

Chapter 6

The Swedish agricultural innovation system

This chapter describes the Swedish Agricultural Innovation System (AIS) and outlines recent changes. It provides an overview of the general innovation system; identifies the actors in agricultural innovation and their roles; describes main trends in public and private investments in agricultural R&D, and discusses mechanisms to foster knowledge flows and national and international collaboration; and gives an overview of policy incentives for the adoption of innovation, outlining the role and diversity of knowledge and innovation intermediaries, including farm advisory services. The final section describes research outcomes and impact, as well as innovation adoption in primary agriculture and food processing firms.

Key points

- Agri-food research is largely part of, and well integrated with, the general innovation framework.
- There is less innovation in food and agriculture than in other businesses, but new survey results should help farmers' decisions to innovate and evaluate the impact of policies.
- Public research mainly takes place in universities.
- Swedish universities achieve high research excellence rankings, but linkages between basic research, applied research and industry are weak as they are in the AIS where there are also weak links to advisory services.
- Governance of research and innovation remains weak, constraining efforts to channel research towards addressing main challenges.
- Budget expenditure on agricultural R&D accounts for a smaller share of agricultural gross value added than in many neighbouring and European Union (EU) member states, but farmers fund some of the applied agricultural research.
- International co-operation in public research is mainly within EU programmes and the Nordic council.

6.1. General innovation system

In Sweden, the agricultural research and innovation system is fully integrated into the general innovation policy and institutional framework. The economy-wide framework for science, technology, and innovation provides the incentive structure in all sectors. Agricultural Innovation Systems (AIS) are increasingly driven by economy-wide process and organisational innovations, developments in ICT, and the bio-economy. A high profile for innovation will ensure that general knowledge and specific knowledge in other fields (needed to develop and implement agriculture innovation) are available, and that economic actors and society in general embrace an innovation culture (OECD, 2014a).

Performance

As outlined in various OECD reports (OECD, 2013, 2016a and 2016b), the strengths of the Swedish Innovation System contain good framework conditions, including a strong and stable macro economy and institutional framework, along with a high quality of life and significant equality. Innovation also benefits from the strong human resource base, high investment in R&D, the strong science base,¹ the excellent innovation performance of the economy and good positioning in international networks.

In particular, Sweden is a strong performer in a number of areas facilitating interactions and innovation skills. Sweden is becoming a world's leading economy in exploiting opportunities of digitisation through the ICT infrastructure and e-government development. Skills for innovation are also high, with the share of doctorate graduates in science and engineering, and adult's ability to solve technical problems, being top among OECD countries (Figure 6.1).

High investment in research is a major feature of the Swedish innovation system (OECD, 2016b). Both the public and private sector invest strongly in research and research intensity is well above the OECD average. Public expenditure on R&D accounts for a significant share of the government budget (3.7% in 2016). As a share of GDP, public expenditure on R&D is higher than the OECD average, placing Sweden among the OECD top 5 performers. Moreover, the Government foresees an additional SEK 2.8 billion in government expenditure on research by 2020 to reach 4% of GDP. Business expenditure on R&D is also relatively high at 2.3% of GDP (Figure 6.1). Industry R&D is concentrated in large firms, which dominate the Swedish economy. The largest firms (at least 250 employees) accounted for about 78% of total R&D expenses in 2015.

Much of the public expenditure on R&D goes to research at Swedish universities,² which are well placed in global rankings of world-class universities and publications. They received about a third of total R&D funding, mostly from the public sector. Public sources fund 89% of R&D carried out in government and higher education organisations, with private and foreign sources accounting for 4% and 7% respectively (OECD, 2016c). Higher-education expenditure on R&D, at 0.9% of GDP in 2014, is among the highest in the OECD area (Figure 6.1).

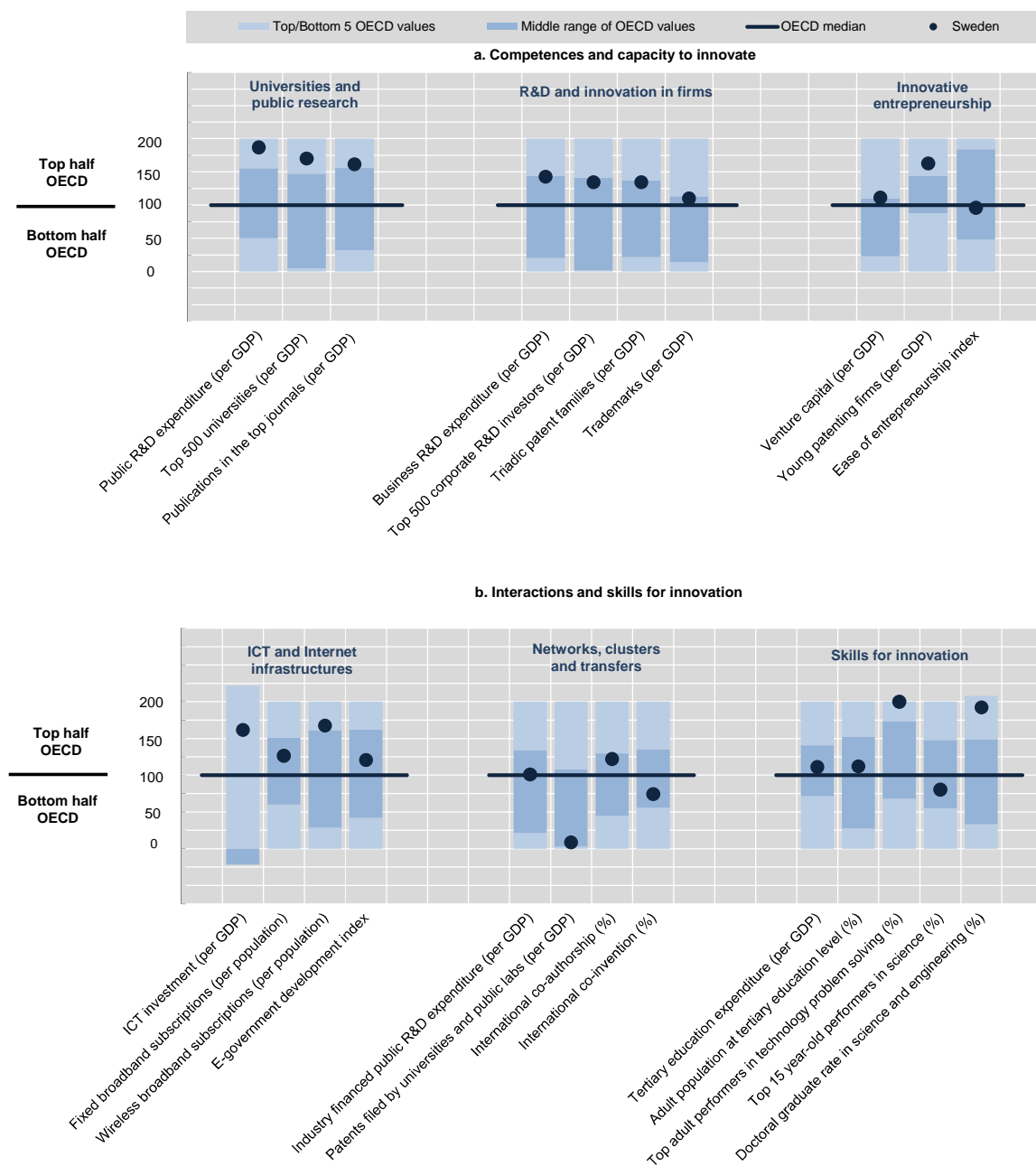
There have been changes in public funding mechanisms in the last decade. In particular, funds delivered through institutional block grants have increased (OECD, 2016a). Currently, institutional block grants account for about 45% of public funding for research in Swedish universities, with the remainder delivered through project funding. Around 20% of block grant funding is allocated on the basis of performance in attracting project funding and in publications, up from 10% in 2009. From 2018 allocation will be based on three criteria: performance in attracting project funding, publications and co-operation with companies and society. The aim is to incentivise both research excellence and relevance by rewarding publications, external project funding, and the use and impact of research and business contacts (OECD, 2016b).

However, an evaluation of recent efforts to channel R&D funds towards new priorities and establishing new partnerships, including the Strategic Innovation Areas (SIA) and the OECD (2016a), notes that they have not been truly effective in improving performance. The report identifies weak

governance as a constraint to prioritisation and strategic development, and suggests the problem lies in the overall innovation system (Box 6.1).

Figure 6.1. Science and innovation in Sweden

Comparative performance of national science and innovation systems, 2016



Source: OECD (2016), *OECD Science, Technology and Innovation Outlook 2016*, OECD Publishing, Paris, http://dx.doi.org/10.1787/sti_in_outlook-2016-en.

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Box 6.1. Main weaknesses of Sweden's innovation system identified in OECD reports

2012 OECD Review of Innovation Policy in Sweden (OECD, 2013): Lack of comprehensive innovation policy; reduced training; with few exceptions, relatively modest centres of excellence at Swedish universities; lack of contact between academia and small and medium-sized enterprises; drop in the rankings in terms of citations and leading publications of Swedish research although Sweden is still above the world average; problems with the financing of innovation projects; unclear regional innovation policies; and lack of evaluation.

2016 OECD review of innovation Policy in Sweden (OECD, 2016a): Some aspects of financing for innovation; declining educational performance; a sub-optimal academic intellectual property system; small academic centres of competence/excellence; weak links between traditional universities and small and medium-sized enterprises; weak innovation policy compared to policy in other areas (e.g. education); lack of holistic perspective concerning innovation policy; many medium-sized funding agencies funding similar research; unclear governance in regional innovation policies.

The 2012 OECD evaluation of the Swedish innovation system (OECD, 2013) identified some weaknesses, which recent changes have aimed to address (Box 6.1). A second OECD review of innovation policy in Sweden focused on these changes, noted remaining weaknesses and provided recommendations to improve the governance of the system and the performance of innovation programmes (OECD, 2016a).

The Swedish government has recently made efforts to address these weaknesses and to further improve framework conditions for innovation. These include the introduction of a modest R&D tax relief scheme, and reform of public venture capital so that it becomes less risk averse and focuses more on early-stage investments, where there are often shortfalls in private venture capital to improve technology transfer and commercialisation, in particular through closer collaboration between industry and academia. The industrial public research institutes, which were grouped into a single holding entity (known as RISE the Research Institutes of Sweden Holding AB) in 2009, have received further government funding and gone through a major restructuring since 2014 in order to achieve a consolidated and internationally competitive Swedish industrial public research institutes. RISE is intended to serve as a knowledge partner for businesses, as an intermediary between academia and industry, and as a nexus for participation in EU R&D projects (OECD, 2016b).

However, in the OECD's view the governance of the innovation system continues to remain weak despite recent improvements, such as the development of a long-term strategy for research and innovation and the creation of a national council to monitor and improve policies, as well as the introduction of challenge-driven programmes aimed to strengthen the capacity of the system to respond more effectively to society's innovation needs (OECD, 2016a).

Box 6.2. Evaluation of R&D activities

Research and higher education actors are responsible themselves for ensuring the quality of their research. Research councils are required by the Government to evaluate their own research. As formulated and regulated in the Government appropriations for each council, evaluations are required to cover the quality of research and its effects from a diverse perspective. By law, public universities and university colleges are individually responsible for quality. The Swedish Higher Education Authority is responsible for quality at a national level, as described in the Research and Innovation Government Bill.

The government, research and higher education actors recognise the need to strengthen research evaluation. Swedish research organisations dedicate a relatively high share of research core funding to evaluation (20%) (Swedish Research Council, 2014). To ensure high quality, they should have a well-established internal system for quality assurance. Despite not being compulsory, several higher education actors have undertaken an external and objective evaluation of their research quality. While welcoming this development, the Swedish Government emphasises an increased need to develop research evaluations even further.

