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A positive use of FORCE

Tullberg, Cecilia; Jagtap, Sandeep; Becker, Per; Grimberg, Åsa; Hammenhag, Cecilia; Johansson, Jonas; Kalling, Thomas; Lundin, Ola; Nilsson, Fredrik; Nordell, Emma; Norrman, Andreas; Purhagen, Jeanette K; Schelin, Jenny; Wilhelmsson, Fredrik

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Total number of authors:

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LUND UNIVERSITY

PO Box 117
221 00 Lund
+46 46-222 00 00

FORCE IS SWEDEN'S NEW CENTRE TACKLING FOOD SYSTEM SHOCKS WITH PLANT-BASED INNOVATION, RESILIENCE, FOOD SAFETY AND TRADE STRATEGY FOR A SUSTAINABLE, SELF-SUFFICIENT FUTURE

A positive use of FORCE

Why preparedness matters

The world has become an increasingly unpredictable place. Constant disruptions to supply chains – especially food supply chains – have forced countries to reconsider their food systems and reduce their reliance on other nations for essential food needs¹. In response, Sweden has taken a proactive step by establishing the new Centre for Food System Resilience and Competitiveness (FORCE) at Lund University, funded by FORMAS, a Swedish Research Council for Sustainable Development. This centre is specifically designed to address these critical challenges.

Transitioning the current food system towards sustainability and resilience is now essential². The agricultural and food industries are currently contributors to global sustainability issues, accounting for more than 25% of greenhouse gas emissions³. Additionally, an estimated one-third of all the food produced is wasted⁴. The current food supply chain model, characterised by centralised production, heavy reliance on imports, and a just-in-time philosophy, is particularly vulnerable to disruptions from extreme weather events, global transportation issues, and geopolitical conflicts. This has highlighted the need to increase self-sufficiency and preparedness, particularly in countries like Sweden, where the level of imported goods is high⁵. Strengthening national capacity to produce, process and store food is crucial to ensure long-term food security and resilience.

To address these issues, there is a growing need for a radical change that fully utilises agricultural raw material for both food, feed and technical applications. As emphasised by the UN Sustainable Development Goals and the Paris Agreement, transforming food systems and promoting healthy diets are essential steps forward⁶.

To this end, plant-based foods are attractive options, as they are generally more environmentally sustainable compared to animal-based food and play a key role in achieving a healthy diet⁶. High-protein crops serve as attractive components in plant-based meat, dairy analogues,

and protein feed, the latter currently with import levels at 66% in Europe⁷. Furthermore, the current instability in global trade – driven by geopolitical tensions, infrastructure challenges, and shifting trade policies – highlights the need for robust trade assessments and policies that support food security.

In the new centre FORCE, we have gathered researchers, experts and stakeholders from various scientific areas, taking a holistic perspective on a plant-based food value chain, aiming to strengthen preparedness, resilience, and competitiveness. Our work-packages are shown in Figure 1. We achieve

Figure 1 FORCE Centre for Food System Resilience and Competitiveness is divided into three different work packages (WP), 1) Risk, governance and policy; 2) Sustainable and safe food value chain; 3) Innovation and flexibility in the food value chain. Plant-based food value chains, starting with beans and peas, cereals and oil crops, are in focus in all parts of FORCE.

WORK PACKAGE 1: Risk, governance and policy



WORK PACKAGE 3: Innovation and flexibility in the food value chain

a transdisciplinary approach of the centre by integrating social sciences (economics, strategy), with natural sciences (plant breeding, cropping systems, food and biotechnology, microbiology), and engineering sciences (risk management, critical infrastructure resilience, supply chain management, packaging and logistics). There are several other centres funded by FORMAS focusing on areas such as fossil-free energy in agriculture and the food sector, sustainable animal agriculture, and marine foods. FORCE will be closely connected to these centres, as each addresses a different yet interconnected aspect of the whole food system.

