather than using the cells as ingredients. These methods complement traditional agriculture, fostering the creation of integrated value chains.

Cellular agriculture is particularly valuable in promoting the circular economy, as it allows for the efficient use and refinement of side streams, generating added value from previously underutilized resources. It also plays a vital role in diversifying food production, especially in regions facing agricultural challenges. Through these advancements, cellular agriculture helps minimize environmental impact. However, integrating these methods into existing food systems brings uncertainties for several stakeholders, including primary producers, industry stakeholders, consumers, and regulators. Well-defined transition pathways and supportive RDI policies are essential to facilitating collaboration and ensuring a successful transformation of food production.

To fully unlock the potential of cellular agriculture, it is crucial to recognize the need for a system-level transition. As a rapidly evolving sector, understanding the long-term impact and strategically positioning the growth of cellular agriculture will be key to enhancing Finland's competitiveness in sustainable food production. Therefore, it is essential to engage diverse stakeholders in discussions on what cellular agriculture is, what it enables, the new capabilities required for adoption, and the practical steps for national and regional implementation. To bridge the gap between theoretical possibilities and real-world applications, we have adopted a shared agenda approach, ensuring that several relevant actors collaborate in shaping the future of this transformative technology.

Establishing a shared agenda is crucial for several reasons. Shared agendas have proven essential in guiding collective action toward sustainability, ensuring that stakeholders work toward a common vision for the future. When groups align a shared understanding of sustainability and profitability, they can identify opportunities for collaboration, coordinate their efforts more effectively, and achieve impactful change. Beyond fostering cooperation, shared agendas also build trust and consensus by offering a unified narrative. When stakeholders feel heard and see their priorities reflected in a shared framework, they are more likely to remain engaged and committed to the outlined goals. This, in turn, strengthens long-term collective action by creating a sense of ownership and responsibility. Moreover, shared agendas provide clear monitoring mechanisms, allowing stakeholders to set measurable targets, track progress, and refine strategies as needed, ensuring sustained momentum toward sustainability. In the ongoing EU_PRIMED project, five European regions are pioneering shared agendas focused on Circular Bioeconomy visions.

Achieving a shared agenda for cellular agriculture involves a process of first interviewing stakeholders and second carrying out regional workshops. This paper presents the results of the initial stakeholder interviews.

Method

Altogether 13 interviews with stakeholders in the food system were conducted, including representatives from advocacy groups/associations, companies, and education. The interviews were semi-structured, thematic discussions, and the collected data was synthesized. Two researchers were present in each interview. The interviews were recorded, and notes were taken during the interviews. Microsoft Copilot AI tool was utilized to extract the main findings from the interviews, followed by a review of the processed data by two researchers to identify any inconsistencies.

Results and discussion

Key insights from the stakeholder interviews are summarized below:

1. Opportunities in cellular agriculture:

- **Sustainable Food Production:** Cellular agriculture supports the goals of sustainable food production. Utilizing circular economy principles helps reduce waste and use side streams as raw materials. This improves product quality and environmental friendliness, offering a balanced future that combines traditional and cellular agriculture methods.
- **Economic Growth and Innovation:** Cellular agriculture offers significant opportunities for economic growth and innovation. It enables the creation of hybrid products that combine cellular agriculture and traditional ingredients, which could attract consumers. Additionally, Finland has the opportunity to become a leading player in the field, promoting national economic growth through top-notch innovations.
- **Environmental Benefits:** Transitioning to cellular agriculture offers significant environmental benefits. By reducing the number of production animals, biodiversity and water ecosystems can be improved. Additionally, cellular agriculture promotes a more cohesive and local supply chain, helping to reduce pollution.

2. Hopes for the future:

- **Consumer acceptance and policy adaptation:** Overcoming consumer doubts through public tasting events of new food products and adapting EU policies are crucial for the acceptance and growth of cellular agriculture.
- **Technological advancements and economic viability:** Accelerating technological development and building cost-effective production facilities in Europe are essential for cellular agriculture to be economically viable and globally competitive.
- **Collaboration and circular economy:** Promoting collaboration, utilizing agreed carbon footprint metrics, and using side streams to support the circular economy are key to ensuring sustainable and efficient food production in the future.

3. Networks and collaboration:

- **Importance of Collaboration:** Effective collaboration and networking across sectors are crucial for the success and profitability of cellular agriculture. This includes partnerships with equipment suppliers and other sectors, such as the energy sector, to promote the food system and develop new products.
- **Role of Regional and International Networking:** Networking beyond the food sector and collaboration regionally and internationally are essential. Finland must participate in global

markets and secure international funding to create a strong value chain and attract projects that ensure the scalability of the sector.

- **Participation of Key Stakeholders:** Key stakeholders, including public actors, large food companies, investors, end-users from various sectors, and consumers, must be involved early on. Adapting legislation and gathering consumer feedback are essential to ensure the successful development and implementation of cellular agriculture technologies.

The main findings indicate that according to the interviewed stakeholders, cellular agriculture presents significant opportunities for Finland, aiming to secure supply chains by diversifying food production methods. However, this requires collaboration on several levels, from regional operators to EU level decision makers. In addition, there is a clear need in investing in consumer awareness and product development in order to be able to offer tasty and affordable products.

The role of primary production in the future food system was also discussed. Involving farmers into the discussion of future food production is essential to ensure a fair transition. This was discussed both from the viewpoint of addressing potential threats to their livelihoods, and opportunities in the new value chains. From the educational viewpoint, it is crucial that needs for new capabilities are identified and young people are attracted into the field. As with all stakeholders, it is important that validated, science-based information is available in a form that it is easy to understand, so that juxtaposition can be avoided, and different viewpoints are heard.

In addition to societal acceptance, also infrastructure was mentioned to pose challenges. Establishing production facilities requires substantial investments, making adequate funding essential for success. Increased access to venture capital and loan instruments are particularly critical for small and medium-sized enterprises. Finland's growing renewable energy and IT infrastructure create valuable synergies within cellular agriculture value chains, offering a competitive edge and emphasizing the need for cross-sectoral collaboration.

Overall, the interviewed stakeholders were quite positive towards the potential of cellular agriculture to enhance food security, promote sustainability, and drive economic growth through innovative food production methods, while addressing environmental and societal challenges. Finland's strong biotechnology sector, supported by institutions like VTT, positions it as a leader in this field. Even though the adoption of new food systems will take time, the stakeholders emphasized that with a proactive approach and collaborative efforts it is possible to drive innovation and economic growth. However, there are several milestones that need to be considered and addressed properly to reach the targets. This emphasizes the need for regional discussions with a more practice-oriented approach.

Next stages

South Ostrobothnia's Smart Specialization Strategy was chosen as the guiding framework, emphasizing novel food production technologies to drive regional development. As the project progresses, we will conduct two stakeholder workshops, bringing together representatives from primary production, the food industry, and regional and local public sectors to collaboratively shape a future vision for the region and develop a roadmap to achieve it. The workshops will feature a session on "The ABC of Cellular Agriculture" to enhance understanding of its potential and requirements, alongside a "Futures Shaping" lecture designed to inspire active participation in the exercises. Insights from these discussions will offer valuable lessons on practical implementation, fostering stronger collaboration, and regional resilience.

References

Seisto, A. et al. (2025). Sustainable growth from cellular agriculture value chains: Action plan for Finland. VTT Technical Research Centre of Finland. <https://doi.org/10.32040/2025.CellAg.en>

12.40 Sell, M. & Ashkenazy-Garini, A. Food system labs as a method for transforming food systems through transdisciplinary research and action

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Targeting challenges of food system transformation in a complex world requires systems thinking, but also understanding context specific needs and opportunities. Sustainable solutions involve innovative collaboration between the range of actors influencing and influenced by the food system. Although transdisciplinary participatory approaches have been high on the agenda in the past decade, and Living Labs as a method is supported by funding mechanism and action partners alike, there is still a lack of evidence on how to best establish, run and learn from such initiatives.

The H2020 project HealthyFoodAfrica (HFA) contributes to filling this knowledge gap, based on five years of action across the African continent. HFA worked in ten food system labs (FSLs), supporting multi-actor engagement in various settings.

Living lab typologies and functions

The labs were established based on existing networks and priorities of the local partners. This meant that both contexts, capacities and approaches varied significantly between the individual labs. At project level this was an intentional decision, as the goal was to co-create and pilot context-relevant activities, supported by an iterative engagement with science partners. We have identified three main living lab typologies, which describe the starting points in HFA:

1. Science-based living labs

In four of the FSLs the local lead partner was a science-based institution (Bahir Dar, Cotonou, Kisumu and Nairobi). All had done extensive research work related to food systems, agriculture and nutrition. All partners also had a longstanding experience working in field-based settings, engaging local actors in prioritising actions and disseminating results. However, for most of these partners the Living Lab approach, where all stakeholders were brought together to co-create from the beginning of the piloting phase, was still a new form of engagement.

2. NGO-based

Four of the FSLs were led by local partners representing civil society, either NGOs or farmers' associations, with long-standing presence and networks in the local context (Fort Portal, Lusaka & Chongwe, Rwamwanya, Tamale). Even though they had often engaged multiple stakeholders in their work, the science engagement and innovation approach was new to most.

3. The third type of labs took a market-based perspective, with the goal to develop new products or market systems. For the sake of this study, we have included CSIR (Accra) in this typology, although they are also a research institute. Their focus was on developing new products and processing technologies. The NGO run FSL in Lusaka is also classified under this category, as the work was focused on improving markets.