National innovation policy framework

The Ministry of Education and Research and the Ministry of Enterprise and Innovation are both responsible for research and innovation policy in Sweden. Government policy on research and innovation has defined priorities and resources for a period of four years since the 1970s (see Table 6.A1 for an overview of agriculture-related priorities in the successive government bills). In order to improve longer-term planning, government bills have included a ten-year perspective since 2012.

Within the ten-year perspective, the current bill, adopted in 2017, focuses on investments for 2017-20. Priorities are climate and the environment, health, increasing digitalisation, achieving a sustainable society, and improving the learning outcomes of the education system. The previous Bill covering 2013-16 introduced a more selective, quality-based funding approach, representing a move away from supporting specific sectors towards encouraging cross-sectoral and multi-disciplinary approaches with long-term perspectives.

The Government has developed overarching tools to govern innovation in Sweden, which is mainly carried through by Strategic Innovation Areas (SIO). VINNOVA, Formas and Swedish Energy Agency are co-directing these and the first calls for applications were launched in 2013. Establishing and implementing programmes for strategic innovation areas is a new form of work for building long-term collaborative projects between universities and university colleges, research institutes, industry, the public sector and other actors.

Within SIO, there are two types of actions, Strategic Innovation Agendas and Strategic Innovation Programmes:

- *Strategic Innovation Agendas* (SIA) is the opportunity for a group of actors, in collaboration define visions, goals and strategies for developing a specific areas. Support for such SIA is through open calls, managed by VINNOVA.
- *Strategic Innovation Programmes* (SIP) supports the implementation of SIA and contains projects and other activities that contribute to the agenda's vision and goals. Support for SIP is through open calls at each relevant authority. Vinnova has a specific directive to assist the government with these programmes during the period 2016-18. One of these programmes is directly related to the agricultural innovation system:
 - The co-operation programme on the *circular and bio-based economy* aims to jointly assemble innovation efforts with a view to increase the share of the bio-based economy in the total economy and to promote circular solutions. Within this programme, Vinnova points at a number of opportunities (e.g. improving resource efficiency; consumers' willingness to test new things; good natural conditions for the production of biological raw materials; and being at the forefront of the digital era) and a number of challenges (e.g. national initiatives around this innovation area are missing; existing rules and instruments do not create incentives to spur development).
 - The remaining four programmes may have indirect relations to agriculture: travel and transport for the next generation; smart cities; life science; online industry and new materials.

In parallel to the SIA, Vinnova's *Challenge Driven Innovation* programme focuses on specific societal challenges, namely future healthcare, competitive industries, sustainable attractive cities, and the information society.

Changes in national innovation priorities

Government priorities for R&D have changed in the last decade. While overall budget expenditures on R&D have increased by about 4% per annum during the period 2005-16, budget expenditure on R&D

for policy areas such as health care, social environment and security, and energy and water supply have more than tripled, while those for culture, media and leisure, pedagogics and public management have decreased strongly (Table 6.A2). Budget expenditures on R&D for agriculture, forestry, hunting and fishery have been relatively stable following a small decrease in 2007, while those for the environment and nature conservation slightly increased.

Priorities for agriculture and food research and innovation

Within the general framework, priorities related to agriculture and food research are set out in government bills on research (Table 6.A1). There are no strategic innovation programmes related to sustainable food and agriculture, but some programmes may have significant impacts on the future development of the agro-food sector as outlined in Table 6.1. No specific financial means are directly assigned to the sectors, so it is very much within the power of the sectors themselves to be a part of the development of these strategic innovation areas.

Table 6.1. Sweden's 17 Strategic Innovation Programmes

Strategic innovation programme	Area	Potential relationship to agriculture	Potential relationship to food
Infra Sweden 2030	Sustainable transport and innovative infrastructural solutions	Efficient and sustainable transportation of goods	
Drive Sweden	Automated transport systems	Efficient and sustainable transportation of goods	
RE:Source	Sustainable waste	Resource efficiency and sustainable production and consumption, circular economy	
Smart Built Environment	Reduce environmental impact of construction		
Medtech 4 Health	Innovations in medical technology		
Innovair	Increase turnover and export shares of the air industry		
Grafen	Increase usage of graphene		
Smartare Elektroniksystem	Increase industries dependent on electronic systems		
Internet of things	Increase usage of internet advantages	Built-in sensors, smarter communication and information to increase efficiency of production	
BiolInnovation	Create conditions to adapt to a bio-based economy	Spillover effects from the forest industry	
SWElife	Life science and improve its infrastructure		
STRIM	Mining and minerals		
LIGHTer	Lightweight materials		
Processindustriell IT och Automation	Process industry information technology		Digitalisation, automation of the process industry
Produktion 2030	Enhance production through six priority areas		
Metalliska material	Increase innovations and market shares of the metal industry		

Strategic innovation programme	Area	Potential relationship to agriculture	Potential relationship to food
Smart and sustainable cities	Long-term solutions for a sustainable society (<i>Start at the beginning of 2017</i> SEK 40 million annually)	Dynamic relationship between rural and urban areas. Sustainable and efficient cities need to interact with surrounding areas, urban agriculture	Sustainable and long-term efficient food production

In addition, food and agricultural policies and strategies include measures regarding knowledge and innovation. The Food Strategy put forward in 2017 for discussion, for example, includes a number of measures regarding knowledge and innovation, including research (Table 6.A3). Within the EU framework, the Swedish Rural Development Programme (RDP) includes specific measures to facilitate knowledge transfer and co-operation among innovation actors, while broader measures supporting investment and sustainability may facilitate the adoption of innovation (Chapter 5). There are also several recent research projects specifically target R&D related to the food sector.

6.2. Actors, institutions and governance of the agricultural innovation system

Agricultural innovation systems involve a wide range of actors who enable, guide, fund, perform, and facilitate innovation. The key players include policy-makers, researchers, teachers, advisors, farmers, private companies and consumers.

Industry

Farmers and agri-food businesses are the main users of knowledge and innovation generated in the agricultural innovation system, but increasingly innovations and new knowledge also have a tendency to spread across industries and sectors, with more focus on collective goods and less on applied research. The expert opinion from the Swedish University of Agricultural Sciences (SLU) on the governmental investigation for competitiveness concludes that external financiers have focused on applied research related to agriculture and horticulture to issues related to the environment, animal welfare and new products, while the research aimed directly at increased competitiveness has been neglected (SOU, 2015). As discussed in the final section, adoption of innovation in the food and agriculture sector is lower than the national average. As the food sector consists of small and medium-sized companies, there are structural factors that can affect innovative capacity. In particular, they do not always have the resources to undertake R&D and commercialise new products.

Traditionally, farmers participate in field experimentation. Their involvement in innovation generation of projects is supported within the RDP (Chapter 5). Concerning the R&D innovation in the food industry, the most important role of the Swedish Food Federation (Livsmedelsföretagen)³ – which has approximately 900 member companies, representing all types and sizes of companies in the food industry – is to address and highlight present and future challenges.

Government

The government plays a role in the governance and funding of the agricultural innovation system, by setting policy, monitoring the implementation of programmes and evaluating policies. In Sweden, monitoring and evaluation mechanisms are the same for all policies, but the evaluation of research is the responsibility of research institutions. Given the importance of innovation for regional development, regional governments also play a role in the agricultural innovation system, as outlined in Box 6.3.

**Box 6.3. Regional role in food and agriculture innovation:
The example of the Västra Götaland region**

About 20 years ago, Region Västra Götaland (VG) was transformed from a County Council into a Region. Today, 14 of the 21 county councils in Sweden are constructed as regions. County councils have had their primary responsibility within health care. Regions still have the same obligations, but are also responsible for public transport, culture, regional growth and development, and infrastructure planning. The remaining seven county councils are scheduled to be formed into regions in 2019. This should result in a more coherent political structure at the regional level and better conditions for co-ordination of national and regional initiatives in the fields of food and agriculture.

Regions are obliged to follow the Act on the regional responsibility of development, which implies some regulations specifically related to food and agriculture. In Region VG, this implies:

- Develop, establish and co-ordinate a strategy for development at the county level. The food industry is identified a strategic area in the growth and development strategy towards 2020.
- Distribute the use of some public resources to regional growth. In Region VG these funds have included support for innovative firms in the food industry.
- Carry out tasks under the EU Structural Funds programme. Region VG has chosen to co-ordinate parts of the different structural funds and have decided to prioritise co-ordination of funds to food and the green sector. The VG region states that the main difficulty to co-ordinate on a regional level is the structure of the RDP due to its national perspective. Examples of ongoing projects are those focused on better matching education and demand for labour, Food Accelerator (*Livsmedelsacceleratoren*) and the Nordic Taste and Flavour Centre.

In Region VG, priorities are determined through the regional development strategy, but also a regional climate strategy. Food is one of four prioritised areas. About SEK 30 million were annually distributed to projects within the food and the green sector between 2013 and 2016. The new programme has about the same annual funding. The process of developing the National Food Strategy has spurred some other regions to also develop food strategies (e.g. Västernorrland, Halland, Skåne and Kalmar).

Since regions are responsible for development, they are also involved in the agricultural innovation system. The Region VG is an example of a region that aims to turn competencies into practice. The Research Institute RISE is located in the region and some universities and university colleges. They have a collaboration agreement between SLU and the region (Skara location), with the ambition to spread higher knowledge to firms in the sector. The region also gives annual long-term funding with the ambition to spur the creation of networks and collaboration. Examples of such platforms are *Agrovät*, *Lokalproducerat i Väst* and *Skolmatsakademien*.

There is also some collaboration between regions, but some regions wish to increase this in the future and it might be necessary for regions to access higher knowledge related to agriculture and food. Today, collaboration on these issues is far too fragmented. Innovation is another area with challenges. Some regions want a more holistic approach to innovation in order to include the entire food chain and with a more nation-wide coherent structure of regions, and management. However, the main difficulty is that Sweden has very heterogeneous regions with varying sizes, varying resources and different types of industry interests and hence with different regional priorities.

Knowledge and R&D organisations

Knowledge generators include universities, research institutes, government bodies and companies. Most public research in Sweden takes place in universities and most agricultural research is related to activities at the SLU. Research institutes have a limited role in the Swedish R&D system and there is no dedicated agricultural research institute, although the RISE network covers small agriculture-related activities. Some agriculture-related activities are also located at the National Veterinary Institute (SVA).

Universities

In Sweden, universities are the main actors in public research. There are around 50 university colleges, universities or other organisers of higher education, with at least one university and/or university college in every county. The Ministry of Education and Research is responsible for higher education institutions and research. The SLU is a central actor in knowledge creation related to the agricultural industry (Chapter 4). Besides the SLU, there are a number of other universities that contribute to knowledge for the food and agriculture sector.

Research centres

Apart from universities, some research institutes and private and public actors offer knowledge to the food and agriculture sectors. The agricultural sector has one major research centre, the AgriFood Economics Centre, which aims to act as a bridge between applied science and policy.⁴ It is financed by a SEK 10 million grant from the national budget and is a platform for co-operation between the SLU and Lund University. The two universities have been commissioned by the Government to conduct advanced economic analyses and evaluations in areas that come under the jurisdiction of the Ministry of Enterprise and Innovation, which include the fields of agriculture, food and fishing, within the Swedish and international contexts.

