



Towards a sustainable and competitive food system

A strategic research agenda

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R2:2020

Dnr: 2017-00169

ISBN: 978-91-540-6122-8

The Swedish Research Council Formas
Stockholm, April 2020

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Foreword

We at Formas, together with Inger Andersson, chair of the national committee for food research, would like to thank everyone who has contributed in various ways to our work on this strategic research agenda.

We wish to extend a special thanks to the other members of the national committee for food research Forte, Mistra, the Swedish Foundation for Strategic Research, the Swedish Farmers' Foundation for Agricultural Research, the Swedish Research Council and Vinnova for their great commitment. This also applies to the working group for the national research programme for food, consisting of representatives from the above organisations.

We would also like to thank all the universities, research institutes, government agencies, industry associations, companies, municipalities, non-profit organisations and others who have contributed by participating in workshops and stakeholder dialogues and who have provided valuable input to the agenda and via our referral procedure.

Since the national research programme for food was initiated before this agenda was completed, several activities have already been carried out. Thanks to ongoing dialogues with end users and other stakeholders, the activities have aligned with the agenda's objectives and can be read about more in detail at www.formas.se

We look forward to our continued collaboration!

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Summary

In “A national food strategy for Sweden – more jobs and sustainable growth throughout the country” (Govt. Bill 2016/17:104), the government stresses the need for an increase in domestic food production that is more competitive and sustainable. Growth, employment and sustainable development are to be promoted throughout the country and food security strengthened.

Despite a few successes in recent years and favourable Swedish conditions, such as robust environmental policies, a high level of animal welfare, low use of antibiotics and safe food production, several challenges remain to be addressed. In addition, the entire food system needs to undergo a transformation within a short time frame. This is not least because Sweden must step up its contributions to Agenda 2030, considering that the food area is so tightly integrated with several of the sustainable development goals.

Increased knowledge and innovation are major drivers behind the transformation. The national food strategy action plan includes several investments in the knowledge and innovation system, and among other measures the government has established a ten-year, interdisciplinary national research programme for food and a national committee for food research.

This strategic research agenda has been developed within the framework of these efforts. It has been developed by Formas in consultation with the national committee for food research and is based on broad dialogue with food stakeholders, written recommendations from higher education and research institutes, businesses and government agencies, and relevant analyses and reports. The agenda aims to help transform the food system by setting out a clearer direction for knowledge development and innovation on the path towards a sustainable and competitive food system. It identifies a number of key perspectives and themes that the research and innovation system needs to address over the next ten years.

The perspectives in the agenda highlight important areas of development to drive this transition. The perspectives are: system perspective, knowledge and skills development, governance and leadership, digitalisation and technology development, regionally and globally, as well as gender equality and diversity.

The themes in the agenda summarise areas having the potential to further boost competitiveness and sustainable development through research and innovation. These themes take the food system in its entirety as their point of departure, and research, innovation and knowledge dissemination need to take place both within and between different themes and at the system level. The themes are: sustainable production systems, tasty food for healthy people and planet, the meal and the consumer, and innovative and safe food.

A number of targets for the research programme have been further developed from the targets and vision of the national food strategy in order to clarify the direction of the programme. The agenda and its implementation also integrate the government’s objectives and targets for the national research programmes, including the improvement of gender equality, an efficient use of infrastructure, and expanded international research and innovation partnerships. These, together with the key perspectives and themes, form the framework for implementing activities and initiatives within the national research programme for

food. The agenda can also serve as a basis for designing and coordinating other research and innovation efforts in the food area.

The activities conducted within the national research programme for food will be characterised by collaboration and co-creation, needs-driven interdisciplinary research, and efforts to strengthen innovation capacity that contribute to impact and that create value for the society and for Swedish companies across the food system.

For the programme to be effective and achieve its objectives, the agenda is complemented by so-called programme logic that guides activities and follow-up. Dialogues and collaboration for implementing the agenda and prioritising actions will continue, and when relevant the agenda will be revised.

The food system involves a variety of stakeholders, and its challenges are both numerous and complex. The agenda's implementation therefore requires a diversity of activities and innovation system and to help achieve a sustainable and competitive food system.

Sammanfattning

I En livsmedelsstrategi för Sverige – fler jobb och hållbar tillväxt i hela landet (prop 2016/17:104) betonar regeringen behovet av stärkt konkurrenskraft och ökad inhemsk och hållbar matproduktion. Tillväxt, sysselsättning och hållbar utveckling ska främjas i hela landet och livsmedelsförsörjningen stärkas.

Trots vissa ljusglimtar på senare år och goda svenska förutsättningar, i form av bland annat stark miljöpolitik, hög djurvälstånd, låg användning av antibiotika och säker livsmedelsproduktion, återstår en mängd utmaningar att hantera och hela livsmedelssystemet behöver ställas om på kort tid. Inte minst för att öka Sveriges bidrag till Agenda 2030, eftersom livsmedelsområdet är så starkt integrerat i flera av hållbarhetsmålen.

Ökad kunskap och innovation är viktiga drivkrafter för omställningen. Livsmedelsstrategins handlingsplan inkluderar flera satsningar på kunskaps- och innovationssystemet och regeringen har bland annat inrättat ett tioårigt, tvärvetenskapligt nationellt forskningsprogram för livsmedel och en nationell kommitté för livsmedelsforskning.

Den här strategiska forskningsagendan har tagits fram inom ramarna för dessa satsningar. Den är framtagen av Formas i samråd med nationella kommittén för livsmedelsforskning och baseras på bred dialog med intressenter inom livsmedelsområdet, skriftliga inspel från akademi och institut, näringsliv och myndigheter, samt relevanta analyser och rapporter. Agendans syfte är att bidra till omställningen av livsmedelssystemet genom att ange en tydligare riktning för kunskapsutveckling och innovation på vägen mot ett hållbart och konkurrenskraftigt livsmedelssystem. Den identifierar ett antal perspektiv och teman som forsknings- och innovationssystemet behöver adressera de kommande tio åren.

Perspektiven i agendan belyser viktiga utvecklingsområden för att driva på omställningen till ett hållbart och konkurrenskraftigt svenskt livsmedelssystem. Perspektiven är; systemperspektiv, kunskap och kompetensutveckling, styrning och ledarskap, digitalisering och teknikutveckling, regionalt och globalt samt jämställdhet och mångfald.

Agendans teman sammanfattar områden med potential att bidra ytterligare till konkurrenskraft och till hållbar utveckling genom forskning och innovation. Agendans teman utgår ifrån livsmedelssystemet som helhet och forskning, innovation och kunskapsspridning behöver därmed ske både inom och mellan olika teman och på systemnivå. Agendans teman är; hållbara produktionssystem, god mat för hälsa och miljö, konsumenten och måltiden samt innovativa och säkra livsmedel.

Ett antal målsättningar för vad forskningsprogrammet ska bidra till har vidare utvecklats från livsmedelsstrategins mål och vision i syfte att tydliggöra programmens inriktning. Agendan och dess genomförande integrerar även regeringens syften och mål för nationella forskningsprogram som bland annat handlar om att bidra till jämställdhet, effektiv användning av infrastruktur och utökade internationella forsknings- och innovationssamarbeten.

Perspektiv och teman utgör, tillsammans med målsättningarna för livsmedelsprogrammet och de generella målen för nationella forskningsprogram, de

övergripande ramarna för genomförandet av aktiviteter och insatser inom det nationella forskningsprogrammet för livsmedel. Agendan kan även ligga som grund för utformning och koordinering av andra forsknings- och innovationsinsatser inom livsmedelsområdet.

De aktiviteter som genomförs inom det nationella forskningsprogrammet för livsmedel ska genomsyras av samverkan och samskapande, behovsmotiverad och tvärvetenskaplig forskning samt av insatser som stärker innovationsförmågan och som bidrar till att forskningen kommer samhället till nytta och skapar värden för svenska företag i livsmedelssystemet.

För att programmet ska vara effektivt och bidra till målsättningarna kompletteras agendan med en så kallad programlogik som vägleder aktiviteter, insatser och uppföljning. Dialoger och samverkan för att genomföra agendan och prioritera insatser kommer att fortsätta och agendan kommer vid behov att revideras.

Livsmedelssystemet involverar en mängd aktörer och utmaningarna är både många och komplexa. Genomförandet av agendan kräver därför en mångfald av aktiviteter och satsningar som koordineras och genomförs i samverkan mellan aktörer för att stärka forsknings- och innovationssystemet och bidra till ett hållbart och konkurrenskraftigt livsmedelssystem.