These differences in contexts and starting points significantly influenced the formation of the multi-actor work and the types of piloted actions. However, some common functions for the multi-actor work were defined. The living lab is/has a multi-stakeholders platform linking actors from different parts of the system, in order to:

- a) map needs

- b) pilot innovations
- c) co-create new knowledge
- d) create ownership of the solutions developed
- e) give voice to underrepresented actors and change power dynamics
- f) create formal representation that can approach policy makers
- g) create a lasting community of practice
- h) create networks with other communities of practice, both within and beyond the local context
- i) mobilize resources
- j) create continuity and sustainability through “institutional memory”

The project did not impose specific guidelines for running the multi-actor work. However, there was a rigorous process for supporting this action, which involved a high level of communication and cross-learning. The key elements at project level included creating a joint understanding of the approach through a kick-off meeting, a roadmap document, and a multi-stakeholder platform ‘building workshop’, providing facilitation tools and goalsetting. Each FSL then made an implementation plan, supported and updated through iterative discussions throughout the project, including developing a Theory of Change to support dissemination and sustainability.

Interaction and cross learning

The project put a strong focus on cross-learning. Unfortunately, this activity was hampered by Covid 19 restrictions. However, interaction between partners across the continent, as well as with European partners, still played an important role. Several different types of cross-learning took place.

- a) Scientific level cross learning, i.e. transdisciplinary cross-learning in a food system context. The project was designed in a way that requires scientific interactions and integrating theories and methodologies from different domains. When setting the focus of study in such new ways, linkages that would not emerge through single disciplines are exposed and individual researchers are facilitated in adopting a transdisciplinary view. This requires training and ongoing dialogue among the researchers, as well as tying the theories to concrete research questions and action. The project promoted this in its consortium meetings, providing opportunities to identify the junctions where the research connects and defining how complementarities that could translate to joint research and new domain expertise.
- b) Research to practice (and practice to research) learning is the theoretical backbone of the living lab approach. This was implemented through ongoing dialogue between scientific partners and FSLs, joint interventions, and planning the work in advance so that each scientific work package worked with at least several FSLs, supporting their activities and conducting research based on this interaction.
- c) Practice to practice learning, or cross FSL learning was also important. Dialogue was promoted in the consortium meetings, where FSLs facing similar issues could learn from each other. Topics included new technologies, but also new way of organizing, new policies, new funding sources, that could be incorporated into their work. Ideally there would be visits between FSLs to experience the work of colleagues first-hand.
- d) Topic based learning was taken further in groups of scientists and representatives of particular FSLs across the project working on similar topics (school gardens, aquaculture, legumes production etc.). These groups were called nets and had regular online meetings to share experiences and recommendations on production topics, such as ‘fruit net’, ‘fish net’ and ‘leg net’.

- e) Finally, a key point for future work, was the “macro-learning”, i.e. the project level learning, where the overall insights were synthesized at a broader food system level. The results from the synthesis work can be upscaled through collaboration with other projects and through policy recommendations and dialogue.

Recommendations and lessons learned

Although successful in many ways, not least through a range of unintended scientific or practical insights and impacts that the project produced, the food system approach also faced challenges. Reflecting on those can be highly useful for other projects planning to implement a similar approach.

Communication is a key source both of success and failure in a Food system lab approach. It is of utmost importance to support and facilitate an open communication culture, where discussion is encouraged. This can help overcome many hurdles, including a lack of common language, which is a high risk when scientists and practitioners engage. There might also be major difference in expectations about what can and should be done, what is realistic, what is the scope, what is the role of each actor, etc. Often scientists are deeply focused on a specific field of their expertise. Action partners, on the other hand, usually target a broader scope, while expecting quicker impact. Reconciling these views and modes of operation requires scientists to adjust and formulate recommendations in response to local needs. However, local actors should also be openminded and willing to consider new and unfamiliar options, adapted to the local contexts, to expand the available alternatives.

Another difference between scientific and action partners is the motivation to participate, which can be simplified as ‘generating knowledge’ versus creating ‘immediate impact’. Especially under funding schemes such as Horizon, the scientific partners have research related deliverables they are committed to delivering, while the work of action partners is usually more flexible. In the best-case scenario, the actors find a way to combine the interests of all. In HFA, some of the scientific teams were more action research oriented, while some had a more “traditional research focus”, as in testing a theory. This was reflected in various types of research questions, data collection methods, outcomes and results. This was in line with the approach of the project, which embraced diversity both in context and implementation.

In summary, the key recommendations for a successful food system lab project are:

- Integrated project design, in which task descriptions, budgets, roles and responsibilities are co-created and clearly assigned to each partner from the onset (especially in areas where scientists rely on FSL work and contribution such as data collection).
- Understanding and integrating the inherent different time horizons relevant to the project. For a scientist 5 years may be considered short term, while action partners can expect practical outcomes sooner. Research and innovation are iterative processes, where even the focus of the intervention can change.
- Monitoring and evaluation, both at project level and of the broader impact, needs to be planned and integrated as an inherent part of the project from the beginning.
- Co-dependencies need to be recognized. Scientists need to work in collaboration with and through the FSLs to get the scientific evidence, while the FSLs get support from the scientists to create new context specific or generalizable knowledge.

12.41 Seppälä, T. et al. Incorporating relational domain into the food environment framework

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The food environment is recognized as a crucial factor influencing people's food consumption and dietary habits. It is typically divided into two domains: external and personal (e.g., Turner et al., 2018). The external domain encompasses dimensions such as availability, prices, vendor and product quality, and marketing, serving as the interface through which the individuals engage with the broader food system. The impact of this interface on individual consumption and diets is moderated by personal opportunities, abilities, and motivations, forming the personal domain of the food environment.

Our daily food environment consists of various places where we navigate to fulfill our diverse needs. These settings can be private (e.g., a home), semi-public (e.g., a school canteen) or public (e.g., a neighborhood), representing different scales of food environments. Initially, research on human food environments focused on the built environment. However, more recently, other types, such as wild and cultivated food environments, have gained attention, particularly in the context of low- and middle-income countries (e.g., Downs et al., 2020).

Our daily food environments often fall short of fostering sustainable and healthy food consumption and diets, prompting growing calls for improvements and reform (e.g., SAPEA, 2023). Responsibility for shifting towards more nutritious and sustainable diets has largely been placed on consumers, who are primarily guided by better and more accessible information. However, food environment research has contributed to a growing call for greater accountability from food environment actors – such as retail, food industry, and governments – who define the economic and political structures that determine consumers' choice environments and actual opportunities to make choices (ibid.). Integrating the personal domain with the external domain in the food environment frameworks has helped to understand how developing just food environments that support healthier and sustainable choice for all requires acknowledging social inequalities and structural context of everyday life that shape people's realities and interactions with food environments on a personal level. However, food environments matter to people not only as places to acquire and consume food, but also for their relational value, which has not been fully recognized by food environment research and policy.

In this paper, we examine the relational values of food environments – such as meaning of food environments in identity building or social connectedness with other people – and explore how food environments can be understood from a relational perspective. We also discuss the implications of incorporating the relational domain into food environment policy. Drawing from literature on human-nature relationships (e.g., Himes et al., 2024) and previous research on food environments, we develop a conceptual framework for understanding food environments through their relational values.

Like nature or natural environments, food environments have instrumental value for people when they contribute to their health, well-being, and pleasure. Prior literature suggests that food environments also serve relational values, which are not necessarily inherent in the food environment itself but are derived from relationships. Relational values pertain to all types of relationships between people and food environments, including relationships between people that involve food environment. For example, people interact with food environments to express their personal identity or cultural values. This implies that people may interact and build stronger relationships with food environments that support their personal identity or are in line with their cultural values (e.g., Balakrishnan & Bleibleh, 2025). Additionally, people interact with food environments to build and maintain their relationships with other people (e.g., Isaacs et al., 2022). Food environments serve as places and food as a medium for fulfilling the fundamental human

needs to belong and feel socially connected, while also drawing meaning from these social bonds. Food environments and sharing food with others provide connections among people, bind communities together, and support social networks. This implies that peoples' social needs impact their interaction and relationships with different food environments.

We propose that the relational domain deserves greater attention in the development of food environments. Although this domain is present in current food environment frameworks based on socio-ecological theory, it is underdeveloped and often reduced to social influences on individual behaviors or socio-cultural impacts on food environments. For example, in the ecological framework of food environments by Story et al., (2008), the social environment – including interactions with family, friends, peers and others in the community – forms a layer of the food environment embedded within physical and macro-level environments, impacting food choices through mechanisms such as role modelling, social support, and social norms. Swinburn et al. (2013) define a socio-cultural dimension, including norms and beliefs, as one of the four dimensions of the food environment impacted by the interactive effects of the food industry, government, and society. Herforth and Ahmed (2015) place social and cultural norms and values as an outer layer affecting the food environment, which consists of availability, affordability, convenience, and desirability of various foods. In their framework, Hawkes et al. (2015) consider the social environment, including social and cultural values, as distinct from the food environment and information environment, which are suggested to mediate the impact of learned food preferences on diets. Turner et al. (2018) view socio-cultural factors as acting alongside political and economic factors as macro-level influences on the food environment and the wider food system. Similarly, Downs et al. (2020) locate the socio-cultural environment – including human capital, networks, religion, culture and conflicts – as an outer layer macro-system impacting different types of food environments, while individual factors – including social capital, preferences, beliefs, values and income – form an inner layer between food environments and diets.

These approaches address the significance of cultural values, social norms, support, and role modelling in shaping behaviors, but food consumption and diets are even more deeply intertwined with the relational nature of humans (Fischler 2011). While interaction between people and the food environment is an essential part of food environment definitions and frameworks, relationships building through these interactions are largely missing from food environment frameworks. We suggest that people build various relationships with food environments while interacting with these environments, and this relationship partly defines their further interaction with the food environment and influences where, what, and how people consume food. Since food environments are not meaningful to people only through food consumption but also serve their social needs, the relationship with food environment is also defined by how they enable the fulfillment of these social needs.