Risk, governance and policy (WP1)

FORCE will define risk scenarios and simulate various crisis scenarios, focusing on enabling

factors for increased systemic resilience in the food system. However, building increased preparedness in this kind of supply chain involving many critical infrastructures is not easy, as it includes numerous actors and decision-makers with different and often contradicting priorities: private companies versus public authorities (on different levels), and local versus global actors⁸. The current food supply is no longer based solely on local systems controlled by governments, but on interrelated global networks⁹. Thus, governance issues become critical, as collaboration can enhance the capability to manage risks and vulnerabilities, and

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increase preparedness and resilience in the food supply chain. Increased resilience, therefore, requires effective analysis and management of risks and vulnerabilities across system boundaries, as well as new coordination and governance mechanisms for supply readiness and system transformation, including both private and public actors. To enhance governance of risk management and contingency handling in food supply systems, we will analyse both the complexities of today's food systems and the use of different governance mechanisms to increase resilience. The focus will be on how accountability, financial risk, and operational activities will be distributed among different actors and what specific governance mechanisms should be employed in various scenarios.

International trade is important for food security in the face of climate change and could reduce the impact of extreme weather on food prices and thus contribute to improved food access¹⁰. In addition, imported inputs such as fertilisers are essential to

domestic agricultural production in Sweden.

However, trade can create new risks such as disruptions in trade flows or trade policy changes. In uncertain times, a common political reaction is to impose export restrictions on key food products¹¹ as demonstrated by frequent export restrictions in times of crises¹². FORCE will lead to a better understanding of international trade and trade policy, which is crucial to achieving food security and promoting productive and profitable domestic food production.

To unlock the benefits of trade, reduce the impact of disruptions in supply chains in certain crisis situations, and counteract the potential negative impact of domestic environmental policies on the competitiveness and global environment, a deeper understanding of the impact of trade and the use of trade policies is important.

To highlight the impact of our reliance on trade and its implications in crises, we will examine various crisis scenarios and the role of international trade and trade policy. Given that a certain level of national food production is central to food security, we will also consider interdependencies between contingency planning and competitiveness in the agricultural system, as well as the implications for optimal policy design.

Past research indicates that synergies exist among agricultural practices for achieving these goals, but desirable practices are not

always in the short-term economic interest of farmers to adopt. We will therefore also investigate the extent of the indirect impact that payments to farmers for public goods have on the competitiveness of Swedish agricultural production and contingency planning by farmers.

Food safety, packaging, and logistics (WP2)

Food safety is a crucial building block in the transition toward sustainable, self-sufficient and competitive food systems that include robust contingency planning. It begins as early as the quality of water and soil in primary production¹³ and the use of animal feed¹⁴. Ensuring food safety requires integration throughout all stages of the food chain – not merely at the product end stage, requiring a comprehensive systems perspective. This becomes particularly critical when systems are under stress or disrupted. Securing a resilient and safe food system involves transparency, effective communication, and synergy between all actors, including sharing and integration of knowledge concerning traceability and the handling history of both raw materials and final products.

In this pressing matter, FORCE will play a crucial role in identifying existing knowledge gaps and advancing microbial risk assessment frameworks, predicting hazards and developing risk mitigation strategies within both new and existing food systems. Work within FORCE will further provide knowledge and formulate guidelines for the safe handling, processing, and long-term storage of food in order to increase resilience and robustness, self-sufficiency, sustainability, and competitiveness.

Additionally, FORCE will address logistical challenges related to different crisis scenarios. This can be related to regional/circular food systems, adaptable packaging solutions, stockpiling of raw materials and long-term storage, transportation before/after processing, and new innovations and services in crisis. Current preservation and packaging infrastructure will be mapped to ensure the quality and shelf-life of produced goods, especially when transitioning between plastics, paper, or canned materials.

Mapping of both imported and domestically produced inputs, such as seeds, fertilisers, and pesticides, will be undertaken to evaluate needs for strategic stock management.

Key research questions are:

FOCUS AREA	KEY TOPICS	FORCE CONTRIBUTION
Breeding & Cultivation	Protein crop diversification, benefits of legumes, Nordic crop breeding	Advance breeding tools for faba bean and pea for Nordic adaptation; promote protein crop resilience in Europe
Processing Techniques & Wholegrains	Wholegrain consumption, extrusion, biotechnology, health benefits, cereals in Europe	Promote wholegrain wheat products; study processing and consumer acceptance; increase healthy, sustainable intake
Novel Food Products	Plant-based alternatives, fermentation, extrusion, shelf life, nutritional value	Develop tasty, long-lasting alternatives using protein & oil crops; focus on taste, nutrition, and consumer appeal
Resource Optimisation	Use of edible/non-edible side-streams, waste reduction, sustainability, non-food applications	Optimise side-stream usage to boost contingency and competitiveness in Swedish food systems
Market Insights	Willingness to buy, product appeal, behaviour studies, retail acceptance	Study consumers & retailers to assess market potential and distribution for new protein products
Innovation & Commercialisation	Business models, R&D, product development, market fit	Engage experts to co-develop competitive strategies and viable business models for novel foods
Public Sector Training	Educational material for schools, crisis food prep, legumes, oil crops, wholegrains	Develop teaching materials for school kitchens to improve resilience during crises