RISE is a network of research and technology organisations (RTOs) that are fully or partly publicly owned. The RTOs within RISE perform industrial research on innovation, but also carry out testing and certification. RISE consists of four corporate groups with 16 RTOs and their subsidiaries. In 2014, the RTOs within RISE had about 2 400 employees. RISE was originally founded in 1997 but became wholly state-owned in 2007. The purpose of RISE is to create a uniform and strong organisation around the gathering and creation of knowledge related to Swedish industries. Some of these RTOs are specifically related to the agriculture and food industries. In its new structure, RISE has six subdivisions: RISE Bioeconomy, RISE Built Environment, RISE ICT, RISE Life Science, RISE Safety & Transport, and RISE Certification. Some of these include RTOs that can be indirectly related to the agriculture and food industries.⁵ Since 2017, the Swedish Institute of Agricultural and Environmental Engineering (JTI) is part of RISE. Together with SP Food and BioScience, it now constitutes the Unit for Agriculture and Food at RISE.

Krinova Incubator & Science Park, located at the University of Kristianstad, is an innovation incubator investment created in 1998, which since 2013 has received basic funding from six municipalities in the County of Skåne. It is currently owned by the municipality of Kristianstad (80%) and the University of Kristianstad (20%). As a public company, all profits should be re-invested into projects that support regional growth.

Funding organisations

The six main funding organisations of the Swedish research system distributed over SEK 12.2 billion in 2016 (Box 6.4). The Swedish Research Council, which covers basic research, is the largest, accounting for over half of total funding (Table 6.2). With over 20% of total funding in 2016, the Swedish Governmental Agency for Innovation Systems, Vinnova, is the second largest organisation and mainly funds demand-driven research.⁶

Several of these research councils, foundations and research initiatives specifically target R&D related to food and agriculture, Formas and Vinnova being the most important. In particular, Formas is specialised in the areas of environment and agriculture, and accounted for about 10% of total research funding in 2016. Moreover, Formas is a major provider of funds for SLU research activities (Figure 6.2), and the SLU is the largest recipients of Formas funds, accounting for 23% of the total in 2015 (Table 6.A3). As in other universities in Sweden, SLU research funds mainly come from public sources.

In addition the Swedish Farmers' Foundation for Agricultural Research [*Stiftelsen Lantbruksforskning*] (SLF), created in 1996 by the Federation of Swedish Farmers (LRF) with the purpose of strengthening the agricultural sector's competitiveness, distributes SEK 57 million annually to support agricultural demand-driven research. The largest recipient is the SLU. The SLF was founded as an independent legal organisation receiving funding from both the LRF and the government.

Box 6.4. The main funding organisations of Swedish research

The Swedish Research Council (*Vetenskapsrådet*) is the largest funder of universities, university colleges and research institutes. It funds basic research within natural sciences, technology, medicine and human and social sciences. In addition to research funding, it performs research evaluation and advises the Government within all research areas, focusing mostly on basic research. It is expected to have a long-term perspective of knowledge accumulation. The authority is also responsible for national research communication issues and represents Sweden in several international organisations.

The Swedish Governmental Agency for Innovation Systems (Vinnova), created in 2001, is a Government agency under the Ministry of Enterprise and Innovation, which funds various research initiatives. Vinnova distributes funds mostly to demand-motivated research within technology, transport, communication and labour markets. Vinnova is also the Government's expert agency within the field of innovation policy, and it acts as the national contact agency for the EU Framework Programme for R&D. Vinnova's aim is to promote collaborations and to promote research and innovation development in Sweden. It has established collaboration with other research financiers and innovation-promoting organisations.

Swedish Energy Agency (*Energimyndigheten*) distributes funds to research, primarily in renewable energy.

The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (Formas) is the third largest funding organisation. It supports basic research as well as demand-driven research within the environment, agriculture and social planning. It works under the Ministry of Environment and Energy, but also receives funding from the Ministry of Enterprise and Innovation. Universities received about 80% of Formas funds, while research institutes receive about 14% in 2015 (Table 6.A4). Funding for research institutes has increased by over 80% since 2011, while funding for university was about 25% higher.

The Swedish Research Council for Health, Working Life and Welfare (FORTE) is a research council supporting basic research and applied research within labour markets, labour organisations, the working environment, health, welfare, public health, caring and social relations. Forte is a government agency under the Swedish Ministry of Health and Social Affairs. In addition to funding research, it is also responsible for evaluating the effects of research and how the results can be translated into practice. It is also active in the dissemination of knowledge.

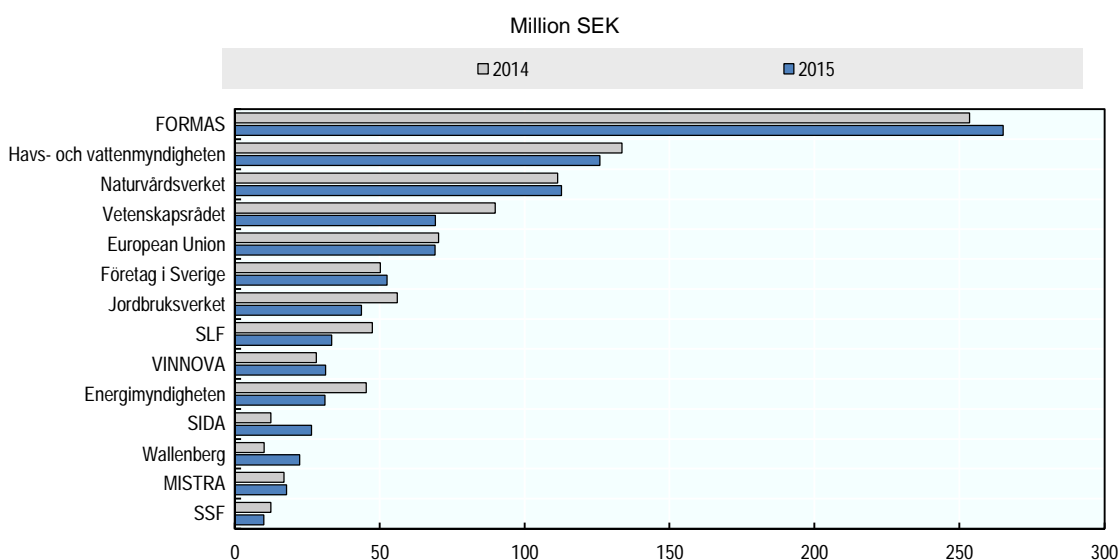
The Swedish Foundation for Strategic Environmental Research (MISTRA) focuses on issues that interact with the challenges of bringing about sustainable social development. MISTRA invests about SEK 200 million annually in various research initiatives with a focus on building inter-sectoral bridges. It evaluates its own contributions to research.

Table 6.2. Research funding, by main organisation, 2016

	Amount	Share in total
	SEK billion	%
Swedish Research Council	6.4	52.4
Swedish Governmental Agency for Innovation Systems (Vinnova)	2.6	21.3
Swedish Energy Agency	1.3	10.7
Swedish Research Council for Sustainable Development (Formas)	1.2	9.8
Swedish Research Council for Health, Working Life and Welfare (Forte)	0.51	4.1
Swedish Foundation for Strategic Environmental Research (Mistra)	0.2	1.6
Total	12.2	100.0

Source: Swedish Research Council (2016), *Forskningsbarometern 2016*, <https://publikationer.vr.se/wp-content/uploads/2016/10/Research-Barometer-2016.pdf>.

Figure 6.2. SLU's main funders, 2014 and 2015



Source: SLU, Annual report 2015.

StatLink  <http://dx.doi.org/10.1787/888933710268>

Knowledge and innovation intermediaries

Knowledge and innovation intermediaries are those sharing and spreading knowledge between actors. The Swedish farm advisory system is relatively fragmented and includes various public and private actors. The public sector has traditionally had an advisory role in the Swedish AIS and there are some important actors in relation to the agriculture and food sectors. The most important actor is the Swedish Board of Agriculture (SBA), which has developed a number of initiatives operating within the RDP. Most of these initiatives are related to developing competencies in rural areas. In the present RDP, support for competence development is available for four focus areas: agriculture competitiveness; animal welfare and shorter food chains; environment and climate in agriculture; and rural development (Chapter 5). Some specific initiatives of the SBA are given in Box 6.6. In the food sector, the National Food Agency plays a major advisory role, while local governments are in charge of policy monitoring and control (Box 6.6).

Box 6.5. Selected SBA initiatives to foster innovation in agriculture

The Focus on Nutrients Initiative (*Greppa Näringen*): This is a peer group initiative to change farmer behaviour as a first step towards meeting Sweden's national Environmental Quality Objectives (OECD, 2015). The project offers free of charge advice farmers on climate issues and plant protection application from advisors, and also an online advisory service that is available at all times. It is the largest single undertaking in Sweden to reduce losses of nutrients to air and water from livestock and crop production. The advisory service is co-ordinated by LRF, in collaboration with the SBA, county administrative boards and farm advisory firms. The project, which has started in 2001, is targeted at full-time farmers and currently has more than 10 000 members, covering about a third of arable land in the region. It is financed by the RDP and by redistributed environmental taxes. More than 50 000 farm visits have been carried out, performed by more than 250 advisors who are employed by 70 different advisory firms across Sweden.

Increased competitiveness in dairy production: This initiative is now terminated, but was active between 2010 and 2015 with a focus on dairy production. It was collaboration between the SBA, Swedish Milk and Växa. The purpose was to offer advices in strategic planning, business models, management and leadership, which were partly financed by customers (farms).

Sustainable young leaders/managers in firms in rural areas: This initiative focuses on leadership, management and entrepreneurship and to expand their knowledge networks.

Ung och Grön (Young and Green): An initiative from LRF, financed by the RDP, it is a joint initiative together with a number of actors such as Växa and CeFEO.

Box 6.6. Other knowledge and innovation intermediaries at national and regional levels

The National Food Agency (Livsmedelsverket) has an intermediary role in terms of knowledge of food quality, and is the authority on food control. It works towards healthy dietary habits, safe foods and fair practices in the food trade. To accomplish this, it uses regulations, recommendations and communication. It also provides competence and knowledge about environmental issues within the food sector, focusing on eco-smart food choices and reducing food waste.

Regional policy: The 21 Swedish counties have their own regional county board, each with a governor appointed by the Government. The county boards are charged with ensuring that each county achieves the goals within a number of policy areas set by the Government, while also considering their own regional conditions. According to the general county board instructions, they have a number of tasks, some of which are related to agriculture and the existence and functioning of the agricultural innovation system: food control, animal welfare control, veterinary issues; regional growth; infrastructure; energy and climate; cultural heritage; environment and conservation; agriculture and rural areas; and fisheries.

Regional development plans: In 2013, the government decided that each county administrative board should develop a regional development programme (RUP). Each county is responsible for creating a strategy for the long-term sustainable development of its region (RUS), in collaboration with actors in the county and relevant partnerships. Many counties also have a regional Innovation Strategy (RIS), sometimes also called the Smart Specialisation Strategy. These prioritise actions in order to build competitive advantages.

Municipalities perform much of the control related to environmental and health protection.

Private actors in the advisory system consist of several firms and consultants with varying competences and knowledge areas. There are also actors which are currently more at the periphery of the sector but which can act as potentially important actors in the future development of the sector. The largest private organisations are presented in Table 6.3.

Table 6.3. The largest knowledge and innovation intermediaries in Sweden

Intermediary actor	Core competence areas	Size	Activities (selection)	Main financial source
The Rural Economy and Agricultural Societies (<i>Hushållningssällskapet</i>)	Agriculture, food, environment, rural development, planning of farm buildings	17 independent associations 700 employees 40 000 members	College education, research, experimental farms, counselling. Stakeholders in national and international contexts.	
Växa Sverige AB	Dairy and meat	40 operational sites 500 employees 7 564 members	Service and counselling, education.	
LRF Konsult/LRF	Accounting, law, business modelling, work environment	130 offices	Service and counselling, education.	LRF, organisation with more than 90 000 small firms.
<i>Länsstyrelserna</i> (County Boards)	Environmental issues related to agriculture	21 (all) counties	Counselling.	Publicly financed
Farm and Animal Health (<i>Gård och djurhälsan</i>)	Health issues, efficiency in animal production	50 employees	Veterinary and production counselling, education	Owned by the industries: Svenska Köttföretagen AB, Sveriges Grisföretagare, Sveriges Nötköttproducent er and Svenska Fåravelförbundet.