In policymaking, relational values can help articulate the idea that specific food environments are fundamentally important to people because of their unique relationship with these places (e.g., feeling safe in a restaurant that adheres to the principles of a safe place, or having a rapport with the shop keeper). Literature on human-nature relationships suggests that these relationships operate similarly to interpersonal relationships (e.g., Lengienza & Aviste, 2025). Leverage points for the development of food environments might be found by exploring the types of relationships we have with our food environments and how we can develop those relationships to support sustainable and healthy diets. We can ask for example, do the pupils feel safe in a school canteen or does the personnel care for the school canteen and be proud of it? Additionally, food environments are important because of the relationships between people that are nurtured within them (e.g., building family bonds in fast food restaurants). This prompts us to explore ways to develop food environments that not only support sustainable and healthy eating but also enhance overall human wellbeing. Such improvements can, in turn, positively reinforce sustainable and healthy dietary habits.

References

- Belakrishnan, G. & Bleibleh, S. (2025). A phenomenological study of place attachment to food spaces: Expatriate and eateries in Dubai. *Habitat International*, 160, 103399.
- Downs, S. M., et al. (2020). Food environment typology: Advancing an expanded definition, framework, and methodological approach for improved characterization of wild, cultivated, and built food environments toward sustainable diets. *Foods*, 9(4), 532.
- Fischler, C. (2011). Commensality, society and culture.” *Social Science Information* 50(3–4), 528–48.
- Hawkes, C., et al. (2015). Smart food policies for obesity prevention. *The Lancet* 385(9985), 2410–2421.
- Herforth, A., & Ahmed, S. (2015). The food environment, its effects on dietary consumption, and potential for measurement within agriculture-nutrition interventions. *Food Security* 7(3), 505–20.
- Himes, A. et al. (2024). Why nature matter: A systematic review of intrinsic, instrumental, and relational values. *BioScience*, 74, 25-43.
- Isaacs, A., et al. (2022). From healthy food environment to healthy wellbeing environments: Policy insights from a focused ethnography with low- income parents’ in England. *Health & Place*, 77, 102862.
- Lengienza, M. L., & Aviste, R. (2025). Relationship between people and nature: Nature connectedness and relational environmental values. *Current Opinion in Psychology*, 62, 101984.
- SAPEA. (2023). Towards sustainable food consumption: Evidence review report. Zenodo.
- Story, M., et al. (2008). Creating healthy food and eating environments: Policy and environmental approaches. *Annual Review of Public Health* 29(1), 253–72.
- Swinburn, B., et al. (2013). INFORMAS: Overview and key Principles. *Obesity Reviews* 14(S1), 1–12.
- Turner, C., et al. (2018). Concepts and critical perspectives for food environment research: A global framework with implications for action in low- and middle-income countries. *Global Food Security* 18, 93–101.

12.42 Stoddard, F. Can the Nordic-Baltic region be free of soy imports?

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From 1961, Europe steadily increased its reliance on imported soy, reaching 45 million tonnes in 2008, representing 70% of supplemental protein in feeds for monogastric livestock (Watson et al., 2017). Imports have declined slightly since then, and still represent over 100 M ha of land in the Americas. European bodies want to reduce dependence on these imports, to reduce exposure to price fluctuations, to increase protein security, and to limit externalized deforestation and land-use change. Attempts by the EU to increase the production of nitrogen-fixing grain legumes for feed protein have had limited success (Zander et al., 2016).

I will present results to answer the following questions.

1. Yields of the main grain legumes, pea and faba bean, are 1.5 – 2.5 t/ha in the Nordic – Baltic region.
 - How much arable land would be required in each country to replace soy imports? Calculations are based on current yields, pea: faba bean proportions, and 24% protein in pea, 29% in faba (global averages from Feedipedia 2025), thus not taking into account differences in amino acid composition.
 - What other crops or land uses would be displaced to provide this land? Most of our region produces more feed barley than it can use, so this portion of the crop could be substituted. Some of our countries have taken land out of agriculture since 1990 (FAOstat, 2025) that could be brought back into use for this purpose.
2. There is a large yield gap in our region. In most years, the most productive fields yield 5 – 6 t/ha, about 3 x the national averages. What happens to the land requirement if yields are raised to a consistent 3 t/ha?
 - Achieving this will require attention to the agronomy and water economy of the crops.
3. Most people in the Nordic countries consume more meat than suggested in dietary recommendations; in Finland, by 15%. What happens to the demand for feed legumes if this relatively small excess is reduced?
 - Not only is the demand for the legumes reduced, the amount of land freed from feed barley is increased.

With a minimum of assumptions aside from farmer willingness, four of our countries could replace all soy imports and the others could substantially reduce their imports. Lithuania has the best potential in the region to grow soy at economic yields.

References

FAOstat 2025. <https://www.fao.org/faostat/en/#data> (visited 30 March 2025)

Feedipedia 2025. <https://www.feedipedia.org/> (visited 30 March 2025)

Watson, C.A., Reckling, M., Preissel, S., Bachinger, J., Bergkvist, G., Kuhlman, T., Lindström, K., Nemecek, T., Topp, C.F.E., Vanhatalo, A., Zander, P., Murphy-Bokern, D. & Stoddard, F.L. 2017. Grain legume production and use in European agricultural systems. *Advances in Agronomy* 144: 235-303. Doi 10.1016/bs.agron.2017.03.003

Zander, P., Amjath-Babu, T.S., Preissel, S., Reckling, M., Bues, A., Schläfke, N., Kuhlman, T., Bachinger, J., Uthers, S., Stoddard, F.L., Murphy-Bokern, D. & Watson, C. 2016. Grain legume decline and potential recovery in European agriculture: a review. *Agronomy for Sustainable Development* 36: 26. doi 10.1007/s13593-016-0365-y

12.43 Tiikkainen, A. A simple lifetime productivity indicator to assess milk's carbon footprint and support herd-level decisions

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Background

Milk production is a major contributor to agricultural greenhouse gas emissions. Reducing these emissions without compromising farm profitability is essential for aligning dairy production with climate goals. Traditionally, indicators such as productive lifespan or lifetime milk yield have been used to assess sustainability at the cow level, but neither captures how efficiently milk is produced over time.

This study introduces the use of a familiar metric—energy-corrected lifetime milk production per living day—as a novel tool for assessing the carbon footprint of milk. The abbreviation CLiP is proposed to provide a concise and communicable name for this indicator. While the concept itself is not new, this is the first study to apply it explicitly in carbon footprint analysis.

CLiP combines lifetime milk, fat, and protein yields with the number of living days, offering a practical summary of overall herd management success. In this study, several key factors, such as age at first calving, lactation duration and dry period length, were shown to significantly affect CLiP values.

Provided by the milk recording system or calculated by farmers themselves, CLiP serves as a practical and cost-effective tool for herd-level benchmarking. As such, it supports both environmentally and economically sustainable dairy herd management. This study focuses on the CLiP of culled cows, thus reflecting the long-term outcomes of past management decisions.

The primary aim was to examine how CLiP correlates with the carbon footprint of milk and feed costs. A secondary objective was to assess the usefulness of CLiP as a management tool to support both environmental and economic optimization in dairy production.

Methods

This case study used long-term data from Kotipelto Farm in Finland, covering 304 culled cows between 2014 to 2023. Data sources included individual cow records, feeding plans, feed consumption data and farm-level annual reports from milk recording. Both the carbon footprint of milk and feed costs were analysed on three different CLiP levels: The Finnish national average in 2023 (14.6), Kotipelto Farm's average in 2023 (18.6), and its internal target level (20.0).

Carbon footprints were calculated using EnvitecVisio software, which estimates CO₂-equivalent emissions per kg of energy-corrected milk (ECM). The calculation methodology complies with IPCC and GHG Protocol standards and is detailed enough to meet the Science Based Targets (SBT) criteria. Feed costs were derived from farm records and calculated per kg ECM in each benchmark group. To simplify both calculations, grazing was excluded from the feeding data.

Unlike conventional annual-based carbon footprint assessments, this study calculated emissions over the entire lifetime of an average cow in each benchmark group. To align with the annual scope required by the EnvitecVisio software, lifetime days in four feeding phases – calfhood, heifer stage, lactation and dry periods – were converted into average animal units. These were then adjusted based on the average age at culling in each group, resulting a 12-month “snapshot cow” representative of the lifetime feeding structure. This enabled more realistic lifetime emission estimates per kg ECM.

For the secondary objective, the dataset of 304 culled cows was analysed in three levels: i) as whole, ii) as a subset of cows who achieved at least 20kg CLiP, to identify contributing factors and optimal thresholds, and iii) excluding cows culled during their first lactation, due to missing first-lactation ECM and dry period data.

Six key indicators were selected for analysis:

- CLiP (kg ECM per living day),
- Age at first calving,
- Total number of calvings,
- First-lactation ECM,
- Average lactation duration,
- Average dry period duration.

The statistical methods applied included linear regression analysis, variance analysis and interquartile comparisons.

Results

The carbon footprint calculations demonstrated a clear decline in emissions per lifetime daily production (ECM). Increasing CLiP from 14.6 to 18.6 reduced emissions by 9.28%, while further increase to 20 resulted an additional reduction of 1.14 %. In total, the carbon footprint decreased by 10.31% between the lowest and highest CLiP levels.

In addition to the carbon footprint results, the calculation method also revealed a reduced need for replacement heifers at higher CLiP levels. Compared to the lowest benchmark (CLiP 14.6), the highest benchmark (CLiP 20) required 13.3% fewer youngstock. Although this reduction represents a potential economical benefit, it was not included in the feed cost analysis.