1. Increased knowledge for a sustainable and competitive food system

When the Swedish Parliament adopted Sweden's first national food strategy in June 2017, "A national food strategy for Sweden – more jobs and sustainable growth throughout the country"¹, it sent a strong signal and provided a solid foundation for the food sector to transition to a sustainable and competitive food system.

The national food strategy emphasises the need to strengthen competitiveness in the Swedish food sector and to increase domestic food production. Food should also be produced sustainably and meet consumer demand. This will promote growth, employment and sustainable development throughout the country and ensure food security.

The food system² is closely integrated in the UN's Agenda 2030 and plays a central role in driving the sustainability agenda forward. With only ten years to go, we urgently need to transform the food system in order to reach sustainable development targets such as achieving food security, ensuring sustainable agriculture and aquaculture, and fighting climate change and the loss of ecosystems and biodiversity.

The conditions for achieving the objectives of the national food strategy and for the Swedish food system to achieve sustainable development are good, partly because Sweden has a strong environmental policy, strong animal welfare, low use of antibiotics and safe food production. But many challenges remain, and there is much to do before we can realise the government's vision for the Swedish food sector and Swedish food production. This also applies to Sweden's sustainable development efforts. Therefore, the food system needs to transform as quickly as possible if we are to become both more sustainable and more competitive.

In the transformation, continuous knowledge and development efforts as well as new innovations play a crucial role. Knowledge and innovation also constitute one of three strategic areas in the national food strategy. The aim is to support the knowledge and innovation system with a view to achieving increased productivity and innovation across the food chain as well as sustainable food production and consumption. The action plan following the strategy includes several activities for strengthening the knowledge and innovation system (see Section 3.1). Formas' remit to establish a national research programme for food is one such activity (Appendix 2). Formas has previously been tasked³ with hosting a national committee for food research with representatives from relevant Swedish research funders. The committee consists of Forte, Mistra, the Swedish Farmers' Foundation for Agricultural Research, the Foundation for Strategic Research, the Swedish Research Council, Vinnova and Formas. Inger Andersson⁴

1. Govt. Bill 2016/17:104, "A national food strategy for Sweden – more jobs and sustainable growth across throughout the country", https://www.government.se/498282/contentassets/16ef73aaa6f74faab86ade5ef239b659/livsmedelsstrategin_kortversion_eng.pdf

2. The food system encompasses the people, processes, infrastructure, institutions and services involved in the production, processing, marketing, consumption and disposal of food (FAO 2017).

3. Formas' appropriation directions from the Ministry of the Environment and Energy for the 2017 budget year concerning Formas – Research Council for Environment, Agricultural Sciences and Spatial Planning, dated 20 December 2016.

4. Inger Andersson is also a former Director General of the Swedish National Food Agency.

is independent chair of the committee. The national committee for food research also serves as programme council for the national research programme for food.

The combination of a national food strategy that prioritises an enhanced research and innovation system with greater interaction among stakeholders lays a solid foundation for boosting research and innovation capacity in the food area in the coming years and transforming it into a sustainable, competitive food system.

1.1 A strategic research agenda for food

This strategic agenda has been developed to help transform the food system by setting out a clearer direction for advancing knowledge and innovation on the path to a sustainable and competitive food system.

Taking the national food strategy as its starting point, the agenda highlights the drivers and areas that must be developed in order to boost research and innovation capacity in the food system so that it can better achieve the objectives of the food strategy and of sustainable development. In both Agenda 2030 and the national food strategy, and continuing in this agenda, the concept of sustainable development covers environmental, social and economic aspects.

The agenda focuses on research that contributes to a system perspective and that is interdisciplinary, needs-driven and takes place in collaboration and co-creation among different stakeholders both inside and outside the food system. Efforts that reduce the time lag from research idea to real-world impact are also central to the agenda and key to its implementation. Collaboration is central to the agenda because innovation takes place in interactions that bring together a broad set of skills and talent and that enable organisations to learn from each other. However, collaboration does not suffice. We also need a clear direction so that research and innovation developed in partnership provide the impacts that are necessary for the transformation. This agenda intends to provide the direction needed, hence the title “Towards a sustainable and competitive food system”.

The food system is not isolated – its challenges are integrated with other major challenges in society. This agenda does not claim to address all these challenges, as its primary purpose is to contribute to the national food strategy’s objectives and vision.

1.1.1 How the agenda has been developed

The agenda was developed by Formas in consultation with research funders from the national committee for food research. The process of identifying the strategic content of the agenda began in spring 2018 and was built on broad dialogue with academia and research institutes, the business sector, government authorities and other stakeholders (Figure 1, Appendix 2).

The purpose of this broad dialogue was to highlight challenges and opportunities within the food area and to identify research and, to some extent, innovation needs over the next ten years in order to make the food system both competitive and sustainable. The dialogue also helped to define objectives for the national research programme and to identify the efforts and activities needed to accelerate the transformation and achieve the national food strategy’s objectives.

The agenda also builds on written input from academia and research institutes⁵,

5. Approximately 30 written recommendations were received from higher education institutions and research institutes; see Appendix 2.

the business sector, government authorities and others, and on analyses and reports on food sector challenges, research needs within the food area, and Swedish strengths and weaknesses regarding research and innovation.

In the process of developing the agenda, Formas has also developed a bibliometric analysis of Swedish food research (Ström and Veide Vilg, 2019) and, together with national committee for food research, surveyed which research and innovation projects in the field were funded between 2011 and 2018 (Appendix 3). The survey aims to facilitate an assessment of potential synergies and ensure the effective use of funds. In addition, an international approach has been taken to draw inspiration from other countries' experiences in challenge-driven research programmes (Swedish Agency for Growth Policy Analysis, 2017, and Appendix 4) and to identify opportunities for a more rapid transformation and goal attainment through international collaboration (see Section 5.3.3).

Among the conclusions was the need for challenge-driven research programmes to work in dialogue and collaboration, and to use a breadth of instruments and methods that are regularly revised to find the best way forward and thus create the greatest benefit in order to solve our global challenges (Swedish Agency for Growth Policy Analysis, 2017). Dialogue and collaboration needed to implement the agenda and prioritise actions will therefore continue, and the agenda will be revised as needed.



Figure 1. The process of identifying the strategic content of the research agenda for food.

1.1.2 How to use the agenda

The agenda aims to guide the prioritisation of activities of the national research programme for food and to facilitate coordination of other research and innovation efforts within the food area. The agenda can also be used for strategic considerations in other contexts, for example, in various national and international research and innovation partnerships.

The food system involves a variety of stakeholders and its challenges are both numerous and complex. The agenda's implementation therefore requires a diversity of activities and initiatives to strengthen the research and innovation system. These need to be coordinated and implemented in collaboration among stakeholders.

1.2 A national research programme for food

The national research programme for food was initiated in 2017 and is a ten-year interdisciplinary programme. According to the government remit, it should mainly promote the following:

- Needs-driven research and innovation
- Dissemination and commercialisation of research results
- An increased understanding of the food chain for educational purposes

Its aim is to support the research and innovation system with a view to increasing productivity and innovation across the food chain as well as achieving sustainable food production and consumption (Appendix 1).

The national research programme for food will be implemented in parallel with the other national research programmes initiated by the government in the 2016 Research and Innovation Bill.⁶ In addition to the food programme, there are national research programmes that focus on antibiotic resistance, workplace research, climate, migration and integration, sustainable spatial planning and applied welfare research. National research programmes are intended to create powerful synergies between stakeholders who complement each other in terms of knowledge, skills and missions. For the national research programme for food, increased interaction with food industry players is particularly relevant.

In the bill, the government describes common purposes and objectives for the national research programmes. These are also important for enabling research and innovation that makes an impact on the food system.

National research programmes should contribute to the following:

- Coordination of research funding in the field
- Interdisciplinary and cross-sectoral research and collaboration
- Activities regarding communication and societal benefit of the research
- Increased impact of research results
- Gender equality
- A more efficient use of infrastructure
- A greater focus on research in higher education
- Enhanced international cooperation and strengthened Swedish participation in the European programmes.

6. Govt. Bill 2016/17:50, Collaborating for knowledge – for society's challenges and strengthened competitiveness, <https://bit.ly/2Peb4KL>

1.2.1 Objectives of the national research programme for food

To clarify the direction of the national research programme for food and facilitate follow-up of its activities and initiatives, several programme objectives have been formulated. These are a further development of the overarching aim to support the research and innovation system so it can increase productivity and innovation across the food chain and ensure sustainable food production and consumption. The objectives are also based on the stakeholder dialogues conducted in the process of developing the agenda. In the long run, they constitute the objectives of the research programme's contributions in the transformation to a sustainable and competitive food system (see also Section 5.3).