There are several companies that provide advice to farmers (Box 6.7). Lantmännen and Svenska Foder on feeding strategies (selling feed), and advice on plant production and risk management on grain and feed, when offering forward contracts. Companies selling stable equipment provide the main advice on silos. De Laval and Leyly provide service and advice on robot milking equipment.

A number of research centres at universities aim to have close relationships with businesses to diffuse knowledge and innovation. Some of these are directly related to the agricultural and food sectors (Box 6.8).

Box 6.7. Examples of successful Swedish companies

Väderstad (www.vaderstad.com): Väderstad builds farm machinery. Their vision is to become a global supplier. They have experienced a rapid growth during the last decade with sales five-fold since year 2000. The five largest markets are Sweden, Germany, UK, France and the Russian Federation. They have 13 subsidiaries, mainly in Europe, but since 2016 they have one in Canada. In 2016, the turnover was EUR 200 million.

DeLaval (www.delaval.com/en-us/about-us): DeLaval is the worldwide leader in milking equipment, founded more than 130 years ago. It has 4 500 employees and operates in more than 100 markets. DeLaval, alongside Tetra Pak and Sidel, is part of the Tetra Laval Group.

Tornum (<http://www.tornum.com/en/about-us>): Tornum develops and manufactures grain facilities and has, with its experience and a strong brand, evolved into a market-leading global supplier. They collaborate closely with customers in both industry and agriculture.

Lantmännen (<https://lantmannen.com/en/>): Lantmännen is an agricultural co-operative and Northern Europe's leader in agriculture, machinery, bioenergy and food products. Owned by 25 000 Swedish farmers, has 10 000 employees, operations in over 20 countries and an annual turnover of SEK 40 billion.

Box 6.8. Research centres as knowledge intermediaries

RådNu is a regional actor (mostly southwestern parts of Sweden) but with the ambition to become a national actor to establish the demand for research into challenges in rural areas. Its purpose is to be a platform for research and competence development providing all kinds of advice. This initiative is a joint project between the Region Västra Götaland and the SLU.

KFC (Kompetenscentrum för Företagsledning): The centre was created in 2014/15 (at the SLU in Alnarp) and is a joint initiative between the Centre for Family Enterprise and Ownership at Jönköping International Business School and other parts of the SLU in Skara, Ultuna and Umeå. It is a strategic initiative with the aim of increasing knowledge about different aspects of business management to improve competitiveness.

CeFEO (Centre for Family Enterprise and Ownership): The centre was launched in 2005 and is a research and learning centre at Jönköping International Business School (JIBS). It is the first centre of its kind in Northern Europe and the aim is to further strengthen research into entrepreneurship and business renewal. The centre is interdisciplinary and international. There is strong collaboration between SLU Alnarp and JIBS/CeFEO.

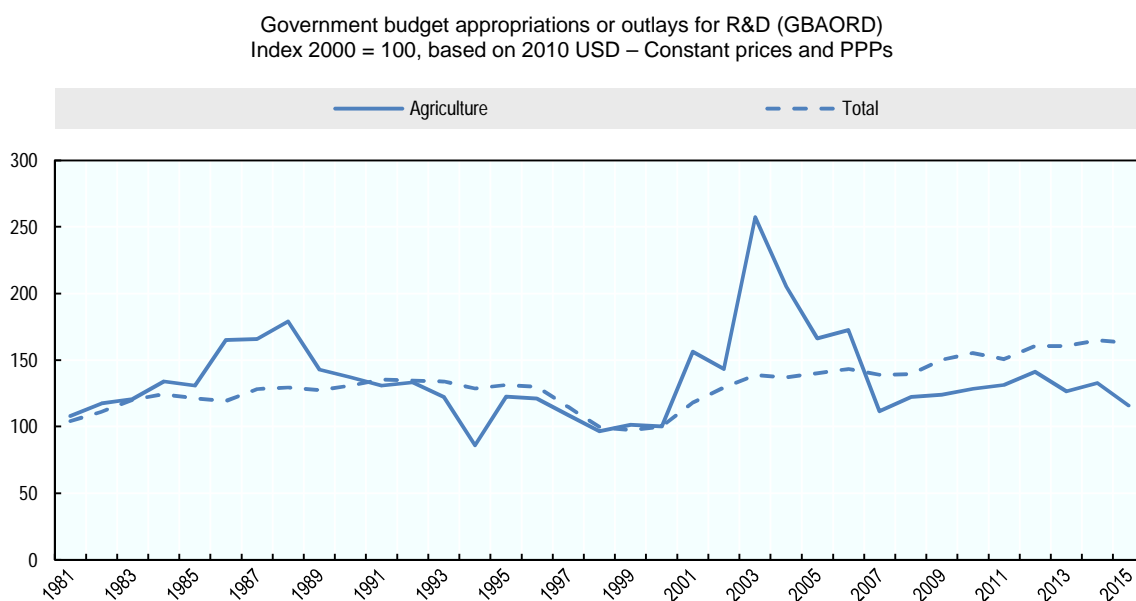
6.3. Public and private investments in agricultural R&D

The public sector continues to be the main source of funding for agriculture R&D, whether performed in public or private organisations. There are no specific provisions for funding agriculture research in Sweden, although one funding organisation specialises in agriculture-related areas. Business investment in R&D is normally driven by market demand, but governments also provide different kinds of incentives. There is information on the private sector's investment in research for the primary sector, but not for agriculture specifically. Some funding comes from a foundation created by the farmers' federation.

Trends in government funding for agricultural research

Government budget expenditures on R&D for agriculture are typically more variable than total R&D expenditure over time, reflecting changes in government priorities (Figure 6.3). Following record levels in the early 2000s, budget expenditures dropped in 2007, and despite some increases in following years, had not reached their 2005 level in 2016. The intensity of public expenditures on agricultural research is low and variable. The research intensity of budget expenditure on agricultural R&D – expenditure expressed as a share of agricultural gross value added (GVA) – was 0.9% in 2015 (and equal to economy-wide research intensity) compared to 0.5% in 1981 and 1.8% in 2005. Compared to neighbouring countries, public research intensity for agricultural R&D is much lower in Sweden (Figure 6.4).

Figure 6.3. Long-term developments in government expenditure on total and agricultural R&D, 1981-2015

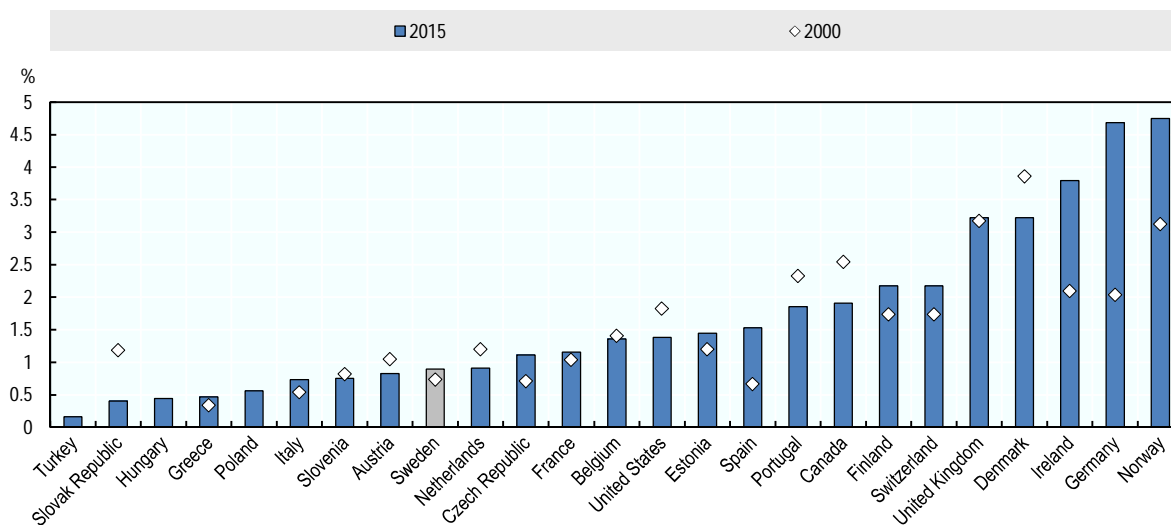


Source: OECD (2017), Research and Development Statistics, <http://stats.oecd.org/> (extracted in July 2017).

StatLink  <http://dx.doi.org/10.1787/888933710287>

Figure 6.4. Agricultural R&D intensity in selected countries, 2000, 2015

GBAORD as a percentage of agricultural value added



Notes. 2002 instead of 2000 for Estonia. Public expenditure on R&D is Government budget appropriations or outlays for R&D comes from OECD R&D Statistics, and value-added from OECD Gross Domestic Product statistics.

Source: OECD (2017), OECD statistics [Research and Development, OECD National Accounts].

StatLink  <http://dx.doi.org/10.1787/888933710306>

Public incentives to private investments in R&D

Most public support to private R&D is through direct funding, although some general provisions in the tax system can affect R&D, knowledge creation and knowledge spill overs including in food and agriculture. R&D tax rebates in Sweden apply strictly to research and not to development activities.

Deductions from employer contributions

Since 2014, all businesses, Swedish as well as non-Swedish, that pay employer contributions are allowed to make 10% deductions from the employer contributions for employees working with advanced research or development. The deduction can be made irrespective of the sector, size or type of business. Moreover, it does not matter whether the employees carry out R&D within the business itself or at another business.⁷

There is a further deduction related to specific support areas. Employers in support areas have the opportunity to make an extra deduction from the employer contributions. Support areas are the municipalities in inland Norrland and the northern parts of the counties of Värmland and Dalarna. However, due to EU regulations on state aid, this deduction is not possible for the transportation, agriculture, aquaculture and fishery sectors.

Donations for research to physical persons and legal entities

Until 2004, donations to research were deductible from taxable income or profit, making them relatively attractive as investments. However, with the abolition of the inheritance and gift tax in 2004, this advantage vanished. As for legal entities, it is permissible to deduct contributions to research if the research or technological development supported has or is likely to be of great significance to the contributor's business. This means that there is a general deductibility for contributions to research at universities, colleges and corresponding institutions. Overall, while other OECD countries encourage gifts and donations in various forms by reducing or exempting them from tax, in terms of both individuals and companies, Sweden has instead tightened the law.

6.4. Creating knowledge markets and networks

Intellectual Property Rights (IPRs), knowledge networks and knowledge markets are of growing importance in fostering innovation. Reinforcing linkages across participants in the AIS (researchers, educators, extension services, farmers, industry, NGOs, consumers and others) can help match the supply of research to demand, facilitate technology transfer, and increase the impact of public and private investments. Partnerships can also facilitate multi-disciplinary approaches that can generate innovative solutions to some problems.

Intellectual property rights for biological innovations

The characteristics of different types of IPRs used in Sweden to protect biological innovations are shown in Table 6.4. Following EU regulations, patents cannot be issued for new plant varieties or new breeds in relation to conventional biological processes. However, they can be granted if the invention is not specific to a specific sort of plant or specific breed. The Swedish Patent and Registration Office issues patents in their modern forms in line with the patent regulation (SFS, 1967).

Plant variety protection is similar to an issued patent. These rights declare that the party that has created a new plant variety has reserved all rights to it. The SBA issues these rights, and there is a requirement that the plant should be new, distinguishable, uniform and stable. The protection means that no other actor exempt breeders can use the specific plant or identical plant variations in any form. Sweden became a member of the international union for the protection of new varieties of plants in 1971 and signed the 1991 convention in 1998. As in many Northern European countries, IP protection in general, and patent protection in particular, is strong in Sweden (Figure 6.5).