Feed costs per ECM unit were 0.03 € lower in both higher CLiP groups compared to the lowest one, suggesting improved feed efficiency in longer-living, more productive cows. For instance, in a cow with lifetime production of 40 000 kg ECM, this difference would translate to approximately 1 200€ total feed cost savings.

All six performance indicators selected for the study included CLiP (ECM lifetime daily production), which served as the key outcome variable, and five explanatory variables potentially associated with it. All explanatory variables showed statistically significant correlations with CLiP ($p < 0.01$), highlighting key areas for management interventions:

- Age at first calving. The only indicator with negative correlation to CLiP. Earlier calvings improves CLiP, but biological limits must be respected. First calving should not occur before 22 months of age to ensure sufficient growth and development. In Finnish national data, the CLiP values began to decline when the age at first calving exceeded 26 months. At Kotipelto farm the optimal age was 25.5 months. Cows calving after 33 months consistently performed poorly in both this dataset and previous research.
- Number of calvings. A strong positive correlation was observed. On average, each additional calving increased CLiP by two units. Achieving five calvings per culled cow appears optimal for attaining high CLiP values.
- First lactation ECM. Strongly associated with higher CLiP. However, a first-lactation yield of 11 000 kg ECM was sufficient; extreme values beyond this level did not offer further benefits and tended to be associated with early culling.
- Lactation duration. Cows with higher CLiP had longer lactations. While official recommendations suggest shorter lactation cycles to improve calving intervals and

reproductive efficiency, an average duration of 339 days appears suitable for achieving high CLiP.

- Dry period duration. Optimal dry period to high CLiP was 55 days, which is close to national recommendations. Periods shorter than 37 days may compromise cow recovery, while longer periods provided no additional benefit.

Conclusions

This study demonstrates that CLiP is a powerful and practical tool for simultaneously integrating economic and environmental goals in dairy herd management. Higher CLiP values were clearly associated with lower carbon emissions per kilogram of energy-corrected milk and with improved feed cost efficiency. The indicator combines lifetime milk yield and lifespan into a single, interpretable measure, making it a promising tool for evaluating long-term cow productivity and now also to sustainability evaluation.

By shifting a focus from short-term production figures to lifetime efficiency, farmers can reduce emissions without compromising profitability. The results suggest that even small improvements in CLiP – through better management of age at first calving, reproductive performance and lactation structure – can yield measurable environmental and economic benefits at herd level.

A major strength of CLiP lies in its simplicity and accessibility. It can be calculated using existing milk recording data, requiring no additional investment or complex software. This makes it suitable for a wide range of farm sizes, production systems, and management styles. Moreover, CLiP is compatible with other emission-reduction strategies, such as feed additives, improved genetics and manure management, supporting a holistic approach to climate-smart farming.

CLiP also serves as a long-term performance indicator, summarising the success of multiple management decisions made over the cow's life. This makes it a valuable tool not only for farmers but also for advisors, breeding organizations and policymakers seeking practical metrics for improving both productivity and sustainability.

In conclusion, integrating CLiP into routine management and advisory practices provides a low-threshold, cost-effective way to support more sustainable dairy production. Its relevance will only increase in the future, as pressure grows to demonstrate both climate responsibility and economic resilience in food production. As such, CLiP may become an important part of the toolbox for meeting both national and EU-level sustainability targets in the dairy sector.

12.44 Tuomasjukka, S. & Tarkkio, A. In the mood for change? Can a single question predict proenvironmental food choice changes?

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Background and aims

To mitigate the most destructive consequences of the ecological dual crisis of climate change and biodiversity loss, changes in individual behavior are essential. The most commonly used theories in environmental psychology for explaining proenvironmental behavior, such as the Theory of Planned Behavior (TPB), Norm-Activation Theory (NAT), and Value-Belief-Norm (VBN) theory, share several common elements. By integrating elements from different theories, such as values, beliefs, norms, and self-efficacy, higher explanatory power has been achieved compared to the original models.

The testing of models of proenvironmental action almost invariably involves measuring intention rather than actual behavior. Since intention often does not translate into action (the intention-behavior gap), the explanatory power of these theories is often weak, and their utility in promoting sustainable food choices can even be questioned.

We conducted an intervention in a university self-service restaurant, providing information about the negative impacts of rice on biodiversity. The intervention reduced rice consumption by 62%. In an exploratory manner, we sought to explain this change through a typical set of background values, norms, knowledge, and emotions.

Methods

A total of 195 participants in a food biodiversity intervention completed an extensive value and biodiversity questionnaire before the intervention. Each participant consumed five separate, monitored meals. We created subgroups from individuals who initially consumed rice and then ceased its consumption, categorizing them based on their commitment to avoiding rice (1, 2, or 3 consecutive meals without rice) ($n=57, 43, \text{ and } 32$, respectively). We then analyzed the role of background variables in their behavior by comparing the means of the rice-avoiding groups with the rest of the participants.

Results

In groups avoiding rice for 1 or 2 consecutive meals, we found no statistical difference in any of the 67 measured background factors. Thus, there were no differences in egoistic, altruistic, or biospheric values, nor in a broad spectrum of biodiversity knowledge or awareness of biodiversity loss risks. Additionally, subjective or personal norms, self-efficacy, nature-related emotions, and sustainability actions did not differ between the groups. These findings were consistent for both individual questions and the respective sum variables.

In the group that demonstrated the strongest avoidance with 3 consecutive no-rice meals, we found a difference in one background question. Respect for other species, part of biospheric values, distinguished this group from the rest of the participants ($p<0.02$). However, the group variable for biospheric values did not differ.

Conclusions

Our findings suggest that the question sets validated for currently dominant environmental psychological theories fail to measure individuals' readiness for a sustainable lifestyle. We hypothesize that this inadequacy stems from an insufficient measurement of the moral obligation necessary for radical changes in strongly routinized habits, such as everyday food choices, as evidenced by recent updates to TPB-based models.

Moral obligation, a pivotal element in the Value-Belief-Norm theory and measured as personal norms, appears to be inadequately captured with typical food-related norm questions. Consequently, it fails to reflect the effect that norms (i.e., moral obligation) have on intention and subsequent actions.

Instead, after repetitive reduction of group size based on commitment to rice avoidance, a single question from the biospheric values set emerges as an explanation for the action. "Respect for Earth and harmony with other species" is higher among strongly committed individuals, as measured by their changed and sustained proenvironmental food choices. Compared with other biospheric value questions, it inherently involves a moral obligation to treat the Earth and other species with respect. This is an abstract moral obligation that focuses on the intrinsic value of nature and other species, differing from other biospheric values which either focus on more specific protective actions or highlight a personal connection to nature.

The lack of explanatory power of norms in the drastic dietary changes achieved in the intervention, coupled with the emergence of moral obligation as presented in the biospheric values question, underscores the need for further research in the formulation of questions to accurately measure the true moral obligation that influences people's food choices.

12.45 Valujeva, K. et al. Balancing agricultural and forestry land use: a practical approach to sustainable agroecosystem management

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Context

Sustainable land use has become increasingly important as societies seek to address climate change, biodiversity loss, and food security. Agricultural land, which supports food production and rural economies, also contributes to environmental problems such as greenhouse gas emissions, habitat destruction, and water pollution. In contrast, forests play a vital role in climate regulation, biodiversity protection, and maintaining water quality. This has led to growing interest in afforestation—the process of converting agricultural land into forest. However, this land-use transition is not always economically attractive to landowners, particularly because income from forestry is often delayed for decades, while farming typically provides annual returns. Moreover, converting farmland to forest can lead to irreversible soil changes and restrict future land use. As a result, many landowners hesitate to adopt afforestation despite financial incentives. Policymakers and landowners need reliable and accessible tools to compare the profitability of different land uses in the short term, while still considering long-term sustainability. This study addresses this need by developing a practical method for comparing the economic value of farming and forestry at the parcel level.

Objectives

The main objective of this study is to create and apply a framework that allows landowners and decision-makers to assess and compare the short-term profitability of agriculture and forestry. Unlike traditional models that require long-term forecasts and discounting future returns, the proposed approach is based on current market conditions and calculates profits on an annual basis. This makes it easier for landowners to understand and use in their decision-making. The method is particularly useful in regions where farming is only marginally profitable and where afforestation could offer both environmental and economic benefits. By focusing on parcel-level data, the approach supports more accurate and locally relevant evaluations. This allows for the identification of areas where afforestation is not only environmentally beneficial but also financially reasonable. The study also supports policymakers by providing evidence to develop land-use strategies that balance economic development with environmental goals.

Methods

The study is conducted in Latvia, where both agriculture and forestry are important land uses. Agricultural profitability is calculated per hectare using data from the Farm Accountancy Data Network (FADN), gross margin estimates, official statistics, and expert evaluations. The analysis includes major crop groups and grazing animals, while excluding intensive livestock sectors such as poultry and pigs that are not directly linked to land use. To ensure accuracy, labour costs are adjusted based on national wage data rather than relying on reported profits, which often reflect unpaid family work. The calculations also account for land quality, which is measured using a point-based index and corrected with current productivity data. Forestry profitability is estimated using a new concept called “deposited profit,” which treats the yearly increase in

timber volume as an economic gain, similar to a savings deposit. This approach avoids the need for long-term projections and instead uses current prices for different types of wood products. Forestry costs include planting, maintenance, thinning, and harvesting, all based on national data. Spatial analysis is carried out by aggregating the parcel-level data into a uniform grid of one hectare to allow for consistent comparison and clear visualization of results across the country.