Research and innovation should better contribute to the following:

1. A sustainable, competitive and attractive food sector
2. The ability to achieve profitability for stakeholders throughout the food system
3. Ensuring that the Swedish food system is resource efficient, contributes to gender equality, is environmentally friendly and is climate neutral
4. Good food security in Sweden as well as preparedness and resilience to climate change and societal disruptions
5. An increase in Swedish food production that is in demand worldwide for its added value, such as long-term sustainable production and high food safe
6. Sustainable food consumption and reduced waste throughout the food system
7. International recognition that the Swedish food sector is innovative, sustainable and known for tasty food that promotes well-being and health.

For the research programme to be effective and achieve the objectives, the agenda is complemented by a so-called programme logic which guides activities, initiatives and follow-up through specific targets. Using programme logic gives the programme transparency while allowing for the flexibility needed to maintain timeliness, relevance and impact over the programme period (see Section 5.3.4).



2. The food system's challenges and conditions

This chapter describes the overarching challenges facing the food system and the conditions for successful research and innovation in the food area. These provide an important background to the research and innovation needs presented in subsequent chapters. The approach is global, but the conditions are based on a national perspective.

2.1 Global challenges, national conditions

Security policy, climate change and the depletion of biodiversity are macro factors that emphasise the importance of competitive, sustainable food production and consumption in Sweden.

A growing global population is driving increasing food production, and demographic shifts along with increased prosperity are putting pressure on the Earth's resources and ecosystems. At the same time, 25-30 percent of all food produced globally is lost or wasted (IPCC, 2019). Food waste in Sweden is between 10 and 50 percent, depending on product type, and occurs mainly in the consumer chain (Swedish Environmental Protection Agency, 2019a; Stockholm Resilience Centre, 2019). Unsustainable production and consumption cause greenhouse gas emissions, disrupted ecosystems, reduced biodiversity, impoverished soils and seawater eutrophication, among other effects. In addition, our eating habits in the Western world are the single most important risk factor for lifestyle diseases. Not only does this pose a major threat to public health, but it represents a great cost burden for society. Moreover, widening gaps in health resulting from eating habits are a matter of democracy and justice (Swedish National Food Agency, 2019a).

Sweden is at the forefront in its inclusion of sustainability at all stages of the food system and is well positioned to meet many of society's challenges (Swedish Board of Agriculture, 2018a). We have a strong environmental policy and Swedish production has high standards in terms of the environment and climate, animal health and welfare, and food safety, with a low use of antibiotics and low or no chemical pesticide residues compared with other countries (Swedish Environmental Protection Agency, 2018a). Sweden is also one of the few countries whose dietary guidelines include environmental and climate considerations. But we need to do more, and there is no time to lose.

Statistics Sweden's report on the implementation of Agenda 2030 in Sweden indicates that Sweden must make drastic reductions in national greenhouse gas emissions if we are to stand a chance of achieving the target of net-zero emissions by 2045 (Statistic Sweden, 2019). Food production accounts for a significant portion of these emissions (Swedish Environmental Protection Agency, 2018b). And since we import about half of the food we consume, a large part of our environmental and climate impact takes place outside Sweden's borders (Swedish Board of Agriculture, 2019a; Swedish Environmental Protection Agency, 2018a). We are not reaching the goal of sustainable use of seas and marine resources, and threatened species continue to be eradicated at the same rate as before. The Statistics Sweden report

concludes that it is unlikely we will achieve the national environmental objectives and that we will continue to face major challenges around health inequalities and other issues.

On the national level there is currently a great deal of interest in food, the environment and climate, and new consumption trends have led to an increase in demand for certain Swedish foods (Swedish Board of Agriculture, 2019a). Public meal programmes, the restaurant industry, dining experience tourism and new business models in the supply and logistics chains can further contribute to sustainable food consumption, thereby driving the evolution of the Swedish food system and boosting competitiveness throughout the food chain (National Agency for Public Procurement, 2019). A system that relies more heavily on demand to determine what is produced can enable a more rapid shift to a sustainable, competitive food system.

2.2 Research and innovation

Advancing a sustainable transformation of the food system and boosting the competitiveness of the business sector requires a stronger research and innovation system and the proper utilisation of public research resources within the food area. This is because research results should underpin evidence-based decisions and actions, and because strategic investments should be made that address the needs of the food system and help to create innovative solutions to current and future challenges.

Two independent reports show that Swedish food research is of high scientific quality and is widely used by researchers in other countries (Ström and Veide Vilg, 2019; Swedish Research Council, 2019). Swedish researchers in the field are active internationally to a great extent, and close to one-fifth of scholarly publications are produced in cooperation with industry. The food system is broad and complex. Food-related research spans multiple fields of research and disciplines and is conducted at many different universities and research institutes as well as at private companies. During 2005–2017, nearly 6,000 scientific articles were published within the food research field by Swedish researchers (Ström and Veide Vilg, 2019). Most of these publications addressed consumption (including nutrition), followed by production and processing. The most cited articles are also within consumption, followed by production and food safety.

In terms of funding, the largest share of public research grants in the food area between 2011 and 2018 went to research in primary production, followed by processing, consumption and food safety (Appendix 3). A comparison of 11 European countries shows that the distribution of Swedish funding across the food system is in line with the average on the European level (Appendix 3, Standing Committee on Agricultural Research, 2018). In nominal values, Sweden is in the same comparison at a medium-high level in terms of public research funding for the food system (Standing Committee on Agricultural Research 2018). Public investment in food research and innovation in Sweden has varied over time, which makes collaboration and long-term planning more difficult (Appendix 3). This can be compared with the transport sector, for example, where recurring, long-term co-financing for research, innovation and development by the state and automotive industries over the last ten years has greatly benefitted developments in this area (Strategic Automotive Research and Innovation, 2018). Sweden is one of the strongest innovation countries, highly

ranked in the transport, forestry and steel industries. But in the food sector, innovation is weak (Roland Berger, 2018). The investment of Swedish food companies in research and development is low. Only 0.27 percent of food sector turnover in 2015–2017 was used for research and innovation (Swedish Board of Agriculture, 2019a). Lack of profitability and small margins are highlighted as reasons why research and innovation lack momentum (Swedish Food Federation, 2016; Roland Berger, 2018).

The food sector consists of many small and medium-sized enterprises. The major corporations, with the largest research and innovation capacity, are foreign-owned and mainly conduct research, development and innovation activities outside Sweden. Because so few players in the Swedish food area are involved in research and innovation, the food sector struggles to identify research needs and to absorb and translate new knowledge into new values (Swedish Food Federation, 2016). The OECD notes that in primary production, the links between basic research, applied research, producers and advisory companies are weak, resulting in the sub-optimal use of knowledge and thus the need to strengthen these links (OECD, 2018a).

Moreover, many food companies report in difficulties finding workers with the right skills, and the level of training at the companies is generally low (Swedish Food Federation et al., 2018a). In the long run, this weakens competitiveness and slows productivity growth (Swedish Board of Agriculture, 2019a). Upskilling, within digitalisation and other areas, could contribute to higher productivity growth, more profitable companies and a higher level of innovation (Swedish Board of Agriculture, 2018b; OECD, 2018b).

Companies in retail are undergoing a structural shift in which globalisation, digitalisation, automation and new distribution models are changing the playing field. To address and leverage these changes, the sector must invest in research and innovation and in raising the level of education (Swedish Retail and Wholesale Council, 2019). The hospitality industry, which includes food tourism, currently has only limited research activities. Yet it has the potential to grow and contribute to a more competitive food system (R&D Fund of the Swedish Tourism & Hospitality Industry, 2019). Public meal programmes are also characterised by a low degree of innovation, and this area has difficulty attracting skilled staff (RISE, 2019).

2.3 Competitiveness and profitability

Companies in the food system constitute a substantial business sector in Sweden. Companies operating in primary production and processing alone make up the third largest business sector in the country (Swedish Food Federation, 2019). The food system is thus vital for employment, economic growth and thriving rural areas. So, it is unfortunate that Swedish food companies are grappling with weak profitability and low growth (Swedish Board of Agriculture, 2019a). The Swedish Board of Agriculture's report shows that competitiveness across the entire food chain shrank during 2011–2017, mainly due to reduced profitability in primary production and in the food industry (Swedish Board of Agriculture, 2019a). The report also highlights the need for investment in research and innovation to strengthen productivity and increase the level of processing, particularly in primary production and the food industry, in order to increase the profitability of businesses.