Table 1. Overview of the key focus areas and contributions within Innovation and flexibility in the food value chain (WP3) in FORCE.

- How to coordinate the distribution of breeding and cultivation, and storage of sustainable crops and nutrients (existing and new) and what prioritisation strategies are needed depending on crisis scenarios?
- How can preservation and packaging technologies be used to minimise environmental impacts (e.g. energy for cold chains) and contribute to increased food security, while still being safe to eat?
- How can sourcing and production locations be optimised for logistics in circular food production and shared in a crisis situation?
- How can Industry 5.0 principles be applied to improve sustainable and circular economy as well as resilience?
- What new business models are needed for sustainable and circular food and retail setups, and what governance structures are suitable for these?

Innovation and flexibility in the food value chain (WP3)

In FORCE, we will advance plant breeding and cropping systems for primary production of plant-based raw materials, with a particular focus on protein crops, given the current heavy reliance on imported soybean and soybean meal for feed and food in Europe⁷.

Beyond its import dependency, soybean cultivation is associated with significant environmental

impact, including deforestation and biodiversity loss. Diversifying protein crops cultivation generally in Europe has therefore several important roles to play and will contribute to increased food resilience⁷.

Legumes have multiple benefits as they are high-protein, nitrogen-fixing crops that can replace meat in the diet and require less nitrogen fertiliser. Despite these advantages, grain legumes (i.e. legume crops grown for the dry and edible seed; pulses) occupy less than 1.5 % of arable land in Europe, compared to 14.5% globally¹⁵.

However, legume crops such as faba bean and pea hold strong potential for expanded cultivation in Europe. Despite their environmental and agronomic benefits, plant breeding for these crops under Nordic conditions has been largely neglected for decades.

In FORCE, we aim to strengthen breeding tools for faba bean and pea to improve their adaptation to the Nordic climate and expand cultivations further north. In addition, industrial hemp cultivation and utilization will be evaluated due to its potential to be used as a whole crop. Industrial hemp can easily be organically cultivated and it has a high CO₂ fixation ability. The seeds, rich in oil (omega-3 and 6), as well as proteins and fibers, can be used in food applications, while the remaining parts of the plant have various uses for different material applications.

Food processing is the next step in the value chain, where protein crops, oil crops, cereal wholegrains,

and side-streams are utilised to create nutritious and sustainable food products.

Here, innovative techniques, such as biotechnology and extrusion technologies, will play an important role. In FORCE, we aim at increasing wholegrain consumption of wheat-based products, combining food processing with consumer acceptance and consumer behaviour studies.

Wholegrains are important, as cereals are among the main crops cultivated in Europe, with wheat being predominant (almost 50% of total production of cereals in 2023), and Europe being one of the top exporters of wheat globally¹⁶.

However, there's a pressing need to increase wholegrain consumption, as much of the current intake consists of refined grains. Enhancing wholegrain consumption would improve health outcomes, as low consumption is a major nutritional challenge⁶.

Moreover, it would maximise cereal kernel utilisation, reduce side-streams, and introduce novel products. Promoting wholegrains also enhances preparedness, by offering storable, shelf-stable, nutrient-dense, and energy-efficient food options with minimal processing requirements.

Another interesting aspect of food processing is the development of future meat and dairy analogues, as they provide an attractive alternative to animal-based food consumption, are commonly considered environmentally friendly, and might provide a way to consume new crops in a well-known format.

In FORCE, innovative process techniques within biomass- and precision fermentation, extraction, and extrusion will be developed and evaluated for formulation of new nutritious and tasty food products with long shelf-life stability.