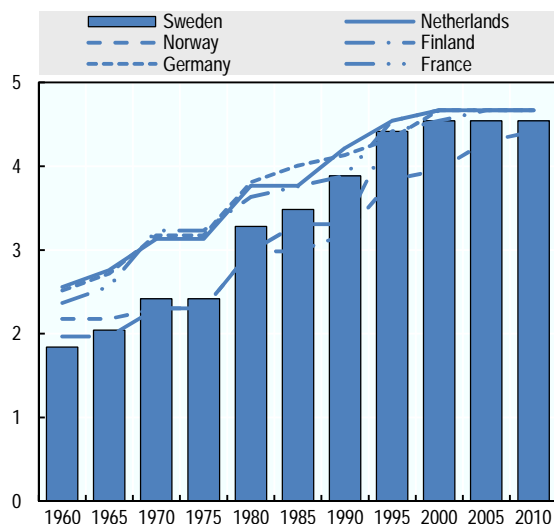
Table 6.4. Intellectual property rights

	Type of regulation	Year available	Length of protection
International trade	Deregulations of the agricultural market	1995	
Trade mark	Trade mark regulation 1960:644; 2010:1877	1960 with 2017 amendments	Ten years with the possibility to prolong
Patent	Patent regulation (1967:837)	1967 with 2016 amendments	Maximum 20 years
Plant varieties ¹			25-30 years

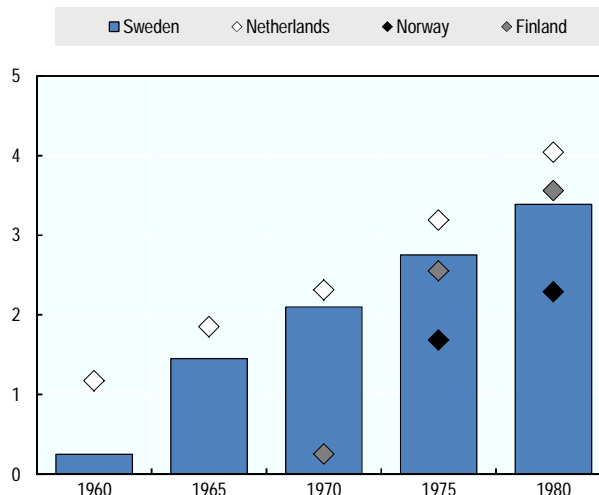
1. UPOV and European Plant Variety Rights Regulation, 2100/94.

Figure 6.5. Intellectual Property Protection

A. Patent Protection Index, 1960-2010
Score 1-5 (best)



B. Plant Variety Protection Index
Score 1-5 (best)

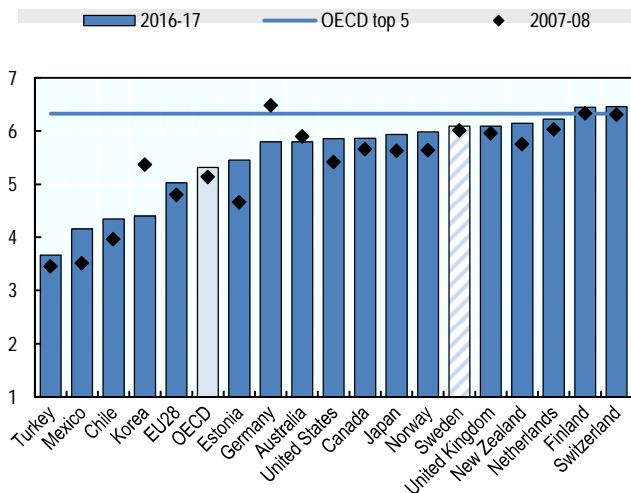


Sum of indices for duration, enforcement, loss of rights, membership and coverage.

Source: Unpublished update to the series from Park (2008), "International Patent Protection: 1960-2005", Research Policy, No. 37, 761-766.

Source: Campi and Nuvolari (2013): Intellectual property protection in plant varieties: A new worldwide index (1961-2011), LEM Working Paper Series, No. 2013/09 <http://hdl.handle.net/10419/89567>.

C. WEF Intellectual Property Protection Index
Score 1-7 (best)



OECD top 5 refers to the average of the scores for the top 5 performers among OECD countries (Switzerland, Finland, Luxembourg, Netherlands and New Zealand). Indices for EU28 and OECD are the simple average of member-country indices.

Source: World Economic Forum (2016), The Global Competitiveness Report 2016-2017: Full data Edition, Geneva 2016.

www.weforum.org/reports/the-global-competitiveness-report-2016-2017-1.

StatLink <http://dx.doi.org/10.1787/888933710325>

Public-private research collaboration

Participation in knowledge networks is important for business-level innovation and renewal, including for food and biotech (Tripl, 2011) and for small businesses in particular (Bjerke and Johansson, 2015). Combinations of different types of knowledge sources are also emphasised in the literature on innovation systems (Asheim and Isaksen, 2002; Bjerke, 2016).

In Sweden there are a number of prevalent collaborations and clusters of actors within the agricultural innovation system. Some are formally structured in clusters and some are memberships of international networks. The main collaborations and clusters are described in Table 6.5. In addition – as part of the SIA to foster partnerships between public, industry and academic actors – strategic five collaboration programmes were launched in 2016. One of these programmes – on the circular and bio based economy – is directly related to the agricultural innovation system.

Table 6.5. Examples on international, national and regional networks directly related to agro-food

Name of network	“Owner”	Purpose	Sector	Members	Location	Main activities
International / European						
Copa Cogeca			Agriculture	Farmers and co-operatives	Pan-European	Knowledge sharing, networks
Euro Dairy	EU	Increase the economic, social and environmental sustainability of dairy farming			Pan-European	Strengthen connection between science and practice
National						
Ideon AgroFood			Food		National and international	
Analysgrupp	Ministry of Enterprise and Innovation	Information across authorities	Inter-sectorial	Authorities in the ministry	National	Information meetings, knowledge sharing
Lean lantbruk (started in 2010)	LRF	Promote lean production in agriculture		10 actors; sector, SBA ¹	National	Education, ERFA (experience) groups ²
RISE						
Regional						
Vreta Kluster		Development of the green industry	Agriculture, forestry animals, food, renewable energy, aquaculture and gardening.		County of Östergötland	Business park, research, networks, support for business development and applications.
Grönt Kluster (Under construction)				County of Jönköping		Knowledge sharing, networks.

1. Swedish Board of Agriculture; 2. ERFA-groups are forum for focusing on a topic and exchanging experiences with each other.

Universities' external collaboration mechanisms

In recent years, the SLU has developed and implemented a new type of employment called *External Collaboration Specialists* with the aim of combining proficiency in research with extension activities in their subject areas. This type of employment is highly influenced by the US system. *External Collaboration Specialists* share their time between 50% own research and 50% collaboration activities. The collaboration is financed through joint university funds. The collaboration specialists have the opportunity to develop new tools for collaboration with the green sector but also within their own university and with other universities. An important mechanism is the “Student Desktop Researchers”, whereby specialists work together with students on smaller pilot projects in collaboration with SLU Holding, which adds much of the innovation intermediary perspective. Today, the SLU has 16 external collaboration specialists who are located at five places in Sweden (Skara, Alnarp, Uppsala, Umeå and Öregrund). Thus, in terms of geographical location of knowledge and possibilities of external knowledge spill overs, these specialists are highly concentrated. As agriculture becomes more knowledge-intensive, the importance of a location close to higher knowledge may be expected to increase (Bjerke, 2016).

Knowledge activities related to agriculture tend to move towards more densely populated areas as for all knowledge activities (Chapter 4). Therefore, knowledge activities taking place outside the research units (extramural activities) may be particularly important for rural development. Since Sweden has large regional variations in terms of production as well as consumption opportunities, extramural R&D can potentially ease these challenges. From a global perspective, the northern parts of Scandinavia are unique in terms of climate and agricultural conditions. The SLU has a department located in Umeå in order to capture these challenges related to regional variations, namely, the Department of Agricultural Research for Northern Sweden, and is organised jointly between the Faculty of Veterinary Medicine and Animal Science and the Faculty of Natural Resources and Agricultural Sciences. Research and education are carried out in an interdisciplinary environment in close collaboration between soil, plant and animal disciplines. Their research is applied in character with the aim of speeding up the practical value of research, within both agriculture and horticulture.

European Innovation Partnerships for Agricultural productivity and Sustainability (EIP-AGRI)

In addition to national networks, consortiums and competence centres, the European Innovation Partnerships (EIP) – launched in 2012 to contribute to the European Union’s strategy 'Europe 2020' for smart, sustainable and inclusive growth – support an interactive approach to innovation facilitating collaboration along the value chain. This innovation programme is discussed in Chapter 5, as some measures in the current RDP facilitate its implementation.

Collaboration related to innovation in firms

Collaboration may take place within the same industry, with a potentially close knowledge base. Alternatively, there may be collaboration with other industries or even with other sectors. According to the survey carried out by SBA during autumn 2016, the share of innovative businesses collaborating to innovate is slightly smaller within agriculture-related firms and the difference is statistically significant. The share of innovative businesses in the agricultural sector that tend to collaborate within their own industry is about 63%. The corresponding figure is 55% for businesses outside the agricultural sector, which may indicate potential partners within and outside the industry, but may also reflect a special type of collaborative culture.

6.5. International co-operation in food and agricultural R&D

International co-operation on agricultural R&D offers universal benefits. While this is generally true given the public good nature of many innovations in agriculture, it is particularly the case where global challenges are being confronted (as in the case of responding to climate change) and when initial investments are exceptionally high. The benefits of international co-operation for national systems stem from the specialisation it allows and from international spill overs. In countries with limited research capacity, scarce resources could then be used to better take into account local specificities.

Funding of international co-operation

A number of forms of international cooperation are specifically prevalent in the Swedish agricultural innovation system, and are often financed or operated through the main current research funding organisations, notably Formas. The main collaboration initiatives are outlined below:

- The *EU Horizon 2020* programme is an important collaboration platform on research and innovation. Most calls are for Research and/or Innovation projects for researchers and SMEs. The ERA-net Cofund instrument allows national research funders (e.g. Swedish Research Council, Formas) to collaborate around joint calls with EU co-funding to the national contribution. In the Horizon 2020, the ERA-net Cofunds related to the Agri-food sectors with Swedish participation has so far been calls in the SUSFOOD network, CoreOrganic network, Sustainable Animal Production (era-susan), Monitoring and Mitigation of Greenhouse gases (era-gas).
- The *EU Joint Programming Initiatives (JPI)*: Like the ERA-nets the JPIs are public to public partnerships with public research funding organisations/program owners. In the food and agriculture sector there are two JPIs with Swedish participation: JPI FACCE (Agriculture, Food Security and Climate Change) and JPI HDHL (Healthy Diet for a Healthy Life). The JPIs works for aligning national programmes and identify joint actions for European research in their strategic research agendas, useful also for the developing EU and national research programmes.
- Sweden is a member of the *International Institute for Applied Systems Analysis (IIASA)*. Membership is partly financed by Formas, which also represents Sweden in the member organisation. IIASA is an international academic institute that carries out research to resolve future challenges related to climate. The ambition is to use research within the institute as input for policy.
- Formas funds the *Nordic Bio-economy Programme*, which is operated by NordForsk. This is a joint investment between Sweden, Finland, Norway and Iceland with the purpose of producing more knowledge that can facilitate the transition to a bio-based economy. The research is organised in a number of Nordic Centres of Excellence, where researchers from at least three Nordic countries participate.
- Formas has also national responsibility for Sweden's membership of the *Nordic Committee for Research in Agriculture and Food (NKJ)* and is a board representative. NKJ's purpose is to identify research needs and strategic research agendas, and thus promote a knowledge-based agriculture and food sector in all the Nordic countries.