Results

The results reveal significant variation in agricultural profitability across different crop types, land quality, and farm sizes. Crops such as cereals and pulses are generally profitable, even on average-quality land, and especially when produced by larger farms. However, crops like vegetables and fruits are profitable only on high-quality land and under large-scale production. Smaller farms often operate at a loss, particularly in sectors that require high labour input. Profitability is also lower in livestock systems such as sheep and small-scale dairy operations. In many areas of Latvia—especially in the eastern and southeastern regions—agricultural activities result in low or even negative profits. In contrast, forestry offers lower but more stable annual profits across a wide range of land types. Annual profits from forests range from 17 to 244 euros per hectare, depending on tree species and site conditions. Coniferous species such as pine and spruce are especially profitable due to high market value and timber yield. Birch is also profitable, particularly when sold as veneer logs. Forests established on dry mineral soils perform better than those on wet organic soils, which have higher costs and lower yields. When profitability is mapped, clear spatial patterns emerge. High agricultural profits are limited to a few areas, while forestry provides moderate but consistent returns across much of the country. This suggests that afforestation could be a reasonable option in areas where farming is not economically viable.

Conclusions

This study presents a clear and scientifically sound method for comparing the economic performance of agricultural and forest land uses at the parcel level. The proposed approach uses short-term data and avoids complex discounting, making it easier to understand and more applicable to real-world decision-making. It provides useful insights for landowners who must decide how to use their land, particularly in areas where traditional farming is no longer profitable. It also offers a valuable tool for policymakers seeking to promote climate-friendly land use while supporting rural economies. The method can be adapted to other countries or regions with similar data, making it broadly useful for sustainable land-use planning. While the study focuses on financial returns, the same framework can be expanded to include other important values such as carbon storage, biodiversity, and water protection. As European agriculture continues to change and climate goals become more urgent, this approach can help guide responsible and economically sensible decisions about land use. In conclusion, the method supports better land management by aligning short-term economic interests with long-term environmental goals.

13 Papers presented in the conference with no published extended abstract

1. Andersson Malin, Granvik Madeleine, Milestad Rebecka. Different approaches to food systems planning - Examples from three Swedish municipalities
2. Artell Janne, Heinola Katriina, Huttunen Katriina, Pouta Eija, Schulman Alan, Tienhaara Annika, Vainio Annukka, Viitala Sirja. New Genomic Techniques: Attitudes, Beliefs And Willingness To Use Across Farmers And Consumers
3. Bustamante Maria, Martin Michael. The role of business models in scaling sustainable agri-food innovations
4. Chatzopoulou Sevasti. From organic waste to circular economy innovative biosolutions: governance challenges and opportunities
5. Firse Jana, Naukkarinen Veera, Toivonen Marjaana, Timler Carl, Groot Jeroen, Schulte Rogier, Koppelmäki Kari. Exploring entry points to circularity in food production from a farming system perspective.
6. Frieri Francesca, Morone Piergiuseppe, Colasante Annarita, Russo Alberto. The impact of food labels on consumers' choices: the case of Eco-score and Nutri-score
7. Huan-Niemi Ellen, Huttunen Suvi, Jauhiainen Jyrki, Laiho Raija, Lonkila Annika, Paloviita Ari, Simola Sara, Tribaldos Theresa, Niemi Jyrki. Transdisciplinary research via a living lab: just transition, climate change, and sustainable food system
8. Iwarsson Emmy, Holmström Anni, Granvik Madeleine, Milestad Rebecka, Öhlund Erika. Municipal policy on local food, agricultural land and food preparedness – integrated or siloed?
9. Kaljonen Minna, Tribaldos Theresa, Huttunen Suvi, Kortetmäki Teea, Niemi Jyrki, Paalanen Laura, Salminen Jani. Deliberating justice in food systems transformation pathways: a transdisciplinary approach
10. Kokkonen Tuomo, Lamminen Marjukka, Pitkänen Olli, Halmemies-Beauchet-Filleau Anni, Kuoppala Kaisa, Vanhatalo Aila. Faba bean as a substituting protein feed for rapeseed in dairy cow diets: A meta-analysis
11. Koppelmäki Kari, Keränen Fanny, Firse Jana, Huuskonen Arto, Salminen Jani, Norberg Anna, Herzon Iryna. Optimizing livestock production systems for local resource use – Balancing production and environmental impact
12. Kortetmäki Teea. Beyond cost: capabilities and just dietary transition
13. Kurki Kaisa, Kaljonen Minna, Mazac Rachel, Rätty Niko, Herzon Iryna. Culturally acceptable sufficient diets: Negotiating a sustainable consumption corridor for Finnish diets
14. Laila Amar, Hicks Christina, Rao Nitya, Conti Costanza, Robinson James, Thilsted Shakuntala, Barnhill Anne, Gordon Line. An overview of food systems injustices experienced by marginalised groups: A scoping review of reviews
15. Lombardini Chiara, Kauppinen-Räsänen Hannele, Sihvonen Jenniina, Gaiani Silvia. Categorization theory as a means for promoting healthier and more sustainable diets rich in legumes
16. Lombardini Chiara, Lötjönen Sanna, Ollikainen Markku, Sipiläinen Timo, Simojoki Asko, Stoddard Fred, Hyytiäinen Kari. Including Legumes in Crop Rotations in an Uncertain World: A Scenario-Based, Monte-Carlo Cost-Benefit Analysis
17. Maniruzzaman Maniruzzaman, Khazaei Hamid, Jalli Marja, Haapalainen Minna, Schulman Alan, Stoddard Frederick. Interactions between Faba bean and its Botrytis pathogens
18. Matthiessen Lea Ellen, Kopainsky Birgit, Smed Sinne, Gjedsted Bügel Susanne, Dejgård Jensen Jørgen. Sustainable Public Food Procurement in Copenhagen: An Ex-Post Evaluation

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14 Poster abstracts

14.1 Beitane, I. et al. Sustainability in food service companies: the case of Latvia

Professor Ilze Beitane¹, Mrs Gita Krumina-Zemture¹, Mr Janis Jenzis¹, Dr Martins Sabovics¹, Dr Sandra Iriste¹

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Food waste management is an essential part of food service companies' operations, as it affects not only the environment but also the financial performance of companies. The study aimed to assess the actions of food service companies in relation to the causes of food waste generation, solutions for its reduction, and the entrepreneur' opinions on the impact of food waste on the company.

The study involved 109 food service companies that completed a questionnaire based on the study by Principato et al., 2018. The questionnaire was created on a Google form and sent by email to 1000 food service companies. The survey was conducted from June to September 2024.

The amount of food waste generated per working day depended on the company's size. However, 46% of the companies generated 1-5 kg of food waste daily. Food waste in food service companies was divided into the following categories: 50% as a result of technology during food preparation, 43% as a result of customer leftovers, and 7% as a result of management planning impact – incorrect customer flow planning, and inaccurate food product ordering. Measures to reduce food waste included educating staff (90%), offering customers the opportunity to take uneaten food home (86%), and using the freezing method to preserve ready meals (78%). 87% of the entrepreneurs surveyed believed that managing food waste was a matter of social responsibility. 79% of entrepreneurs agreed or partly agreed with the statement that food waste has an impact on the financial performance of the company.

14.2 Bell, Q. et al. Two peas in a pod: a digital twin for climate smart agriculture

Quentin Bell¹, Istem Fer¹, Olli Nevalainen¹, Samu Varjonen¹, Julius Vira¹, Layla Höckerstedt¹, Hui Tang¹, Henri Kajasilta¹, Olli Niemitalo², Iivari Kunttu², Joni Kukkamäki², Juuso Saarinen², Laura Rosenberg³, Liisa Kulmala¹, Jari Liski¹

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In the digital solutions to foster climate-smart agricultural transition (Digi4CSA) project, teams from FMI and HAMK are collaborating to build a farm-scale digital twin with field-level specificity to service farmers and other stakeholders. The digital twin will initially be piloted at Qvidja experimental farm and displayed on fieldobservatory.org before being expanded to Viikki and Mustiala research farms. Nowcasting and near-term forecasting (up to 15 days) will give farmers the information they value now (for example, soil moisture and temperature) and mid-range forecasts based on ECMWF and climatology will allow for seasonal predictions and estimates of management effects on the carbon cycle and greenhouse gas emissions. What-if scenarios will begin with climate, environment, and management scenarios, later expanding to operational costs and economic scenarios to support a robust decision support system. Initially, the STICS soil-crop model will be used to prototype Qvidja and scenario simulations, while remote-sensing based methods will provide up-to-date monitoring, reporting, and verification capabilities. We anticipate challenges regarding data latency and integration, particularly for management plans and actions.

14.3 Bäck. S. et al. Gaps between adults' perceived and actual macronutrient intakes: self-assessment relative to nutrition recommendations is challenging

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Background & aims

Population adherence to nutrition recommendations is measured by dietary surveys, but personal perceptions in adherence to recommendations is less explored. We studied individuals' perceptions of their macronutrient intakes compared to the Nordic Nutrition Recommendations and discrepancies between perceived and actual intakes.

Methods

Data was collected from adults (n 102, 78% women, mean age 47 years) participating in the ScenoProt dietary trial. Perceptions of intakes and sources of carbohydrates, fiber, fats, and proteins were collected by a questionnaire. Actual intakes and sources were assessed with 4-day food records. Associations between sociodemographic factors and the capacity to self-assess nutrient intakes were examined by logistic regression.