Swedish food is often produced under conditions that result in high quality and added value which today's consumers are, to some extent, prepared to pay for (Swedish Board of Agriculture, 2019a). Often, though, the higher prices neither benefit the producers nor make them more competitive (Swedish Board of Agriculture, 2018b). We import about half of the food consumed in Sweden. At the same time, the export rate for food is relatively low: 30 percent compared with roughly 70 percent in other sectors (Swedish Food Federation, 2018b). In addition, profitability and development potential can be adversely affected by inhibitory legislation and cumbersome regulations (Swedish Board of Agriculture, 2019a).

So profitability must be strengthened, along with productivity and innovation capabilities, within the framework of increased sustainability. In this way, the Swedish food sector has the potential to become an innovative growth industry, which this agenda and the national research programme for food wish to contribute to through an enhanced research and innovation system and a direction for the shift to sustainable and competitive food systems.



3. Goals the agenda will help to achieve

As mentioned earlier, the overarching objective of this agenda is to contribute to the goals and vision of the national food strategy. In addition, there are several other objectives and strategies at the national and international levels that are relevant for the food system and that set the direction for sustainable food production and consumption; these strategies therefore serve as guidance for this agenda and objectives of the national research programme for food.

3.1 The national food strategy

The national food strategy was adopted by the Swedish Parliament on June 20th 2017, and is the first Swedish food strategy covering the entire food chain.⁷ The vision for the Swedish food sector is that by 2030 it should be globally competitive, innovative, sustainable and attractive to operate in.

The overarching objective is to obtain a competitive food chain marked by increased production while achieving relevant national environmental objectives, with a view to stimulating growth, employment and sustainable development across the country. The increase in production of both conventionally produced and organic food should respond to consumer demand and be viewed as a means to increase self-sufficiency in terms of food. The vulnerability of the food chain should be reduced.

The national food strategy also includes goals for three strategic areas: “Terms and conditions”, “Consumer and market” and “Knowledge and innovation”. “Knowledge and innovation” aims to support the research and innovation system in order to increase productivity and innovation across the food chain as well as sustainable food production and consumption.

The national research programme for food is one of the measures within “Knowledge and innovation” in the government’s first action plan for implementing the strategy. Other measures include remits to the Swedish University of Agricultural Sciences to establish a graduate school for PhD students in industry; to Vinnova to develop incubation in the food chain; and to the Swedish Agency for Economic and Regional Growth to support food-chain companies and stakeholders in establishing an arena for collaboration (which now is a collaboration arena for food research and innovation called Sweden Food Arena).

In preparation for the upcoming action plan, which runs from 2020 to 2022, the Swedish Agency for Economic and Regional Growth and the Swedish Board of Agriculture have proposed a series of measures to further enhance the strategic area “Knowledge and innovation”. One proposal is to task Vinnova and Swedish Agency for Economic and Regional Growth together with Swedish Board of Agriculture and Swedish National Food Agency developing an innovation forum for in-depth collaboration around promoting innovation efforts within the Swedish food system. This proposal will complement and create synergies with the national research programme for food. Together, these efforts will strengthen the food sector’s innovation capacity. The government is also making further investments

7. Govt. Bill 2016/17:104, “A food strategy for Sweden – more jobs and sustainable growth across the country”, <https://bit.ly/35pA47H>

in the implementation of the strategy as evidenced in the 2020 Budget Bill, which appropriates 176 million kronor to the national food strategy in 2020, and 62 million kronor in 2021 and again in 2022.

3.2 Other national objectives for the food area

In addition to the national food strategy, other food initiatives are ongoing that are relevant to the agenda and affect its direction.

The rural development programme is part of the EU's employment and sustainable growth strategy for 2020. The national programme includes support and compensation for the environment, sustainability and innovation (Swedish Board of Agriculture, 2019b). The EU programme has three overarching objectives: improve the competitiveness of agriculture, achieve sustainable management of natural resources and climate action, and achieve a balanced territorial development of rural economies and communities.

In addition, the government has developed a strategy for environmentally, socially and economically sustainable consumption (Ministry of Finance, 2016). Several of the strategy's measures relate to the food area, and "Sustainable food" is one of the key focus areas.

In addition, the Swedish National Food Agency, together with the Swedish Board of Agriculture and Swedish Environmental Protection Agency, has developed an action plan for reducing food waste as tasked by the government (Swedish National Food Agency, Swedish Board of Agriculture and Swedish Environmental Protection Agency, 2018). The measures aim to achieve sustainable development target 12.3 in Agenda 2030 concerning food waste. The target specifies a halving of per capita food waste by 2030 at the retail and consumer levels, reducing waste throughout the chain. These are clear and important guides to transforming both consumption and production.

One of Sweden's public health policy goals is to achieve good health and equitable health access for the entire population and to close avoidable gaps in health within one generation (Ministry of Health and Social Affairs, 2017). As part of this work, the Public Health Agency of Sweden has identified eight target areas. The eighth area, Lifestyle Habits, is central to good health and equitable health access, and includes good eating habits.

The national action plan for the sustainable use of pesticides (under EU Directive 2009/128/EC) aims to reduce the risks and consequences the use of pesticides entails for human health and the environment. This is a task that requires research and innovation activities.

Of course, the Swedish generational goal and the 16 environmental quality objectives, including the objectives aimed at reduced climate impact, a rich diversity of plant and animal life, and a good built environment (Swedish Environmental Protection Agency, 2019b), are also essential guiding principles for the food area and the desired transformation.

3.3 International objectives for the food area

Food security is a global issue, and our national food system must foster sustainable development on the global stage. Several international objectives are therefore relevant to the agenda's direction.

According to the UN's declaration on human rights, countries should ensure that people have enough to eat (United Nations, 2008). Launched in 2015, Agenda 2030 is an action plan for making human rights a reality for everyone, eradicating poverty and hunger, achieving equality and empowerment for all women and girls, and ensuring lasting protection of the planet and its natural resources (United Nations, 2015).

The agenda has 17 sustainable development goals (SDGs) with 169 targets. The SDGs are integrated and indivisible, which means that one goal must not be achieved at the expense of another. Partnership and cooperation are fundamental elements for the implementation of Agenda 2030. The agenda objectives that primarily concern the food area are: climate change action; adequate nutritious and safe food and water for all; sustainable production and consumption; ecosystem and biodiversity; sustainable use of seas and marine resources; gender equality; decent working conditions for all; and sustainable industry, innovations and infrastructure.

The Paris Agreement is a universal, legally binding climate agreement adopted by most of world's countries and, without a doubt, a guiding principle for this agenda as well. The agreement was reached at the UNFCCC's twenty-first Conference of Parties, COP21, in December 2015. It will come into force by 2020 and contains 29 articles. Under the agreement, global warming must be kept well below 2 degrees Celsius and preferably limited to 1.5 degrees above pre-industrial levels. Moreover, it calls for enhancing the adaptive capacity to climate change and strengthening resilience to climate change in a way that does not threaten food production.

Also highly relevant to the food area is the UN Convention on Biological Diversity, under which the world's countries have agreed on specific targets around ecosystem services. In May 2019, the UN Panel of Experts on Biological Diversity (IPBES) published its report on biodiversity (IPBES, 2019). The report describes the situation as serious or very serious and proposes various measures to reduce the negative trend.

The objectives set by the EU for its common environmental policy also have implications for the transformation of the food system. These objectives include protecting, preserving and strengthening the EU's natural assets, transforming the EU into a resource-efficient, green, competitive and low-carbon economy, and protecting EU inhabitants from environmental impacts and risks to health and well-being.



4. Research and innovation for the transformation – perspectives and themes

This chapter describes the perspectives and themes that the research and innovation system must address in the coming years in order to enable the necessary transformation of the food system.

The perspectives highlight key areas of development that can simultaneously act as drivers in the transition to a sustainable, competitive Swedish food system. The themes of the agenda summarise thematic areas with the potential to contribute further to competitiveness and sustainable development. These themes are based on the food system as a whole. They should not be viewed as separate challenges but instead as integrated elements where research, innovation and knowledge dissemination need to take place both within and between themes and at the system level.

Together with the food programme's objectives and the common objectives of all national research programmes (see Section 1.2), the perspectives and themes form the framework for implementing activities and initiatives within the national research programme for food.

Over the lifetime of the agenda, new issues, challenges and needs might arise in the food area or in other areas and sectors that prove to be essential to the transformation of the food system. For the agenda to remain relevant, the perspectives and themes will be revised as needed.



Figure 2. Perspectives and themes of the agenda

4.1 Perspectives

The agenda's perspectives are key drivers of research and innovation that help to accelerate the transformation to a sustainable and competitive food system.