Nordic co-operation in food and agriculture

Nordic co-operation is a relevant platform for collaboration related to agriculture and food. The Nordic Research and Education ministers lead the Nordic governments' co-operation in research and education. The Council of Ministers helps to ensure that the Nordic countries have a leading position

as a knowledge region. The Nordic Council of Ministers' most important criterion for granting project funding is that the projects must benefit the Nordic countries and adjacent areas, and generate Nordic synergy. Some 500 projects and activities are launched and run per annum.

There are some programmes specifically related to agriculture and food. Among them, NordGens aims to ensure the preservation of genetic resources of farm animals, plants and forests in the Nordic countries and their sustainable use. NordGens office is located in Sweden. The New Nordic food is another programme which sponsors activities to promote the attractiveness of regional cuisines.

Agricultural universities and training of foreign agricultural scientists

SLU has a number of professional degrees, followed by about 80% of the programme students. However, several of the SLU programme degrees do not follow the same structure as the rest of Europe, making their status and the mobility of students rather problematic. The share of foreign students in food and agricultural degrees varies between 1% and 28%, depending on the area of research. It is usually higher in food-related topics than agricultural ones (except horticulture).

Indicators of R&D co-operation

As in many Nordic countries, the share of publications related to agriculture and food with foreign co-authors is higher than the OECD and EU average, reflecting the integration of Swedish researchers in EU and Nordic networks. Conversely, the share of agri-food PCT patents with foreign co-authors is lower than average, as in Finland and Norway (Table 6.6).

Table 6.6. Agriculture and food R&D co-operation, 2006-11

Agriculture food outputs with foreign co-authors as a share of total agriculture and food outputs (%)

	Sweden	Denmark	Finland	Germany	Netherlands	Norway	EU15 average	OECD average
Patents	7.8	22.1	5.4	12.0	16.7	10.3	17.0 ¹	12.7
Publications	62.9	64.3	52.3	55.2	65.1	59.9	57.7	50.8

1. EU28.

Source: OECD (2014), Patent Database, January 2014; SCImago (2007), SJR — SCImago Journal & Country Rank. Retrieved 19 March 2014, from <http://www.scimagojr.com>.

6.6. Facilitating the adoption of innovation in food and agriculture

The potential benefits of innovations are only realised if effectively implemented. Knowledge diffusion and adoption are one of the most difficult challenges in terms of R&D and the knowledge and innovation system. Policy incentives for the adoption of innovation include a wide range of regulatory and financial approaches, including business investment support, and support to public-private co-operation arrangements and participation in networks. In primary agriculture, training, extension and advisory services can facilitate the transfer and successful adoption of innovation (OECD, 2014a; SOU, 2015).

Given the very large number of often-small farmers, extension services have a particularly important role to play. They are critical in facilitating farmers' access to technology and knowledge and in farmers' effective participation in innovation networks and ability to formulate their specific demands, in particular to support diffusion of innovation in small agri-food firms. In many countries, farmers often rely on advice from various public and private actors to innovate. There are indications that firms in rural areas are even more dependent on their ability to collaborate with others in order to be innovative, and this means that they are even more dependent on effective infrastructure (Bergman, 2017; Bjerke and Johansson, 2015).

Performance of farm advisory services

The low density and long distances in rural areas poses governance and evaluation challenges of the Swedish farm advisory system. Many actors in the agricultural innovation system acknowledge the need to strengthen the link between basic research, applied research and advisory services to improve the impact of research. In some areas in particular, advisory services are poorly related to frontline research. A report from the Swedish Government suggests that universities and university colleges can, and should have, a greater focus on competence development for agricultural industries in the future (SOU, 2015).

Between 2014 and 2016, a number of action plans were created in order to address some of the major challenges that some agricultural industries are facing. Table 6.7 summarises the main findings and outcomes of these action plans. Many of the industries have to tackle similar challenges. Beef and lamb are both industries that lack vertical co-ordination. This may be a result of producers combining their production with other types of production, resulting in lower demand for advisory services. The fruit and vegetables sector has a closer relationship with the end-consumer, and producers are more specialised. This suggests that the horticulture sector is far more developed than other agricultural sectors in terms of leadership, management and market knowledge, including through vertical co-ordination (SBA, 2016).

Table 6.7. Action plans created during the period 2014 to 2016

	Producer/owner of action plan	Suggested main need	Suggested actions	Results
Dairy	Government, industry and local authorities	Advisory services but no means to finance access at the firm level	Subsidised advisory services for firms in crisis, with a focus on business management	LRF Mjök was tasked with developing this action further
Pork	Industry, government and authorities	No coordinated organisation for advisory services on production	Diversified advisory services for (basic and front-runners)	Svenska Pig was given the task of developing this further and creating a network. All suggestions were lacking funds
Beef	Industry, government and authorities	Monitoring and management tool for beef production	Produce tools and create best-practice farms	Difficulties with coordination since almost all beef producers combine beef production with other agricultural activities and buy other types of advisory services related to them
Lamb	Industry, government and authorities	Increased number of advisors, creation of monitoring farms	Development groups, develop monitoring tools	Similar problems to those described for beef
Fruits and vegetables	Industry and government	International benchmarking	Education and coordination	Industry

There have been a number of evaluations directed towards advisory services and government support for capacity building (Gruppen, 2007; SBA, 2016; ECA, 2015; Skåne, 2015). The reports contain detailed analyses of the situation, but there are some main conclusions:

- Evaluations of government support for competence development suggest that farmers' needs are not sufficiently taken into account.
- Younger farmers and animal producers express high demand for competence development and also have a relatively high willingness to pay for these services.

- Farmers mostly appreciate individual advisory services.
- Larger farmers need sophisticated advisory services, in leadership, risk management, markets, entrepreneurship and production processes.
- For many farmers their main source of knowledge is other farmers.
- The RDP could allocate funds to develop better methods for knowledge diffusion.

Mechanisms to facilitate the commercialisation of innovation

Some innovation support targets small and medium sized enterprises (SMEs). Vinnova's grant support schemes for innovation in SMEs are under a new umbrella programme, "Innovation Projects in Companies", which is targeted at the early development of high-risk companies working on a novelty in the industry with international potential. Vinnova has also launched a pilot innovation vouchers scheme targeting SMEs (OECD, 2016a).

In 2009, the government set up (with public funding) eight non-sector specific Innovation Offices at Swedish universities. Offices were set up at another four universities in 2012. The innovation offices take an active role in the innovation system by giving support in terms of commercialisation of research ideas with innovation potentials. They also inspire research towards a more innovation-oriented path. One of these innovation offices, SLU Holding, is directly related to agriculture and associated sectors, and is located in the university.⁸

SLU Holding is an independent limited company that is fully owned by the SLU, with the primary task of supporting knowledge-intensive innovations within the green sector. SLU Holding has three types of main activities to: i) provide innovation support, guidance and evaluation of ideas coming from the SLU; ii) invest financially in ideas/start-ups in the early development stage; and iii) provide business support for the SLU's strategic plans and future investments.

In cases where innovators related to the SLU are at a start-up phase of firm creation, SLU Holding can make direct investments or assist with finding external financing. In addition to capital investment, the SLU also provides expertise. Today, the SLU is active in six holding companies addressing varying interests.

In 2016, the SLU created a Green Innovation Park in order to create an innovation environment in Ultuna, open to all companies and research organisations. There are currently 40 companies located in this park, as well as the SLU and the National Veterinary Institute. The park is close to Uppsala University with its high technology laboratories and Biomedical Centre. This Green Innovation Park is expected to be attractive to small and large businesses and service companies, as well as manufacturing companies. Today, it is a joint venture between the SLU and real estate Academic House with support from the Regional Council of Uppsala, Uppsala and the European Union

6.7. Innovation performance in food and agriculture

R&D outcomes

Overall progress to create and adopt relevant innovations can be usefully monitored, including using proxy measures, such as the number of patents or bibliographic citations (OECD, 2014a). It should be noted, however, that although the number of patents is an informative proxy, it is not a comprehensive indicator of the outcomes of the innovation system, as not all innovations are patented, not all patents are used, other IPR systems exist for plant varieties, and trade secret knowledge, rather than patents, are frequently used for food processing innovations. In addition, numbers must be complemented with indicators of patent quality.

In 2015, the agriculture-related sciences with the highest number of publications were Ecology, Environmental science, Plant science, Forestry science and Veterinary medicine (Table 6.8). The SLU

contributed to a high share of Swedish publications in Agricultural sciences, dairy, and animal sciences, Plant production, Forestry and Soil Sciences.

Table 6.8. Number of publications for the top ten agriculture-related research areas in 2015

	Number of published articles	Average citation (normalised for research field citation), 2010-14	SLU share of Swedish publications within the research area, 2010-14 (%)
Ecology	164	1.64	31
Environmental science	152	1.37	18
Plant science	103	1.53	41
Forestry science	92	1.20	68
Veterinary medicine	91	1.50	73
Genetics	52	1.14	10
Agricultural sciences, dairy, and animal sciences	51	1.22	87
Plant production	49	1.33	73
Biochemistry and molecular biology	49	1.30	7
Environmental technology	41	0.82	12
Soil and water	38	1.35	64

Source: SLU annual report (2016), <https://internt.slu.se/globalassets/mw/org-styr/planering-utveckling/uppfoljning-utvardering/SLU-arsredovisning-2016.pdf>.

According to agricultural patent applications filed under the Patent Co-operation Treaty, which protects inventions in all signatory countries, and data on publications and citations, Sweden is below the EU and OECD averages for its contribution to world research on food and agriculture (Table 6.9). The share of agri-food related patents in the country's total number of patents is lower than the EU15 and OECD averages. As in many other countries, most patents are in food processing rather than agricultural science. Compared with neighbouring countries, Sweden has also lower specialisation in agricultural and food sciences, except in terms of citations. Its contributions to world agricultural and food sciences are lower than the share of the sector in GDP.

According to a government report, the quality of Swedish agriculture and forestry research and veterinary research is comparable to that in other natural sciences in Sweden. In the early 1980s, it was also high by international comparison, at about 80% above the international average. This has now decreased and was about 25 to 30% above the international average for 2009 (GOS, 2008).

Table 6.9. Agriculture and food R&D outcomes, 2007-12

	Sweden	Denmark	Finland	Germany	Netherlands	Norway	EU15 average	OECD average
Agro-food specialisation: Agro-food science outputs as a share of country's total (%)								
Patents	3.6	11.3	3.4	4.4	8.8	10.3	6.9	5.6
Publications	7.9	10.2	9.7	6.4	6.9	11.4	8.4	9.4
Citations	20.4	8.7	9.3	16.9	6.4	11.0	1.8	11.9
Country's contribution to world agro-food science output (%)								
Patents	0.4	0.5	0.2	2.7	1.0	0.1	0.6	0.7
Publications	1.2	0.9	0.8	4.5	1.6	0.8	1.9	2.0
Citations	1.4	1.1	0.8	5.7	2.8	0.7	2.4	2.4

Source: OECD Patent Database, January 2014; SCImago. (2007). SJR — SCImago Journal & Country Rank. Retrieved March 19, 2014, from <http://www.scimagojr.com>.

Improving the agricultural innovation system to foster adoption

As described above, there are evaluations of support to competence provision in the RDP, but no evidence considering the effects in terms of productivity and efficiency. Existing surveys emphasise the demand for knowledge and advisory services among firms in specific industries in the agricultural sector (SBA, 2016). Box 6.9 contains the recommendations related to the performance of the AIS in the final report from the Committee on Rural Development (SOU, 2017), and from the Report on competitiveness in the agricultural and horticultural sectors (SOU, 2015).