Results

Discrepancies were found in relative proportions of the three categories 'below/according to/above the recommendation' between perceived and actual intakes regarding the nutrition recommendations. Participants rated themselves rather according to or above than below the recommendation. The most distinct gap was discovered between perceived and actual carbohydrate intakes, e.g., proportions of participants being below the recommendation: 8% measured as perceived intake; 70% measured as actual intake. Gaps were also observed for fat and protein. Cereals were one of the most common protein sources but only 8% of the participants named them. No associations emerged between age, gender, or education (46% with a master's degree or higher) and the capacity to self-assess intakes.

Conclusions

Our study suggests that self-assessment of macronutrient intakes is challenging. Misperceptions can hinder the adaption of healthier and more sustainable diets. Interpretation of nutrition recommendations to the public could be improved.

14.4 Forsman, L. In search of business models for local and systemically sustainable food

Ms Laura Forsman¹

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Background aims

The current global setup of food production/consumption systems lead to detrimental ecological and social externalities. A key problem is the highly commoditized nature of food attributed to product-oriented thinking. Thus, new business models and offerings are necessary for achieving sustainable food systems. A novel framework for sustainable product-service systems (S.PSS) for food is developed to explore such concepts. It facilitates the design of business models and solutions organizing local food production, distribution, and nutrient recycling in a systemically sustainable manner.

Methods

The framework is theorized through combining the S.PPS model (Vezzoli et al., 2021), FAO's Food Security dimensions (Practical, 2008), and EU's Food2030 agenda (European Commission, 2016). They are synthesized into a framework for conceptualizing novel offering and business models – i.e., S.PPS concepts – delivering sustainable food systems outcomes. The application of the framework for local food production, distribution, and nutrient recycling is showcased.

Results

The results include an original analytical framework for conceptualizing S.PSSs for sustainable food systems. It applies S.PSS model's three approaches (product-oriented, use-oriented, and result-oriented services) for creating availability, access, utilization, and stability value for consumers/citizens and the society, aligning with Food2030's criteria for sustainable food system outcomes. 18 emerging and novel business model, offering, and solution concepts are described showcasing the deployment of the framework.

Conclusions

The framework and the showcased concepts illustrate how servitization of food production, distribution, consumption, and nutrient cycling can be deployed in the sustainability transition into local food systems creating environmental, social and economic value.

14.5 Fu, Y. & Irz, X. Optimizing sustainable diets with mycoprotein in Finland

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Background aims

Meat alternatives could serve as a steppingstone for a sustainable dietary transition featuring large meat reductions, with mycoprotein one of the most promising options. This study aims to characterize a culturally acceptable, healthy and low climate impact Finnish diet that incorporates mycoprotein, hence establishing the potential role of mycoprotein in the transition.

Methods

An original quadratic optimization model minimizing the weighted distance from current diet was designed, with mycoprotein introduced as a new food within the meat group. The model first simulated a healthy diet with mycoprotein, then reduced the diet's greenhouse gas emissions (GHGE) while maintaining total consumption of the meat group.

Results

The healthy diet sustained around 80% of the current meat consumption with small amounts of mycoprotein included. For further GHGE reductions, red and processed meats were replaced mainly by poultry, followed by mycoprotein with an increasing share. The meat group's share of the diet's GHGE first decreased drastically (due to beef reduction) then increased moderately, while the expenditure share first dropped slightly then rose (as mycoprotein increased), but all simulated diets remained more affordable than the current diet.

Conclusions

Healthy diets with small amounts of mycoprotein combined with other meats can achieve moderate GHGE reductions (around 30%), but large GHGE reductions would require unrealistically large consumption of mycoprotein, while also raising potential nutritional and acceptability problems.

14.6 Gaiani, S. et al. Increasing resilience of Nordic food systems through agriculture

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The COVID-19 pandemic and the global geo-political and economic instability have affected Nordic societies at all levels and in all areas and have demonstrated the fragility of the food systems including the agricultural, forestry and fishing sectors. Increasing resilience of the Nordic food systems' is now a high political priority which should aim at increasing stability, but also at supporting adaptation and transformation of the food systems and robustness towards climate change mitigation.

A number of strategic approaches should be put in place, ranging from ecosystem-based approaches - such as diversification, land restoration, agro-ecology, and agroforestry that can bolster food production while providing multiple benefits such as yield stability and ecosystem health- to sustainable resource management in response to distribution shifts of terrestrial and aquatic species under climate change.

In the case of the Nordic countries, two of the most relevant concerns regard the environmental performance of the agricultural sector and the efficient creation of value added along the food chain. In Norway, for instance, only 3% of the total support to agriculture is dedicated to research and innovation and the governmental support to producers is the highest among OECD countries, with 59% of farmers' revenues coming from government support.

Our intervention aims at identifying which approaches might promote innovation, sustainability and long-term resilience in the Nordic food systems, with a specific focus on the agricultural sector.

14.7 Järviö, N. et al. A Finnish database for biodiversity impacts of food items consumed in Finland

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Food production is a major driver of biodiversity decline due to factors such as (expanding) land use, greenhouse gas (GHG) emissions, application of fertilizers and water use for irrigation. Through logistic chains, dietary choices made locally have a biodiversity impact globally. In our research we show the biodiversity impacts of 617 food items regularly consumed in Finland and the overall Finnish food consumption. To this purpose, we used the multi-regional input-output database FABIO to link consumption with production locations. We considered several environmental flows including those that had not previously been considered in biodiversity assessments of Finnish food products (land use, GHG emissions, water use and fertilizer applications) and estimated biodiversity impacts using the GLAM 3 and LC-IMPACT life cycle impact assessment methods for terrestrial, freshwater, and marine ecosystems. The resulting database containing biodiversity impacts of Finnish food products will later be published in Zenodo.

Results showed us that most of the biodiversity impacts caused by Finnish food consumption occurred outside of Finland. We identified the greatest loss of terrestrial biodiversity in Latin America through land use and land transformation. Most of the marine ecosystem losses occurred within the countries surrounding the Baltic Sea explained by additional fertilizer inputs putting extra pressure on an already struggling ecosystem. Freshwater ecosystem losses were mostly caused by irrigation of consumed crops grown in the United States. Inclusion of multiple biodiversity loss drivers (e.g. climate change) showed to be essential when assessing the biodiversity impacts of land-based animal sourced foods, particularly for Finland.

14.8 Kadulin, A. et al. Why farmers manage or abandon semi-natural grasslands: a systematic review of motivations and barriers

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Semi-natural grasslands are vital biodiversity hotspots, supporting key ecosystem services directly or indirectly derived by human. However, sustainable management of semi-natural grasslands is increasingly threatened by agricultural intensification, socio-economic pressures and shifting policy frameworks. While agri-environmental subsidies serve as a primary conservation tool, reliance on financial incentives alone may not assure farmers' long-term engagement, particularly as policy priorities and funding mechanisms.

A systematic literature review was conducted to synthesize findings from empirical research across various European contexts to identify the motivations and barriers influencing farmers' decisions to either manage or abandon semi-natural grasslands.

By categorizing push and pull factors, the literature review highlights the role of economic incentives alongside alternative drivers, such as cultural identity, ecological awareness, policy design, and institutional support. Our findings suggest that while financial incentives are essential, non-economic factors significantly shape decision-making, emphasising the need for multi-faceted adaptive conservation strategies.

As policy landscapes evolve, integrating social, economic and environmental dimensions into nature conservation efforts is imperative for the sustainability of semi-natural grasslands. Our study emphasizes the importance of resilient, evidence-based policies that go beyond financial mechanisms to support the long-term management of semi-natural grasslands and establish their vital role in biodiversity and landscape conservation.

14.9 Kähkönen, K. et al. Transforming the food system for sustainability: the role of agri-food cluster in North Savo

Kaisa Kähkönen¹, Jade Hirvonen¹, Kati Partanen¹, Dr Ardita Hoxha-Jahja¹

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To address sustainability challenges, we must transform the food system structure. Enhancing the efficiency of long-established raw material and value chains is no longer sufficient. Developing sustainable innovations in the food industry requires identifying and piloting new business opportunities.

In North Savo, the food sector is a smart specialization priority. Achieving the necessary structural change requires closer collaboration and broader networking among stakeholders. Consequently, a cluster has been established to unite food chain actors, including companies, research institutions, and public actors, to achieve a competitive advantage through cooperation. The Agri-Food cluster integrates the entire food chain, from primary production to food processing and supply chain, including supporting functions.

The North Savo Agri-Food cluster includes over 40 food chain actors: half are companies, a quarter are RDI organizations, and the rest support rural entrepreneurship, such as municipalities. Membership is also open to actors outside North Savo.

Cluster organizations promote collaboration, networking, and learning, serving as gateways to European cooperation networks and direct EU funding. They bring together development-oriented actors to address shared challenges and support development through various funding channels. The North Savo Agri-Food cluster has strengthened the recognition of the region's food sector strengths and enhanced cooperation among actors within and across regions. Through the European Cluster Collaboration Platform (ECCP), international networks and collaborations with European food sector clusters have been established. The cluster has also increased coordination of the region's food sector advocacy efforts at regional and national levels.

14.10 Korhonen, K. et al. Perspectives on the potential of legume production and consumption from farm to fork

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Background aims

Legume consumption is still relatively low, and the Nordic Nutrition Recommendations 2023 suggests increasing it. Comprehensive, multi-input research regarding views on legumes has been scarce. Considering the perspectives of the different actors in the system provides a more comprehensive overview and can help to design measures to support the growth of the legume sector. The aim of this study was to identify new opportunities to promote legume consumption and production.

Methods

Three surveys were conducted among primary producers (N=2 085), consumers (N=1 000), and food services (N=82) between 2020-2024. The survey data were analysed using descriptive statistics, Chi-Square test and One-Way ANOVA or Welch test.