Much remains to be discovered in terms of nutritional aspects, related to anti-nutrients, side-stream utilisation, texture and taste, business models, consumer behaviour and food safety connected to these novel foods as well. Here, both oil crops, such as hemp, and protein crops are expected to play an important role. Optimised use of edible and non-edible side-streams for both food and non-food products further supports the sustainability, contingency and competitiveness of the transitioned Swedish food sector.

A critical factor for profitability is that consumers accept and like the food products from the new food value chains. To this end, we will incorporate

behavioural science in FORCE to ensure that these aspects are included.

Bringing a new product to market and establishing a foothold can be a challenging task. Assessing market potential and profitability requires understanding expected consumer behaviour and willingness to buy and pay for the product, considering market conditions and food preferences.

This will be examined in FORCE and this research will provide insights into the potential future market for protein crops and the factors influencing consumers' willingness to buy new products.

Additionally, identifying distribution channels is crucial for reaching consumers. We will focus on retailers to determine the factors influencing their willingness to introduce new crop-based protein products into their product range.

For industry to develop novel foods successfully, firms and organisations must implement strategies involving R&D, product development, and commercialisation, framed within competitive business models. This requires the right resources, organisation, value chain position, and market alignment with customer preferences and competing offerings.

Without successful strategies and business models, investments and prospects for long-term development will be limited. FORCE will engage experts on innovative business models, strategy researchers and industry partners to collaboratively develop solutions to these complex challenges.

Finally, an educational package will be developed in collaboration with the municipalities focusing on public meals, such as kitchens within schools. This educational material will include information on how to cook food from wholegrain kernels, oil crops and whole dried legumes, which may be necessary in times of crisis.

Overall outcome and action

Transforming the food system requires collaboration among people, and FORCE aims to become a key component of this puzzle by providing a transdisciplinary, innovative, and stimulating research environment that strengthens preparedness, resilience, and competitiveness in the agri-food system.

Don't hesitate to reach out if you want to connect – we are just initiating the work, and we cannot make this transition alone. ■

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Cecilia Tullberg, Assistant Professor in Food Biotechnology, Department of Process and Life Science Engineering, Division of Biotechnology at Lund University
email cecilia.tullberg@ple.lth.se

Sandeep Jagtap, Senior Lecturer in Engineering Logistics and Supply Chain, Department of Industrial and Mechanical Sciences, Division of Engineering Logistics at Lund University
email sandeep.jagtap@tlog.lth.se

Per Becker, Professor of Risk and Sustainability at Lund University
email per.becker@risk.lth.se

Åsa Grimberg, Researcher in Plant Breeding at the Swedish University of Agricultural Sciences
email asa.grimberg@slu.se

Cecilia Hammenhag, Associate Professor in Plant Breeding, specialising in genomics-assisted plant breeding at the Swedish University of Agricultural Sciences
email cecilia.hammenhag@slu.se

Jonas Johansson, Associate Professor in Critical Infrastructures at the Division of Risk Management and Societal Safety, Lund University
email jonas.johansson@risk.lth.se

Thomas Kalling, Professor of Strategic Management at Lund University and the Sparbanken Skåne Centre for Sustainable Enterprising (SSCEN)
email thomas.kalling@fek.lu.se

Ola Lundin, Associate Professor in Ecology at the Swedish University of Agricultural Sciences,
email ola.lundin@slu.se

Fredrik Nilsson, Professor in Packaging Logistics at the Department of Design Sciences, and Centre for Innovation Research – CIRCLE at Lund University
email fredrik.nilsson@plog.lth.se

Emma Nordell, Project manager, Cooperation Office, Lund University
email emma.nordell@fsi.lu.se

Andreas Norrman, Professor in Supply chain structure and organization, Department of Industrial and Mechanical Sciences, Division of Engineering Logistics at Lund University
email andreas.norrman@tlog.lth.se

Jeanette Purhagen, Associate Professor in Food Engineering at the Department of Process and Life Science Engineering, Division of Food and Pharma, Lund University
email jeanette.purhagen@ple.lth.se

Jenny Schelin, Associate Professor in Applied Microbiology at the Department of Process and Life Science Engineering at Lund University
email jenny.schelin@ple.lth.se

Fredrik Wilhelmsson, Researcher in Economics at AgriFood Economics Centre, the School of Economics and Management, Lund University
email fredrik.wilhelmsson@agrifood.lu.se