Box 6.9. Recommendations of recent evaluation reports regarding the AIS

The Committee on Rural Development prepared a report to analyse the **effectiveness of government policy for rural development** in the last 40-50 years (SOU, 2017). The final report, presented in January 2017, includes 75 suggestions for future rural policy, a number of which relate directly to knowledge and innovation for rural firms within and outside the agricultural sector. The suggestions pertain to the following areas:

- Increasing access to capital and giving more rural responsibility to incubators and financiers. More specifically, to address the need for more financial capital in the sparsely and very sparsely rural areas procedures. The Committee therefore proposes proposals to strengthen the assignments to Almi Företagspartner AB, Saminvest AB and Vinnova for that they will work for business development in these rural areas. Almi will focus even more on locally-owned industries and Saminvest will be commissioned to ensure investment in Sweden seven northern-most counties
- Strengthening the whole chain of innovation, from research to firm/farm. Expanding the present subsidy system within the RDP and EIP.
- Strengthening the export infrastructure in rural areas.
- Improving digitalisation/broadband.
- Providing deductions on transportation.
- Increasing accessibility to knowledge and knowledge creation.

In 2015, the Government presented a report analysing **competitiveness in the agricultural and horticultural sectors** (SOU, 2015). Suggesting a strategy and measures for developments up until 2030, the report included a number of important observations:

- Good competitiveness in the crop industry.
- Weak competitiveness in parts of livestock production.

- Generally weak profitability, but higher in large farms.
- A relatively small part of the firms account for a large part of production.
- There are large differences within the country, with a strong move towards fewer but larger firms in southern and central plains areas; and fewer but not always larger firms in southern and central forest areas.

The report presented a number of suggestions for strategic policies, which have played an important role in the creation of the Swedish food strategy. The main challenges for knowledge and innovation in agriculture to be taken into account in the 2017-20 Research and Innovation Bill were also outlined: Being able to compete requires regularly acquiring new knowledge and innovation, as well as updating products, methods, processes and organisations. This places great demands on actors within research, advisory services, education, the business sector and development. It also places demands on the knowledge and innovation system. The strategy needs to be attractive for private Swedish and foreign actors to invest time and money in research and development.

Needs-driven research and priority areas: The Inquiry considers that more public funds should be allocated to needs-driven research to strengthen the competitiveness in the sector. Better production processes, entrepreneurship and market knowledge are examples of prioritised knowledge areas. The Inquiry therefore makes the following proposals:

- That the instructions of the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (Formas) be amended so that, to a greater degree, the Council can help ensure that research contributes to increased competitiveness.
- That the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning and the SLU be instructed to report more clearly on the share that goes to needs-driven research and which needs are met by this research.

Increased private involvement and collaboration: Private companies and industry organisations need to increase their involvement in the knowledge and innovation system and improve their procurement skills. The institutes need to become stronger within the agricultural and horticultural sector. The Inquiry considers that greater strategic co-operation is needed among actors in the knowledge and innovation system. There needs to be more co-operation between the business sector, higher education institutions, institutes, advisory services and government agencies. The Inquiry proposed that:

- the SLU be instructed to report the scope and effect of co-operation with the business sector, and also the tasks of the institutes.
- The SLU, together with relevant business and public sector organisations, be instructed to produce a special programme for industry-based doctoral students.
- the Government should engage the OECD to analyse the Swedish knowledge and innovation system in the agricultural and horticultural sector, including the future role of the Swedish University of Agricultural Sciences.

Skills provision and advisory services: Companies providing advisory services play an important role in the knowledge system as a bridge between academia and the business sector. To strengthen competitiveness, the advisory services must function better. The Inquiry therefore makes the following proposals:

- That the SLU, together with Swedish and international experts, be instructed to analyse and present proposals on how higher education can strengthen skills provision for primary production.

In addition, the Inquiry emphasises the following assessments:

- Companies providing advisory services, which generally are small and have limited resources to invest, should develop skills in areas that are strategic to both expert knowledge and entrepreneurship.
- Skills provision should be facilitated by improving the opportunities for admission to vocational higher education institutions, including for those changing profession.
- It is important that it is possible to combine natural resource use programmes at upper secondary schools with post-secondary studies, while at the same time practical knowledge remains important.
- It is important that there is a higher degree of national co-ordination of skills development and advisory measures in the RDP.

Previous evaluations of the RDP have specifically emphasised the need to make innovation support more efficient since this is the most important factor in terms of enhancing agricultural innovation (see **Box 5.2** in Chapter 5; Rabinowicz, 2013). Since the sector is composed of many relatively small firms, many of them may also be assumed to experience difficulties in making large strategic R&D investments. This may justify a specific innovation support system directed towards the Swedish agricultural sector, but with the emphasis on incorporating it into the innovation systems of other sectors. *Ex-ante* evaluations of the present RDP show only little, if any, effects or potential effects on innovation in agriculture and food.

Source: SOU (2015, 2017); Rabinowicz (2010, 2013); Sweco (2014).

Selected examples of adoption of innovation at the farm level

Some innovations have been important within the agricultural sector in recent times. Selected examples are discussed below. They resulted in changing the demand for knowledge on production and adoption of new technologies. Few other reports emphasise this need for new knowledge and highlight a number of weaknesses in the Swedish agricultural system. Through the technology shift, Swedish agriculture has dropped its ranking in terms of competitiveness from the perspective of knowledge (SBA, 2015a; 2015b). Farmers need to improve knowledge in management and leadership, mostly due to new technology and structural changes.

Milking robots

The first milking robots were introduced in Sweden in 1998, and by the end of 2012 there were 1 100 farms with robots, producing about 33% of total milk (Landin, 2014) in about 22% of the milk farms (Bergman, 2017). The investments related to these robots, such as the reconstruction of dairy plants, were largely financed through the RDP. About 288 dairy farms received investment support from the RDP in relation to automation of their dairy plants. From 2007 to 2009, the average investment in these farms was SEK 6 million (SBA, 2012). The average investment support from RDP was about SEK 1 million, i.e. about 16% of the total costs of investments.

Bergman and Rabinowicz (2013) studied the spread of the milking robot, using a survey with 800 respondent dairy farms. They found that about 16% of the farmers considered that the most important source of knowledge on whether or not to invest in technology was other dairy farmers. The second most important source of knowledge was the robot supplier. Advisory firms came third in this list. The authors also found that the likelihood of investing in new technology increased substantially when the farmer already had knowledge about new techniques and new technologies.

Reindeer herding

Reindeer herding has undergone a major technological development. Main changes concern transport and communication. However, it was not until the end of the 1970s that the snowmobile came into general production, reducing labour costs substantially. In the 1980s, the use of motorbikes and helicopters also became popular. Today, old and new technologies are used side by side. This is partly due to the very high costs of the new technology. At present, much of the new technology (satellites, and information technology) is being tested, even though reindeer herders suffer from insufficient communication infrastructure (low quality or absence of broadband). This willingness to try new technology may be one factor explaining why this sector is one of the most prominent in terms of applying for innovation subsidies in the RDP.

Innovation in the food industry

According to the Community Innovation Survey, food processing firms in Sweden are less innovative than all manufacturing firms. Close to half of them reported having introduced some innovation in 2012-14 compared to 57% for all manufacturing firms (Figure 6.6). The share of innovative firms among food processing firms is lower in Sweden than in Finland, France, Germany, Italy, Norway, and the United Kingdom for example, but it is higher than in Denmark or Estonia (Figure 6.7). In international comparison, the gap between food processing and all manufacturing firms is also relatively large in Sweden.

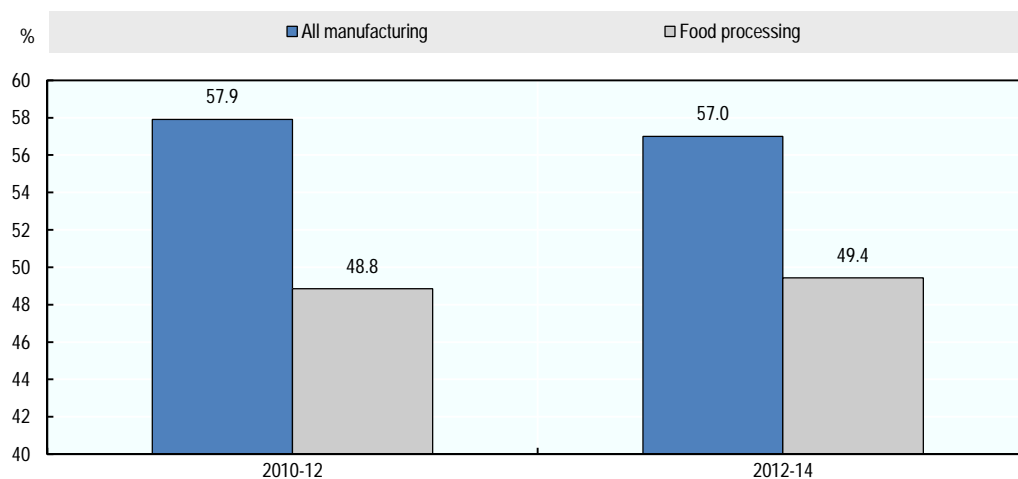
Innovation in food and agricultural firms

In the second half of 2016, the SBA carried out a national innovation survey which was very similar to CIS, but with broader coverage of Swedish firms (i.e. including smaller firms). The SBA survey of 2 000 respondents included firms of all sizes, both within and outside the agricultural sector. The aim

was to analyse innovation activities in rural and urban areas and in agricultural and non-agricultural firms.

The SBA survey also found that the share of innovative firms is lower among agricultural firms than among non-agricultural ones (Table 6.B1). For all types of innovations, about 42% of the agricultural firms report themselves as being innovative whereas 50% of the non-agricultural businesses consider themselves to be innovative. Moreover, the share of innovative firms is 10 percentage points higher in urban areas than in rural areas. In both cases, differences are statistically significant.

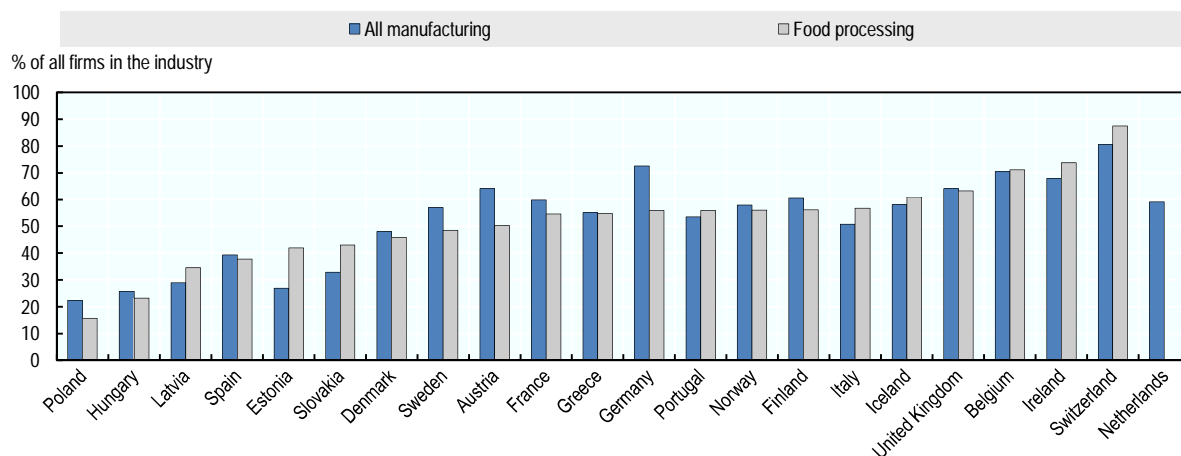
Figure 6.6. Share of innovative firms in Sweden



Source: Statistics Sweden (2017), Education and Research, Community Innovation Survey, www.scb.se/en/finding-statistics/statistics-by-subject-area/education-and-research/.