The perspectives in focus are:

- System perspective
- Knowledge and skills development
- Governance and leadership
- Digitalisation and technology development
- Regionally and globally
- Gender equality and diversity

4.1.1 System perspective

The challenge of shifting to long-term, sustainable and competitive food production and consumption is complex and multifaceted. Complex challenges demand research and innovation that have a system perspective. This means that research and innovation must take all parts of the system into account (stakeholders, regulations, technological development, the market, etc.) and address or consider different levels of society locally, nationally and internationally. A system perspective reveals flows and interactions, fostering collaboration, innovation and the implementation of effective solutions as well as better resource utilisation. It also helps to identify bottlenecks and measures that can create leverage in the transformation to a sustainable and competitive food system. While some issues must be specific and at times narrowly defined, they need to relate to a greater understanding of systems and to common goals.

Research must strive to solve conflicts of objectives and interests and to balance priorities in the transformation to a sustainable and competitive food system. One example is the goal to increase production and create more jobs and growth while still achieving national and global environmental and public health objectives. Another potential conflict of objectives involves how integrating new technologies will impact employment, competitiveness and consumer confidence in the food sector. By taking a system perspective, synergies between objectives and interests can be identified and addressed using innovative solutions, products, services and processes.

Using a system perspective when planning and implementing research and innovation initiatives helps to promote a more efficient transfer of knowledge and solutions among different parts and levels of the food system. It also enables the expertise, methods and technologies from other sectors and the surrounding community to be captured and contribute to the transformation. The interplay with other systems and sectors needs to be intensified, and integration with other innovative Swedish players reinforced and broadened to leverage the potential of this interplay, such as the interplay with ecology, the environment and climate, energy, transport, health and culture.

A system perspective helps to ensure a successful outcome for the innovations and for well-balanced, evidence-based decisions and measures needed to effectively transform the food system.

4.1.2 Knowledge and skills development

There is a great need for more knowledge dissemination and skills development in the food sector if we are to fully adopt new scientific findings and new technologies, meet new challenges and leverage the potential that is available for Swedish food production.

Research plays a central role in developing new knowledge that improves the understanding and skills of stakeholders throughout the food system, today and into the future. At present, however, infrastructures, processes and methods that help to convey knowledge to the right stakeholders in the system must be developed, broadened and more efficient. In primary production, for example, knowledge and skills around management, organisation and marketing must be strengthened in order to fully benefit from added value in a competitive, profitable way (Swedish Board of Agriculture, 2018b). Higher education and skills development must be closely linked to the needs of stakeholders, especially with regards to new technologies and digitalisation. The level of education in the food sector is generally low, and working in the sector must be made more appealing in order to secure a highly educated workforce for the long term.

Problem-solving approaches and co-creation in research for increased innovation capacity are needed to a greater extent. This entails new ways of approaching research and requires new skills, fresh leadership and other forms of understanding which also have implications for research and higher education.

In a consumer-driven food system, well-informed consumers who consume and act sustainably, accept proven technologies and make healthy choices are important. Both research and innovation that make knowledge available in a smart way can help provide consumers with well-balanced information grounded in science and tools that steer them and the development of the food system in the right direction.

4.1.3 Governance and leadership

Effective and appropriate governance in the food area can help to enable financial viability within our planet's boundaries while increasing the production of safe food, improving health and equitable access to it worldwide, and strengthening integration in society, including between urban and rural areas. Governance can take place in many ways – through policies, regulations and financial incentives – but it can also be driven by civil society, citizen social movements, norms and values.

More knowledge is needed to ensure that policies, instruments and structures can more efficiently support the food sector in its transformation to sustainable production, while ensuring Swedish food security and the ability of Swedish companies to take market share from global competitors. Policy instruments can help to integrate different sustainability perspectives, including the financial viability of businesses as they shift to new production methods, services or products. Effective instruments as well as other broader initiatives and interventions must be developed based on science and proven methods, and tested in different ways before being scaled up and fully utilised in the food system. Governance must also take into account the different stakeholders' circumstances, dependencies and possible conflicts of interest.

Innovative, committed and bold companies and organisations that show leadership are vital for the transformation to a sustainable and competitive

Swedish food system. Also important are the norms and values of public authorities, universities and businesses that are driving the sustainability agenda forward through their own commitments and partnerships. These are especially important for gaining credibility with citizens and attracting new labour.

In a major transformation, stakeholder roles often change and new opportunities emerge. For example, we are now seeing brand stretching and new business models emerge partly thanks to society's increasing digitalisation, but also because of other macro changes and drivers. We need governance that supports innovation and entrepreneurship through effective regulations and tools as well as fair conditions that help to leverage new business opportunities.

Research must support the ability of civil society and social movements to drive change, and help people to understand and accept the effects of these changes in society. Using this point of departure, we can design and implement initiatives that accelerate the transformation to a sustainable and competitive food system.

4.1.4 Digitalisation and technology development

Digitalisation and technology development will be crucial for our ability to address major global challenges. They drive the evolution of society as well as the transformation of the food system.

Digitalisation allows us to do brand new things, and to do things in completely different ways than we could before. The food area shows the potential to apply new technologies and leverage the capabilities of digitalisation to a degree not done before (Swedish Agency for Growth Policy Analysis, 2019).

Increased digitalisation, together with the use of big data and new technological advancements, enable higher productivity and competitiveness throughout the food system (OECD, 2018b). For example, they can enable innovative agricultural technologies, new methods for producing and processing food, a sustainable intensification of food production and waste reduction at all stages, thus contributing to food security. Digitalisation provides new opportunities for dialogue and interaction between stakeholders in the system. This can help to shorten the route between producer and consumer and to better adapt production to demand, as well as to leverage citizens' engagement and skills as society evolves and changes. At the same time, digital technologies and skills show the potential to contribute to food safety, effective control and traceability in the food system, personalised nutrition, service innovations in distribution and consumption, and simplification for businesses. In other words, digitalisation promises to rapidly change and improve all stages of our food system.

Yet digitalisation and other technology developments present new challenges. This is why critical perspectives must also be taken into account regarding the acceptance of new technologies, how consumption data is collected, and how data is validated, analysed, harmonised and integrated. The effective use of both technology and data requires addressing issues like integrity and ethics, the risks of connected systems and legal considerations.

Sweden is one of the world's strongest innovation countries, with a general openness to using innovative new solutions to solve global challenges. Parts of the food sector are already high-tech and automated, but there is great potential to increase productivity, promote safe working conditions and reduce environmental impact by further digitising and developing the sector's technology

capabilities. For the many small and medium-sized enterprises in the food sector, this poses a challenge. In order to benefit from the rapid development taking place in these areas, companies need investments and talent in digital tools and work methods. But they also need infrastructure as well as properly functioning internet connectivity throughout the country.

4.1.5 Regionally and globally

Regional engagement and initiatives are vital to Sweden's food security and to the development of an innovative food system throughout the country. Regional food systems have the stakeholders, knowledge, mandate and perspectives that can spark action and the implementation of sustainable measures based on local conditions. Regional activities and stakeholder networks create fruitful ecosystems for co-creation in research, innovation, knowledge dissemination and skills development, which should be leveraged. Continued efforts are needed to strengthen regional collaboration and to provide nationwide opportunities for incubation and acceleration within the food system.

Yet the Swedish food system is part of the global system, and circumstances outside of Sweden therefore affect its ability to achieve a sustainable and competitive food system. This includes the food system's role in public health, gender equality and diversity, corporate profitability, and society's preparedness and resilience in the event of disruptions. While global competition can represent a challenge to the profitability of Swedish companies, leveraging the global market is necessary to ensure competitiveness. So we must take action regionally, nationally and globally to achieve a long-term transformation of the Swedish system.

Sweden is a leading country within sustainable food production and has good prospects to show leadership and leverage the global market in this transformation. We, too, have a responsibility for the global food supply, especially in the face of a changing climate. We currently import about half the food we consume. An increase in the domestic production of more sustainable food can make a contribution to a more sustainable production of food around the world. At the same time it would boost the profitability of the Swedish food sector, creating jobs and growth across the country.