Results

All respondent groups recognised the potential of legumes. Although, food services had the most optimistic views on them. Different respondent groups varied in their views on what should be highlighted in the communication on legumes, but healthiness was a fairly strong common theme. However, one health promoting property of legumes, high fibre content, did not seem to be identified. Most consumers preferred using legumes as such. In contrast, food services' requirements for processed products were relatively high, and the simpler use of legumes as a side dish was minimal.

Conclusions

Our results suggest that supporting food services with legume-based side dish development is one strategy to promote wider use of legumes and increase the familiarity of legumes. Eventually, acceptance could also increase for a wider range of legume-based foods. Overall, this study identified several untapped opportunities for increased legume consumption.

14.11 Kuoppala, K. et al. Resilience of the European dairy sector

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Background aims

The Resilience for Dairy (R4D) project aimed to find out what information and related practical solutions are needed to improve the resilience of dairy farms and the whole milk chain at the European level.

Methods

The project carried out a standardised online survey on data needs and collected the views of the stakeholders. In the national groups including milk producers and other operators, challenges in the dairy sector, information needs and related practical solutions were discussed informally. Needs and solutions were evaluated by experts and 100 solutions were chosen for further evaluation, and subsequently dissemination (see <https://resilience4dairy.eu/>).

Results

Environment/climate change was the topic that scored highest at all levels: challenges, needs and solutions. The economic situation of milk producers, the possibility of hiring skilled labour and ensuring the continuation of the farm management were frequently discussed themes. The economy and the labour situation are closely linked. Practical solutions were most proposed by national juries in relation to animal nutrition and management, grassland cultivation and harvesting techniques, environmental issues, and working conditions. The practical measures implemented at the farm level are considered natural solutions, as they can be influenced by the farm itself. Socially acceptable production methods were considered important for needs, but few solutions were found for this topic.

Conclusions

The current dairy industry within EU faces numerous challenges, which leads to multiple needs within the farms and other stakeholders. Nevertheless, several solutions have been identified with the potential to enhance the resilience of the dairy sector.

14.12 Licite, I. et al. Mapping research and policy processes for Latvia's bioeconomy in the context of the carbon market

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Background aims

This study addresses the need to comprehensively understand Latvia's bioeconomy sector regarding carbon market mechanisms. Mapping previous research and policy processes enables a start of the baseline assessment of the sector's role within carbon market governance. Integrating global, EU, and national perspectives, the research supports the development of sustainable carbon market strategies. This work is part of the baseline assessment of Latvia's bioeconomy sector in the context of carbon markets within the postdoctoral research "Carbon market-based mechanisms as a climate neutrality system tool to promote the development of the bioeconomy sector in Latvia".

Methods

The research employs a dual-method approach: (1) a systematic review of scientific literature to create a dynamic metadata database of scientific research and (2) a structured mapping of policy processes to clarify governance of carbon markets at global, EU, and national levels.

Results

Initial findings underscore the necessity for transdisciplinary approaches to address fragmented research and policy landscapes. The constructed metadata database consolidates global, EU, and Latvian research and is a critical resource for further research. The mapping of policy processes discovers the status quo of the political field and highlights key gaps by providing actionable insights for harmonizing carbon market governance with bioeconomic strategies.

Conclusions

By integrating research and policy insights, the study contributes to developing a resilient bioeconomy and informed governance of carbon markets in Latvia, with implications for broader regional and global contexts. Transdisciplinarity of the research (integrative aspects of life science and socioeconomics) supports scientific competence in climate change mitigation.

14.13 Nurk, K. et al. The perceived risk factors in Estonian agriculture

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It is well-known that every day farmers face risks due to changing natural and economic conditions. This study analyses the perceptions of Estonian farmers about the most important risk factors in the next five years, measured on an 11-point scale.

The paper employs survey data from a sample of farmers (n=628), gathered by structured online questionnaire from November–December 2024. The survey questions covered farmer's perceptions of risks and various strategies to manage risks, and socioeconomic characteristics of the farm and farm manager. To find out the risks faced by Estonian farmers, the average score for occurrence and average potential economic loss were multiplied for each risk factor. Medians of these risk scores helped to categorize the risks into a risk matrix with low and high expected occurrence and low and high expected economic loss.

The perceived key risks varied among different production types. In livestock, aging of equipment, machinery, and buildings was considered critical. In crop production, biggest concern was increasing land rental prices. Horticultural producers identified pests as the most pressing, while for perennial crop growers, spring frost was a major threat. Dairy farmers prioritized drought, whereas pig and poultry farmers were worried about mycotoxins. In mixed farming, high wage expectations of skilled workers emerged as a key challenge.

These results highlight the diverse nature of perceived risks across agricultural production specialization types. This knowledge can be used for more tailored policymaking with regard to risk management, thereby helping to enhance the sector's resilience in changing conditions.

14.14 Paalanen, L. et al. Differences in food consumption and macronutrient intake by diet-related green-house gas emission sums

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Background and aims

The synergies of plant-based diets for the health of humans and the planet are well-known. We aimed to study the differences in food consumption and macronutrient intake between diet-related green-house gas emission (GHGE) sum tertiles.

Methods

Data from the national FinDiet 2017 Survey were used (n=1655, age 18–74, response rate 53%). Diet was assessed by two non-consecutive 24-h dietary recalls. Food consumption and energy and macronutrient intakes were calculated using in-house software and the national food composition database Fineli. Energy under-reporters identified following the EU Menu methodology were excluded resulting in 565 men and 682 women. Diet-related GHGEs were calculated using climate impact coefficients produced with life cycle assessment by the Natural Resources Institute Finland. The GHGE sums were divided into sex-specific tertiles.

Results

The mean daily diet-related GHGEs were higher in men (5.6 kg CO₂eq) than in women (4.0 kg CO₂eq). The consumption (g/MJ) of animal-based foods was higher and plant-based foods lower in higher GHGE tertiles compared with lower tertiles. The intakes of energy and protein (as energy percentage, E%) were higher, and of carbohydrates (E%) and fibre (g/MJ) lower, in higher GHGE tertiles. A tendency of higher saturated fatty acid intake (E%) with higher GHGEs was seen. The intake of polyunsaturated fatty acids (E%) in women was higher in the lowest GHGE tertile compared to the highest tertile.

Conclusions

A tendency of more favourable diets in lower GHGE tertiles was seen. The results support earlier findings on synergies of healthy and climate-friendly diets.

14.15 Popluga, D. et al. Decarbonization strategies in agriculture: from theory to implementation

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The contribution of the agricultural sector to mitigating climate change and achieving the climate and environmental goals set by the European Union depends on how successfully and to what extent greenhouse gas (GHG) reducing measures are implemented in practice, as well as how they are assessed and monitored. Since 2015, under the leadership of the research group of the Latvia University of Life Sciences and Technologies, an approach to monitoring, quantifying and evaluating the contribution of agriculture to mitigating climate change has been developed and approved in Latvia. This approach is based on the Marginal Abatement Cost Curve (MACC), which serves as a convenient and visual tool for evaluating the effectiveness of various GHG emission reduction measures and for climate policy planning. The presentation covers the experience to date and the main directions in developing the MACC approach, which serves as a basis for analysing the potential of Latvian agriculture for moving towards decarbonization. The presentation includes an analytical assessment of Latvia's experience in moving towards decarbonization, as Latvia has gone through a full cycle over the course of 10 years, i.e., from the idea of potential measures to reduce GHG and ammonia emissions to the assessment of their potential, the inclusion of the measure in political goals and the National Energy and Climate Policy Plan. In this presentation the results and successes in the practical implementation of the measures are analysed and recommendations set for further progress towards decarbonization.

14.16 Savallampi, J. et al. Improving biodiversity impact assessment for regenerative agriculture in Finland using environmental DNA and LCA

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Biodiversity is declining rapidly, in great part caused by the agricultural sector and the related occupation and transformation of land (IPBES, 2019; Campbell et al. 2017). Regenerative farming has been identified as a potential means for reducing the pressure on biodiversity through land sharing mechanisms. Life cycle assessment (LCA) is one method that could assess the biodiversity impacts of agricultural practices using characterization factors (CFs), which indicate the loss of species richness levels of different land use types in comparison to (semi-)natural land use. However, current CFs in life cycle impact assessment (LCIA) methods do not properly distinguish between different agricultural practices and are mostly based on species richness losses associated with conventional farming (Järviö et al. submitted). Therefore, development of CFs for regenerative farming practices is needed. However, data on species richness levels for regenerative farming is currently lacking. This study aims to create CFs for regenerative farming in Finland by using environmental DNA (eDNA (Taberlet et al. 2018)).

In our study we measured the species richness levels for regenerative and conventional pasture and crop farms, as well as traditional rural biotopes (TRBs) as a (semi-)natural reference system in the southern part of Finland. Samples of plants, soil, and flying insects were taken in August and September of 2024 and were analyzed using the latest state-of-the-art DNA metabarcoding protocols.

CFs for regenerative farming enable a fair assessment of biodiversity impacts that can help farmers, politicians, and other decision makers to support the sustainable transition of the agricultural sector.

14.17 Savikko, R. et al. Co-creating solutions for climate-smart and resilient agriculture in Finland

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¹Natural Resources Institute Finland

Background aims

The MURU-project (Climate-wise and resilient food system from field to consumer) aimed to promote the adaptive capacity, resilience and climate-smart practices of agriculture and food systems in Finland. By fostering communication and networking among actors, the project sought to disseminate research-based knowledge of climate-smart farming and resilience while strengthening interaction among farmers, agricultural advisors, agrology teachers and researchers.