4.1.6 Gender equality and diversity

Gender equality and diversity help to reveal different perspectives and encourage their use in the development and transformation of the food system. The potential for successful research and innovation processes is achieved when different knowledge, skills and experiences are combined (Bear & Woolley, 2013; Nielsen et al., 2017). At the same time, political, economic and social equality between women and men contributes to all dimensions of sustainable development (United Nations, 2015). Promoting gender equality and diversity also broadens opportunities for recruitment, increases the sector's appeal and speeds its development, which boosts competitiveness. It also helps organisations to maintain an innovative mindset (Confederation of Swedish Enterprise, 2018). Conscious efforts to promote gender equality in organisations generally also helps to create more inclusive products and services, which can increase competitiveness on the market. Such efforts can also make the food sector more robust, provide opportunities to broaden skills and strengthen attractiveness, and promote rural development (Swedish Board of Agriculture, 2019b).

The government's gender equality objectives and its goals for the integration and resettlement of new arrivals should inform all policy-making, including within the rural development programme. There should be great potential for the food sector to both improve its own sustainability and competitiveness while contributing to policy objectives for gender-equal and diverse communities by becoming a more egalitarian sector with increased diversity.

In the action plan for Sweden's work on Agenda 2030, equity and gender equality issues are one of six focus areas. However, a follow-up of Sweden's progress on the goals shows that we need to do more to achieve the goal of gender equality (Ministry of Finance, 2018). Despite long-standing political efforts to achieve economic equality, women and men face different conditions in terms of entering the labour market and career development.

The current state of the different parts of the food system and the measures needed to achieve gender equality and diversity and to drive the food system's transformation must be explored more closely.

4.2 Themes

The agenda's themes highlight areas that show the need and the potential for further development through new knowledge and innovation. They should be viewed as part of a whole, and they aim to provide guidance and direction for initiatives and activities under the national research programme for food.

The guiding themes are:

- Sustainable production systems
- Tasty food for healthy people and planet
- The meal and the consumer
- Innovative and safe food

4.2.1 Sustainable production systems

We need to produce more with less. A crucial success factor is therefore increased resource efficiency in the food system. Our ability to step up production while achieving national and global environmental and climate goals and strengthening the competitiveness of businesses requires a major transformation of the food system, from primary producer to consumer.

We must improve our understanding of climate change impacts on production and adapt production systems to new conditions and sustainable long-term production. The transformation must integrate a profitability perspective, and research must support the transformation to more sustainable forms of production. Food producers have an important but challenging role. Changes should bring about climate and environmental benefits, but they also need to be implemented in a profitable way for businesses.

We need to intensify sustainability efforts through research-based measures in order to future-proof biodiversity, ecosystems, and soil health and function. Enabling this requires new knowledge, methods and processes that promote more circular, integrated production systems that optimise the use of raw materials, inputs, land and water while reducing waste and losses and increasing the recirculation of water, energy and nutrients. By-products and residues from

primary production and processing can be turned into innovative new foods with higher value, thus promoting the profitability and competitiveness of businesses. They can also become a resource for new food packaging materials or for other sectors and purposes, and this requires cross-sectoral cooperation. Integrating disciplines and sectors can lead to measures and investments that also promote job creation, vibrant rural areas, a stable food supply, and regional and national capacity for managing major disruptions.

A renewal of the food system means using new raw materials as well as using conventional raw materials in new ways. Sustainable production must be developed on land, at sea, under the ground, above the ground, and in a factory or laboratory, in both rural and urban areas. Because this will involve new production and process methods, we will need better integration of new technologies and tools that can be applied in areas like plant breeding, precision agriculture and sustainable livestock production as well as in the maritime sector. Research on the transformation of food production must also ensure access to Swedish raw materials and the qualitative aspects of raw materials and food products.

4.2.2 Tasty food for healthy people and planet

Research on food, taste, health and the environment has the potential to improve public health, planetary sustainability and the competitiveness of businesses. Innovations such as sustainable products, methods and processes that provide added value in the form of taste, consistency or nutritional content create new opportunities for both established and new companies.

Poor health caused by dietary habits is on the rise, and we need a shift to a food system that is viable from a health perspective. At the same time, food must be environmentally sustainable. The transformation to a more environmentally sustainable diet is driving demand for more plant-based foods and alternative sources of protein. Research and innovation need to help ensure that these foods are nutritious, healthful, taste good and are accessible in order to gain consumer acceptance and grow the profitability of Swedish food companies.

Knowledge and skills around new methods, technologies and optimised processes for processing Swedish raw materials must be strengthened, all the way from primary production through to the consumer. This can involve plant breeding, the effects of climate change on raw material components, industrial processing operations, the effects of processing and storage on food ingredients and nutrients or the finished product, the health effects of food, and the consumer's sensory and culinary experiences. Sweden has a long tradition of high-quality research within food and health. However, research and innovation in food production and processing, nutrition and health, and sensorics and gastronomy must be better integrated to meet the demand for healthy, good and environmental-friendly food. More knowledge about sustainable nutrition – meaning what is sustainable for both human and environmental health – is needed to transform the food system in a way that integrates both perspectives.

Foods with a specific health profile, functional foods, foods targeted to specific groups and personalised diets are all areas that have the potential to contribute more knowledge to the food sector and boost its competitiveness. The world's ageing population is one example of a trend that places demands on new food for a specific target group. But the sector can also promote better, more equitable health in the population by producing, developing and processing good, nutritious and healthy food for everyone.

Digitalisation, new technologies and new methods enable an in-depth understanding of food and health. They also enable the creation of food surveys with high-quality data which can be used in research and, for example, in innovative new services in the food system.

4.2.3 The meal and the consumer

Consumer demand is a key driver of the transformation to a sustainable and competitive food system. But our eating habits need to become more sustainable. Consumer knowledge, the role of mealtimes and, for example, innovative and supportive food environments therefore have an important role to play, from both a sustainability and a competitiveness perspective.

Today, we need to shift to eating habits that are good for the health of the individual and that of the planet. To enable this shift, the consumer must have the right tools to make good choices. Understanding what affects consumer behaviour and food choices with regards to taste, price, availability, health and sustainability, social norms and marketing is crucial for developing products and services and for promoting more sustainable consumption. Greater consumer awareness can give stakeholders at all stages better prospects for profitability. More innovative outreach initiatives and educational approaches, tools and instruments are needed in the shift to healthy, sustainable consumption and reduced food waste.

Social and cultural factors influence our food choices and meals. The importance of food, mealtimes and gastronomy to well-being, identity, social interaction and group affiliation will affect the development of the food system. Innovative products and services can help to care for food culture, to develop meal experiences and promote experience tourism, thereby generating profitability in the food sector and in the hospitality industry. They can also promote vibrant rural areas and create jobs throughout the country.

Various spatial planning measures and public meal programmes can encourage stimulating food environments and optimise access, both geographically and spatially, to sustainable Swedish food and thus influence its consumption. Well-functioning urban planning that brings urban farms and other forms of production close to the consumer can help us better understand food producers' circumstances and the price of food. Demographic trends, urbanisation and digitalisation also provide scope for more innovation in retail and distribution. New market channels and touchpoints between players in the system, such as between consumer and producer, enable the tailored access and distribution of food according to the individual's needs and wishes.

4.2.4 Innovative and safe food

Innovative and sustainable food from new raw materials, new production systems or new processes can help to transform the food system. As the food of the future is being developed, high food safety standards and traceability in the chain remain important for system stakeholders as well as for consumers and their trust in the food they eat. The sustainable distribution of food and reduced waste are other pressing issues.

Climate change, urbanisation, new value chains, circular systems, and new raw materials and processes open up avenues for new food products on the market. But they can also lead to the emergence of new risks related to the raw materials and the food itself.

New consumption patterns can also bring new risks to human health. The future safety of food demands new knowledge, new methods and processes, risk analyses and preventive measures. Food safety is one of Sweden's strengths that can boost demand for Swedish products and services in a global market, where safe food is a key priority for many (Swedish National Food Agency, 2019b).

Food produced from new raw materials, production conditions and processes that are unfamiliar to the consumer also put ethical considerations and the consumer-food relationship on the agenda. Consumers will need to know where their food comes from, how it was produced and how it was transported for both social and environmental reasons. With increasing globalisation, flows become more complex. New digital technologies and solutions can help to ensure safety, verify ingredients, fulfil traceability, and make product information available throughout the chain down to the consumer.

Packaging that is sustainably produced helps to optimise resource use with regards to the food as well as the packaging materials. Resource-efficient, smart packaging can enable efficient warehousing, distribution, traceability and longer shelf life while monitoring and controlling the ripening process and safeguarding sensory properties and nutritional content. Sweden also has a long tradition and expertise in the packaging industry, which, in cooperation with food producers, can help to create innovative solutions that promote food safety, reduce food waste and increase consumer transparency. There is potential for collaboration among stakeholders from different industries and along the entire value chain for developing new materials, solutions and systems.