Methods

MURU-project (2022-2024) utilized a multi-channel communication strategy, including workshops, webinars, lectures, magazine articles, blogs and social media. Over its duration, the project organized 12 workshops across Finland and 22 webinars. Topics covered included e.g., soil health and fertility, soil food webs, plant health and plant breeding, vegetable production, legume and silage production, farm-scale biodiversity, resilience in dairy farming, means for climate change adaptation and the development of resilient food systems.

Results

Workshops engaged 360 participants, and the webinars 1500 attendees. By November 2024, recordings of these events had been viewed 3,700 times on YouTube. By integrating research, experts, local actors and practical solutions while adopting a holistic approach, MURU-project significantly contributed to building capacity for more resilient and climate-smart agricultural sector in Finland. Improved understanding of knowledge needs and multi-actor discussion on potential solutions facilitates the implementation of feasible rural climate-smart solutions.

Conclusions

Effective climate-change solutions for agriculture need to be developed from the farmer's perspective, with soil health in the core of both farming and climate adaptation. Capacity-building should prioritize practical skills and adopt a positive, solution-oriented communication. Advisors and forerunner farmers are important collaborators in climate communication.

14.18 Stachnik, M. et al. Sustainability intervention's negative effect on the nutritional value of meals in cafeteria

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¹Turun yliopisto

Background aims

The aim was to encourage a shift from high-footprint rice to low-footprint potatoes, with a focus on assessing whether this change would impact the nutritional composition of the meals.

Methods

Data of 195 users was collected from 1 demo and 4 intervention days. Of those, statistical analysis was done for two groups: 19 people who switched permanently to potatoes or pasta and 48 people who never chose rice. Macro and micronutrient data was provided by the restaurant, analysis was aided with AI. Nutritional composition was compared to RDI from Nordic Nutrition Recommendations (NNR 2023).

Results and conclusions

Meals of people who switched from rice had acceptable macronutrient proportions but were notably deficient in calcium (15%), iodine (10%), vitamin D (5%), and vitamin B12 (2%). Sodium levels (2.03 g) far exceeded the 1.5 g daily limit.

In contrast, the meals of people who always chose potatoes showed better nutritional values and macronutrient balance. However, calcium (18%), iodine (20%), and vitamin D (13%) remained insufficient, and sodium (1.95 g) still exceeded recommendations.

Conclusions

While macronutrient intake was not concerning, it could benefit from small adjustments, such as incorporating more vegetables to increase the amount of fibre. However, both groups had notable micronutrient gaps and high sodium level, with those who permanently switched from rice had notably worse outcome in terms of their meal composition when compared to NNR 2023 standards. This suggests a sustainability nudge may adversely impact the nutritional quality of the meal.

14.19 Strøm-Andersen, N. et al. Cultivating sustainable changes in livestock feed production and feeding practices

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Our project, Feed&Feeding, aims to enhance the sustainability of Norway's food system and address national agricultural policy goals by examining feed production strategies and feeding practices. Strategies include altering livestock diets, improving breeding and animal health, and diversifying protein feed sources for both ruminant and monogastric livestock production. Beyond focusing solely on new feed types, we tackle systemic challenges like land use dilemmas for protein crops, the environmental and economic impacts of livestock production, and ripple effects on food security, rural livelihoods, and socio-cultural dynamics.

We will assess environmental impacts (land use change, GHG emissions, soil carbon, nutrient balances, biodiversity) and socioeconomic outcomes (food security, economic sustainability, rural viability) through a comprehensive sustainability assessment. A Multi Criteria Analysis (MCA) framework will evaluate strategies, highlighting dilemmas and potential synergies. Interdisciplinary methods—data compilation, diet optimization, farm sector modeling, surveys, interviews, and workshops—will inform the MCA.

Results will guide strategies for improved sustainability, starting with interviews and surveys of value chain actors to explore how socio-cultural and economic factors influence feed practices. We will examine how developing value chains for alternative protein sources can contribute to addressing livestock sector challenges and how policy instruments can facilitate sustainable change. Policy analysis will integrate findings from linear programming and insights from value chain actors to recommend effective measures.

By combining diverse methodologies, our project will provide actionable strategies to balance environmental, economic, and social sustainability in Norway's food system.

14.20 Suikki, T. et al. The association between the planetary health diet and body mass index in Finnish adults

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Background

The global Planetary Health Diet (PHD) model was developed to improve human health and environmental sustainability. Findings on the association between the PHD and body mass index (BMI) are scarce. Our aim was to examine the association between the adherence to the PHD and BMI in Finnish men and women.

Methods

We used data from the cross-sectional national FinHealth 2017 Study (men = 2021, women = 2510, aged ≥ 18 years). The habitual diet was assessed with a validated food frequency questionnaire. Based on the PHD, we developed an a priori, energy-standardized (2500 kcal) dietary index score adapted for the Finnish food culture to evaluate adherence to the PHD. The score includes 13 food and nutrient groups (score range 0–13 points; higher total score indicating better adherence). Body weight and height were measured by trained research staff, and BMI was calculated (kg/m^2). Linear regression was used for the statistical analysis, adjusting for age, leisure-time physical activity and smoking status.

Results

Mean PHD score was 3,4 (SD 1,3) for men and 4,1 (SD 1,5) for women. In women, the PHD score was inversely associated with BMI (β -0.25 with 95% CI -0.46, -0.05). In men, no significant association between the PHD score and BMI was found (β -0.10 with 95% CI -0.31, 0.10).

Conclusion

The adherence to the PHD was low in both Finnish men and women, however, a higher adherence to the PHD seemed to be beneficial in terms of BMI. Further studies with different anthropometric measurements are warranted.

14.21 Tarkkio, A. et al. Meal pairing dynamics: the relationship between side dishes and main meal types

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Background aims

The sustainability intervention aimed to promote a shift from high-footprint rice to low-footprint potatoes in lunch canteens. To do this it is essential to know how the side dish choice is linked to the main dish. Understanding these pairings can help design more effective interventions.

Methods

The intervention took place in a lunch canteen equipped with weighing systems at each dish station, enabling precise measurement of the grams taken for each dish. Meal composition data from 195 participants were collected during one demo day and four intervention days. Participants encountered text nudges and an informational sticker highlighting potatoes as the sustainable choice during the intervention day.

Results

Informational stickers significantly influenced side dish choices, resulting in a linear decrease in rice consumption and an increase in the choice of pasta during intervention days. Text nudges had no measurable effect. Side dish preferences correlated strongly with main meal types ($P < 0.001$). Fish meals showed a strong preference for potatoes. Vegan meals were overrepresented with rice and underrepresented with potatoes, while vegetarian meals were overrepresented with rice on demo days and with potatoes during intervention days. Red meat meals showed the strongest association with pasta on demo days.

Conclusions

These findings demonstrate that visual prompts, such as stickers, are more effective than text nudges in encouraging sustainable side dish choices. The close relationship between side dishes and main meal types suggests that meal context plays a critical role in dietary decisions.

14.22 Tavakoli, A. et al. Advancing sustainability and workforce development in Satakunta's food industry through technological innovation

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This study explores the adoption of advanced technologies, particularly artificial intelligence (AI), in advancing sustainability practices and workforce development within the food industry in the Satakunta region, Finland. Survey data from 11 companies reveal a significant emphasis on sustainability, with 91% prioritizing waste reduction and by-product utilization to meet environmental goals aligned with European Union regulations.

The research highlights AI's transformative role in optimizing logistics, enhancing resource efficiency, and supporting circular economy practices. AI's integration into workforce training, adopted by 55% of surveyed companies, facilitates personalized learning and real-time performance monitoring, promoting adaptability and productivity. Larger firms are more likely to implement AI, driven by their resource capacity, while SMEs face financial and technical barriers.

Statistical analyses indicate the relationship between sustainability focus and AI adoption ($r = 0.7194$, $p = 0.0115$), positioning sustainability-driven companies as leaders in technological integration. However, the study identifies the need for targeted strategies to address SME-specific challenges, ensuring equitable access to technological advancements.

The study highlights how advanced technologies drive sustainability and workforce development, while emphasizing the need to support SME adoption for a sustainable future in Satakunta's food industry.

14.23 Tānavots, A. et al. Meat quality of forage-fed Hereford beef cattle in a coastal region on small-scale organic farm

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Beef cattle feed was derived mainly from natural coastal grasslands. In winter, the animals were kept in a barn with access to an outdoor walking area. Grain was excluded from the feed ration. The study aimed to monitor the effect of two sires on the quality of young bulls' m. semitendinosus (n=28) over 28 days of wet ageing. A linear model was used for data analysis in R, and the results are presented as least squares means $\pm$ sd.

Meat samples from the offspring of Sire 1 exhibited higher redness (a^*) values across all ageing periods compared to those of Sire 2 ($p < 0.05$). Exudate loss increased significantly with longer ageing periods in both sire groups, reaching the highest levels at 28 days (Sire 1: $5.00 \pm 2.03\%$, Sire 2: $4.04 \pm 2.92\%$, $p < 0.05$). WHC (filter paper method) decreased with ageing, with a significant reduction at 14 days for Sire 2 ($p < 0.05$). No significant sire or ageing effects were observed for WBSF, pH, or lightness (L^*). Bulls sired by Sire 1 tended to have a larger m. semitendinosus area ($78.23 \pm 11.39 \text{ cm}^2$) compared to those by Sire 2 ($72.91 \pm 11.37 \text{ cm}^2$, $p > 0.05$). Circumference and length of the muscles were not significantly influenced by sire. Fat, protein, ash, and moisture contents were similar between sires, indicating no substantial genetic influence on these traits.

In conclusion, sire influenced specific meat quality traits such as redness and colour stability, while ageing primarily affected water and exudate loss traits, highlighting the combined importance of genetics and post-slaughter handling in optimising meat quality.

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