Sweden offers a solid regulatory framework that ensures safe food, good animal health and welfare, and sustainable production. However, closer collaboration among academia, the business sector and public authorities is necessary to achieve well-functioning processes and to encourage progress and innovation in the food sector.



5. Implementation of the agenda and the research programme

Transforming the food system in a way that boosts the profitability and competitiveness of companies while promoting sustainable development is both complex and urgent. Within research and innovation in particular, a wide range of initiatives is needed from different stakeholders and towards common goals.

The agenda's perspectives and themes highlight what the research and innovation system must address in the coming years to enable the transformation and thus set a direction for implementing the national research programme for food. The programme's implementation is also supported by its objectives as well as the government's purposes and objectives for the national research programmes.

In this chapter, we describe more closely what will be important in implementing the agenda. We also describe how the national research programme will be realised, followed up and evaluated using programme logic.

5.1 Collaboration and co-creation

A major transformation of the food system requires innovation and a fresh approach to doing things in new constellations of stakeholders. The business sector, higher education and research institutes, research funders, government authorities, civil society and consumers will all have important roles to play in the research and innovation needed to realise the transformation. Collaboration and co-creation are prerequisites for creating a sustainable and competitive food system. Collaboration must take place in new forms and at different levels in order to coordinate actions, identify and formulate relevant issues, run projects, promote knowledge transfer, develop and innovate. Experience from other challenge-driven research programmes reveals the need for new approaches to setting the agenda, common goals and new processes for priority-setting and cooperation (Swedish Agency for Growth Policy Analysis, 2017). Countries that have been successful in food research and innovation often have long-term joint ventures throughout the sector, with far-reaching collaboration among academia, the business sector and government authorities (Appendix 4). An example of co-creation that takes things one step further is so-called mission-oriented innovation, which is now being developed within the EU's forthcoming framework programme (see also Section 5.2).

The national committee for food research is vital for enabling and ensuring synergies among relevant funders, all of whom invest in research and innovation for the food area. The committee coordinates its efforts, exchanges experiences and identifies priorities. An important partner in efforts to prioritise and design investments is the Sweden Food Arena. Its aim is to increase coordination between companies and organisations throughout the food chain in order to formulate the industry's research and innovation needs. The Arena is also important for strengthening collaboration between business and academia and with other sectors. The Sweden Food Arena and other industry initiatives, professional

organisations, trade associations and networks that bring together the business sector and other stakeholders around research and innovation issues create a favourable environment for strengthening the relevance of food research while increasing innovation capacity in the entire sector.

There are several networks and nodes for collaboration between academic partners, such as Food Science Sweden, a national platform that brings together a number of universities and RISE, with the aim of strengthening Swedish food research and increasing its visibility. But there is potential to further step up coordination and collaboration within academia and research institutes. This can be done through new network constellations, cross-disciplinary partnerships or excellence centres.

Sweden is an elongated country, and local nodes for knowledge exchange and skills development, regional innovation environments and points of contact are needed to boost the innovative power of the food system and reach out to the many small and medium size enterprises around the country. At the same time, collaboration in local food systems needs to be linked to regional and national forums.

5.2 A cohesive research and innovation system

Research and innovation are crucial to the competitiveness of businesses and to sustainable development. But the linear innovation model (basic research, applied research, product development, production and marketing), which has been the dominant approach in the Swedish food sector, has proved to be insufficient and partly limiting for the system. Instead, the national food strategy and this agenda seek a cohesive research and innovation system. In such a system, research takes a more systemic perspective, is needs-driven, interdisciplinary and takes place in collaboration and co-creation among different stakeholders, and innovation takes place at the crossroads of interaction between stakeholders and sectors where knowledge and expertise bring learning to life. At the same time, the realisation has emerged that effective collaboration also requires direction. This agenda intends to step up the transformation by clarifying this direction.

A variety of initiatives from a wide range of stakeholders, as well as new functions, must be developed to strengthen the food research and innovation system. The agenda focuses on needs-driven research and how, in combination with a stronger innovation system, it can especially boost the innovative power of business. The agenda focuses on areas of the food area's innovation system, and does not describe how other areas of society can influence developments.

Innovation processes that translate knowledge into new values can differ, but the combination of different skills, knowledge and experiences provides a good foundation. The degree of innovation in the Swedish food system is currently low. The implementation of the programme plays a vital role in promoting innovation environments in which private companies, academia, research institutes and other stakeholders in different constellations can together boost innovation through improved collaboration and co-creation.

It is important to consider the needs of the business sector and other stakeholders in influencing the direction, stimulating cooperation and achieving a balance between different interests with regards to the agenda and its implementation in the national research programme for food. It is also important to seize fast-growing opportunities that can potentially help to achieve a rapid transformation.

Today, many funding organisations are looking for forms of collaboration that increase the relevance of research and shorten the lag time from idea to real-world impact. One way this is being done is by stimulating co-creation processes in which end users and researchers work together throughout the process, from idea to practical benefit. The forthcoming EU framework programme, Horizon Europe, uses an approach based on so-called mission-oriented innovation and addresses challenges that are important to the public but are not being met using traditional approaches (see also Section 5.3.3). The purpose of a mission is to solve a global challenge by setting clear, time-bound goals. The challenge should be ambitious and should involve many different stakeholders, including the general public, and the solution should require a cross-sectoral system perspective. A variety of both top-down and bottom-up approaches are needed to solve a mission, ranging from traditional research projects to well-defined interaction between stakeholders like citizens and government agencies. Missions will catalyse economic activity, create innovations, solve global challenges and thus create growth with a new direction. This type of instrument adds value through the creation of more spillover effects between sectors compared with more traditional approaches. This approach is already being investigated and tested internationally and nationally by various stakeholders, and it will be part of the implementation of the national research programme.

Which activities will be initiated and how the results will be disseminated and scaled up will be developed both within the research programme and through the efforts of other stakeholders in the system.

5.3 A Swedish platform for food research and innovation

The national research programme for food and its advisory body, the national committee for food research, provide a platform for the co-creation and coordination of food research in Sweden. A cohesive, long-term food programme strengthens opportunities for fruitful synergies with other national and international research and innovation programmes.

Under the national research programme for food, Formas, in consultation with the national committee for food research, is developing and testing new tools and formats for initiatives that best contribute to the national food strategy's vision through the research programme's objectives and to the common objectives of all the national research programmes (see Section 1.2). In view of the common objectives, the programme's activities should also contribute to gender equality, a more efficient use of infrastructure and an increase in the internationalisation of research. As far as possible, the initiatives will have common objectives with initiatives from the business sector, government authorities and other stakeholders. By coordinating the efforts of different stakeholders and continuously monitoring them and gathering existing knowledge, new activities and initiatives can build on previously implemented ones and drive progress. Programme logic for the programme will be developed as a framework for effective action and follow-up (see also Section 5.3.4).

5.3.1 Content and implementation of the research programme

An important ambition in the national research programme is to break down the silos that exist in the food system within disciplines, between researchers and practitioners, and between different stakeholders. The research programme will serve as a platform that enables synergies among stakeholders through measures like dialogue forums, whose goal is to promote mutual learning, initiate collaborative activities and jointly develop new knowledge and solutions. The research programme aims to orchestrate national initiatives targeted to academia, research institutes, the business sector and public-sector organisations to fill the knowledge gap and bring about changes where they are most needed. Initiatives should address the perspectives and themes identified as central to this agenda. In addition, the research programme intends to create new networking opportunities and collaborative projects between researchers, the business sector and other stakeholders. These networks lay the foundation for needs-driven research projects of great societal relevance and potential for innovation that can lead to new products, processes, methods and services that create both sustainability and competitiveness. Initiatives within the programme can involve any aspect of the research and innovation system, including research, innovation, technology development, demonstrations, test beds and market launches.

Activities central to the research programme are those that directly support both collaboration and co-creation and that encourage knowledge transfer, the use of research results and the foundation for innovation in society. These can be designed in various ways. Examples include investments in mobility between academia, the business sector and other stakeholders, platforms or networks that support interdisciplinary or cross-sectoral collaboration around identified challenges, or joint efforts to promote ecosystems in which the stakeholders create research and innovation nodes at the regional, national or international level.

The activities can also include measures for more efficient dissemination of research outputs to businesses, or for the purposes of training or policy development. Other activities might aim to promote collaboration, co-creation or networks for the exchange of knowledge, resources and experiences or for skills development.

More system perspectives are needed, as are projects with breakthrough ideas and innovative solutions. The research programme will particularly welcome implementation research and more business-oriented research that is better adapted to practical application and helps to reduce the gap between research and application. High-quality research will be promoted through access to relevant research infrastructure including research facilities, laboratories, experimental workshops, instruments, methodological tools, archives, databases and other structural services. Digitalisation enables the compilation and use of data, but it also requires infrastructure that provides the ability to efficiently collect, store, process, share and use the data. How this can be supported will be further explored within the research programme.

New forms of research and innovation will require new skills and incentives for researchers, project managers and participants. Efforts that promote these factors can be considered relevant elements of the research programme. A long-term skills supply and the skills base of researchers in academia, the business sector and the public sector can be enhanced through investments in graduate schools with co-funded PhD students.

Other efforts to make knowledge available and impactful within the field or to develop research results for a specific target group, such as systematic reviews for education and policy development, targeted communication efforts for behavioural change, or calls for proof-of-concept proposals, will be vital enablers of the real-world impact and commercialisation of research.

Efforts to boost information dissemination and communication are also important elements of the research programme. Channels for comprehensive information on calls for proposals and activities within food research and innovation as well as dissemination of programme results will continue to evolve, as will matchmaking forums and the dissemination of research results in interactive forms.

5.3.2 Synergies between the national research programmes

In addition to the national research programme for food, the research councils Formas, Forte and the Swedish Research Council previously established an additional six national research programmes as tasked by the government. These focus on antibiotic resistance, workplace research, climate, migration and integration, sustainable spatial planning and applied welfare research. All the programmes address significant national and global challenges facing society. The drivers, consequences and solutions regarding one particular challenge also relate to other challenges, so there are many interactions, synergies and conflicts of interest between the challenges and thus between the programmes. Efforts within the national research programme for food can therefore be carried out in collaboration with other research programmes to enable cross-cutting research and innovation initiatives.

The national research programme for food has clear touchpoints with several of the other national research programmes, such as:

- The programme for sustainable spatial planning – as relates to the food supply, which is part of the built environment, urbanisation and rural development, sustainable transport and logistics solutions, consumption, policy instruments, the circular economy, etc.
- The climate programme – as relates to the impact of food production and consumption on climate change and climate change adaptation, transport, energy, policy instruments, circular economy, etc.
- The programme for antibiotic resistance – as relates to animal health and antibiotic use in food production
- The programme for applied welfare – as relates mainly to the link between food and health.

5.3.3 Part of the European research and innovation arena

A national agenda and a long-term research and innovation programme also enable synergies with global food-related networks and programmes. Under the national research programme for food, activities will take place that aim to bolster national participation in relevant international programmes.

To successfully implement the major changes that must happen within a short time frame, we have to work together across national borders. Through its research and innovation framework programmes, the EU offers good opportunities for mobilising such international efforts. The programmes are open to a diversity of organisations, such as large and small businesses, academia, the public sector, trade associations and civil society.

The parts of the programme aimed at solving societal challenges require that different types of stakeholders and experts work together, from project idea to final results. The project ideas are assessed on their potential to create change and benefit in society, so the different skillsets of the collaborators is important for implementing the project and creating real-world impact. Going forward, the EU will focus even more on users and problem-solvers working together from start to finish and on the new research findings being tested, implemented and utilised to contribute to societal change.

The increasing and more rapid translation of new knowledge into practical use is also, of course, the objective of the national research programme's initiatives. In addition, the research that creates new knowledge must be of the highest quality. International collaboration helps to improve the quality of Swedish food research and strengthen its relevance. In the long run, it adds more value to society.

Creating a more sustainable food system at the global level through research and innovation is a priority both within and outside the EU. The perspectives, thematic areas and tools identified in this agenda also rank high on the agenda of the EU's forthcoming framework programme for research and innovation, Horizon Europe. One of Horizon Europe's overarching objectives is increased employment rates and competitiveness for Europe. Horizon Europe runs between 2021 and 2027 and, like the previous Horizon 2020 framework programme, it is based on three pillars: Excellent Science, Global Challenges and European Industrial Competitiveness, and Innovative Europe. Global Challenges and European Industrial Competitiveness is divided into six clusters, one of which focuses on food, bioeconomy, natural resources, agriculture and environment. Because these clusters are broad and span several different systems, many perspectives are needed for a sustainable transformation of the food system. One proposed partnership is specifically on "Safe and sustainable food systems for people, planet and climate". The system perspective and breadth of approaches to the EU framework programme provide a solid foundation for coordinating national and international efforts and giving Swedish stakeholders, both from the private sector and academia, the chance to participate in research and programmes jointly funded by the EU and its member states.

The Global Challenges and European Industrial Competitiveness pillar, Pillar II, also includes the aforementioned missions initiative. A mission is characterised by the fact that it is driven by civic engagement, addresses major global challenges, is highly ambitious and has time-bound objectives that will be achieved using diverse efforts and tools in collaboration between stakeholders from different sectors. At the time of writing, five missions have been identified and initiated, one of which is Soil Health and Food.

Because the national agenda is aligned with Horizon Europe, Sweden gets a real possibility to both influence the direction of future European initiatives and to encourage Swedish stakeholders to participate in transnational partnerships and projects funded through the EU.

5.3.4 Programme logic

Programme logic will be used to ensure the successful implementation of the agenda and the national research programme for food. The activities linked to the agenda will be prioritized and materialised through the programme logic. This logic describes how the research programme is intended to work and provides a logical framework for activities, actions and follow-up in the research programme.

The programme logic is based on an analysis of the desired results and effects needed to achieve the programme objectives as well as the necessary activities and actions. It integrates the perspectives, themes and objectives of the agenda, and includes the general objectives of all the national research programmes. The programme logic also helps to link the agenda with the national food strategy vision and the sustainable development goals.

The process of developing both the programme logic and the agenda uses a bottom-up approach, involving relevant stakeholders both in the design and the future activities of the programme. Clear, measurable targets will be developed to specify the results that must be achieved and to guide the formulation of ambitious yet realistic research and innovation initiatives and collaborations involving multiple stakeholders.

The programme logic and its implementation aim to balance the need for advance planning with the need for flexibility so that events and changes in society as well as the results of follow-up and evaluations can be taken into account. Activity plans with a shorter time horizon are created using the programme logic. The implementation will also strive to enable synergies with other national and international programmes and activities. Initiatives are prioritised and coordinated together with the national committee for food research and in dialogue with other food stakeholders, such as Sweden Food Arena, academia and research institutes, in order to ensure streamlined efforts that address the circumstances and needs of different stakeholders.

5.3.5 Follow-up and evaluation

To monitor the progress of the national research programme for food and the implementation of the agenda, activities and initiatives are followed up annually. A more detailed evaluation is planned further into the programme period. The follow-up and evaluation aim to ensure that programme activities and actions follow the programme logic and deliver results that help to achieve the agenda's objectives.

As previously described, the agenda and programme logic must have built-in flexibility in order to take the evaluation results into account. Major changes in the food area or other areas, whether domestic or global, can also necessitate a reprioritisation of the agenda's perspectives, themes, objectives and activities as well as a revision to the agenda (see Figure 3).

At the end of the research programme, a final evaluation is planned that reviews how well the programme reached the objectives of the agenda and contributed to the sustainability and competitiveness of the food system.

In accordance with Formas' remit, an annual report for the national research programme for food will be submitted to the Government Offices as well as to the Swedish Board of Agriculture. The Swedish Board of Agriculture is tasked with conducting an annual follow-up and evaluation of the national food strategy, in addition to an in-depth analysis every four years. Its remit includes formulating relevant indicators for following up and evaluating the national food strategy. Formas works with the Swedish Board of Agriculture to produce follow-up indicators within the strategic area for knowledge and innovation.

Analysing the impact of national research programmes on the research and innovation system will also be relevant. Since the national research programmes

are long-term and relatively new components of the Swedish research funding landscape, the programme's organisation and logic will also be evaluated. Additionally, Formas' evaluations will inform the overall evaluation of investments in national research programmes that the government intends to initiate.



Figure 3. The research agenda describes overarching needs and priorities, while activity plans will specify the activities that will be conducted within the national research programme for food in the short term. Continuous follow-up, dialogue and evaluation are important elements of the research programme.



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7. Appendices

1. Government remit to establish a national research programme for food
2. How the strategic content of the agenda has been developed
3. Survey: Research and innovation funding 2011–2018
4. International outlook

Formas is a government research council for sustainable development. We fund research and innovation, develop strategies, perform analyses and conduct evaluations. Our areas of responsibility are environment, agriculture and spatial planning. We conduct analyses that facilitate the efforts to achieve Sweden's environmental goals. We also communicate research and research results.

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