StatLink  <http://dx.doi.org/10.1787/888933710344>

Figure 6.7. Share of innovative firms in selected countries, 2014



Source: Eurostat (2017), 2014 Community Innovation Survey, <http://ec.europa.eu/eurostat/data/database> (extracted in September 2017).

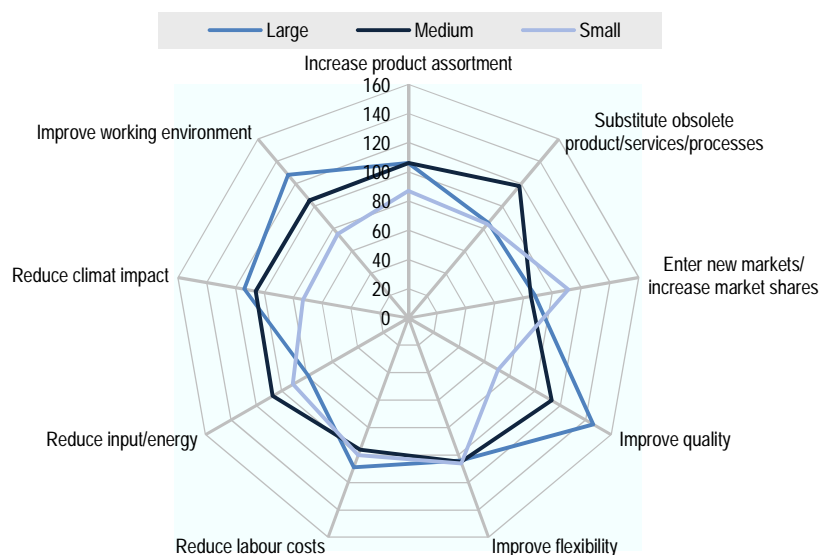
StatLink  <http://dx.doi.org/10.1787/888933710363>

For firms within agriculture, the main reasons to innovate are to “improve quality” as well as “reduce labour costs”, “reduce climate impact” and “improve working environment”, while to “substitute obsolete products” or “increase product range” seem to have relatively little significance for innovation activity at these farms (Figure 6.8). Businesses outside the agricultural sector responded that the main reason for innovation is to “improve quality” and “improve the work environment”, as well as “to enter new markets” (Figure 6.9). At first glance, the comparison suggests that non-agricultural firms are more focused on products/services, while agricultural firms are more focused on innovations related to the product and production process, such as health and safety, environmental impact and labour costs.

Concerning barriers to innovation, about 4% of the non-innovative, non-agricultural firms indicated that they made significant efforts to innovate (Table 6.B2). This is about the same share as for farms. However, there is a large difference (statistically significant) between the two in terms of whether or not they are making any efforts at all. Above three-quarters of farms are not making any effort at all, compared to two-thirds of non-agricultural firms. In both cases, this share can be considered relatively high.

When asked what have been the largest obstacles to innovation, non-innovative respondents mentioned the reliance on a previous innovation as the main reason for both groups of firms (Table 6.B3). A lack of innovative ideas is the reason that has the least importance for firms outside the agricultural sector. Minimal competition is the largest reasons for agricultural businesses not engaging in innovation. For the majority of the on-innovative firms (both agriculture and non-agriculture) lack of capital and credit does not seem to be a significant barrier to innovation (Table 6.B4).

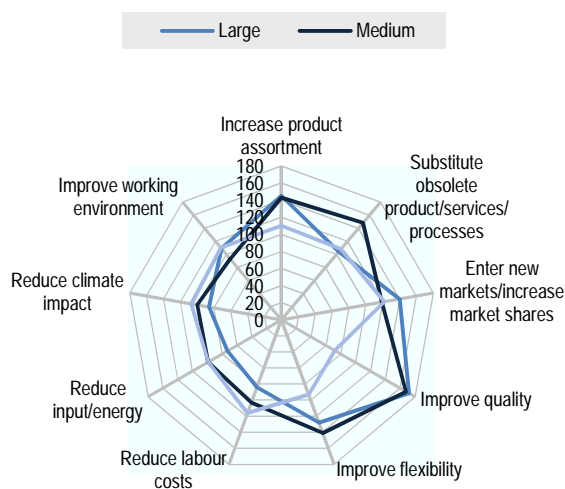
Figure 6.8. Reasons for innovation: Agriculture



Source: SBA innovation survey.

StatLink  <http://dx.doi.org/10.1787/888933710382>

Figure 6.9. Reasons for innovation: Other businesses



Source: SBA innovation survey.

StatLink  <http://dx.doi.org/10.1787/888933710401>

Innovation can help improve the environmental performance of firms. When asked whether the innovation they introduced will have environmental benefits, a larger share of agricultural businesses responded positively compared to non-agricultural firms (Table 6.B5). Lower use of energy, emissions and nutrient leakages were mentioned by over 55% of agricultural respondents, and higher biodiversity by over 60% (multiple answers were possible). Some of these environmental benefits are directly linked to business competitiveness, such as less material consumption and reduced energy consumption. Others are more difficult to directly connect to corporate immediate competitiveness, such as the promotion of biodiversity or reducing emissions of greenhouse gases.

Among businesses outside the agricultural sector, the reduction of energy consumption and energy efficiency accounted for the largest share of answers, both of which can possibly have a direct effect on business competitiveness. This is also the top answer for agricultural businesses, in 1996 followed by innovations that enhance biodiversity. One explanation for this is, of course, related to natural farming being located near the site-specific natural resources and close to nature and biological resources.

Notes

1. The low number of patents filed by universities is due to the “professor's privilege” that entitles researchers (instead of institutions) to patent their inventions (Figure 6.1).
2. On average, about half of public funding for R&D goes directly to universities and university colleges. The remainder goes to Research Councils or civil and defence authorities (Swedish Research Council, 2016).
3. The organisation is a member of the Confederation of Swedish Enterprises (Svenskt Näringsliv) and FoodDrinkEurope.
4. The AgriFood Economics Centre has replaced the Swedish Institute for Food and Agricultural Economics, a former governmental agency under the Ministry of Agriculture.
5. OECD (2016a) contains an evaluation of RISE.
6. Beside the six main organisations presented in Box 6.4, there are several authorities that also finance research in different areas. For these actors, only a minority of their total budget is assigned to research funding.
7. Corporate groups are considered as one company and not as many individual firms.
8. These are the locations of the remaining innovation offices: Chalmers (Innovationskontor Väst), Gothenburg University, Karolinska Institutet (Innovationskontoret vid Karolinska Institutet); KTH Royal Institute of Technology (Interact); Linköping University (InnovationskontorEtt); Luleå University of Technology (LTU Business AB); Lund University (Innovationskontor Syd); Mid Sweden University (Fyrklövern); Stockholm University (Innovationskontoret); Umeå University (Innovationskontor Norr) and Uppsala University (UU Innovation).

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Annex 6.A

Background tables and graphs

Table 6.A1. Government Bills on research 1975-2016

Year	Name	Priorities related (directly and/or indirectly) to agriculture and food
1975	Regeringens proposition om forskningsrådsorganisationen inom utbildningsdepartementets verksamhetsområde	
1978	Regeringens proposition om vissa frågor rörande forskning och forskarutbildning	
1982	Regeringens proposition om forskning m.m.	Ecological causalities and land ecology Food: production, consumption, diet, food policies
1986	Regeringens proposition om forskning	New production methods in agriculture and horticulture Environment, climate Biotechnology
1989	Regeringens proposition om forskning	Environment, natural resources and energy
1992	Forskning för kunskap och framsteg	European Union and European collaboration
1996	Forskning och samhälle	Ecological production and horticulture Collaboration on rural development
2000	Forskning och förnyelse	Ecological- and sustainable production
2004	Forskning för ett bättre liv	Environment and sustainable development Innovation
2008	Ett lyft för forskning och innovation	Research quality Energy
2012	Forskning och innovation	Innovation Competition Sustainability
2016	Kunskap i samverkan	Agenda 2030 Fossil-free production Sustainability Circular and bio-based economy Sector collaboration

Table 6.A2. Budget expenditure on R&D by policy area, 2005-16

SEK Million

	2005	2010	2014	2015	2016	Annual change 2005-16
All areas	23 775	29 470	32 871	33 132	34 389	4.1
Agriculture, forestry, hunting and fishery	521	469	510	441	509	-0.2
Industrial activity	1 293	1 037	930	1 219	1 334	0.3
Energy and water supply	552	1 465	1 450	1 352	1 620	17.6
Transport and telecommunications	718	1 538	1 410	1 305	1 462	9.4
Living environment and spatial planning	185	221	273	355	409	11.0
Physical environment and natural conservation	525	542	661	494	554	0.5
Health care	226	560	575	689	784	22.5
Social environment and security	105	377	579	335	344	20.8
Culture, media and leisure	212	65	49	73	83	-5.5
Pedagogics	162	197	56	66	93	-3.9
Work environment	223	133	171	169	182	-1.7
Public management	480	195	145	258	285	-3.7
Exploration of the earth and the atmosphere	169	206	122	318	337	9.1
General scientific development	13 963	20 691	24 732	24 193	25 458	7.5

Source: Statistics Sweden (2017), Education and Research, www.scb.se/en/finding-statistics/statistics-by-subject-area/education-and-research/.

Table 6.A3. Disbursed research funds from Formas by recipient, 2015

	Disbursed	Share of all funding	Change since 2011
	'000 SEK	%	%
Universities	958 974	79.9	24.6
SLU	276 607	23	
Lund University	113 096	9.4	
Chalmers School of Technology	98 381	8.2	
Gothenburg University	84 411	7	
KTH Royal Institute of Technology	71 881	6	
Uppsala University	70 811	5.9	
Stockholm University	64 036	5.3	
Umeå University	60 629	5.1	
Research Institutes	163 307	13.6	80.7
Forestry Research Institute of Sweden	39 994	3.3	
Stockholm Environment Institute	39 455	3.3	
IVL The Swedish Environmental Research Institute	27 936	2.3	
SLF The Swedish Farmers' Foundation for Agricultural Research	32 600	2.7	
Other governmental authorities	44 655	3.7	50.8
The Swedish Research Council	14 388	1.2	
Sweden's Innovation Agency	13 317	1.1	
Academies of sciences	11 739	1	37
International organisations	10 285	0.9	-49.5
Other	11 110	0.9	-23
Total funding	1 200 070	100	

Source: Formas Annual Report 2015.

Annex 6.B

Innovation in food and agricultural firms: Survey results

Table 6.B1. Share of innovative firms, 2016

	Share of all firms in each category (%)
Share of innovative agricultural firms	42
Share of innovative non-agricultural firms	50
Share of innovative firms located in urban municipalities	51
Share of innovative firms located rural municipalities	41

Source: SBA innovation survey.

Table 6.B2. Non-innovative businesses' efforts to innovate during the last three years, 2012-15

As a % of all non-innovative respondents

	Non-agricultural	Agricultural
Yes, large efforts	4.3	4.4
Yes, small efforts	27.2	16.1
No efforts	67.3	78.0

Source: SBA innovation survey.

Table 6.B3. Significance of different reasons for Not introducing an innovation during 2012-15 for agricultural and non-agricultural businesses

As a percentage of all respondents

	Low demand for innovations in the market	No need, due to previous innovations	No need, due to very little competition	Lack of innovation ideas
Non-agricultural				
Large	13	17	10	7
Medium	11	11	10	10
Small	15	11	15	12
No significance	46	47	50	55
Agricultural				
Large	9	10	6	9
Medium	9	9	11	15
Small	12	11	12	12
No significance	55	57	58	51

Source: SBA innovation survey.

Table 6.B4. Significance of different obstacles in terms of not carrying out innovations during 2012-15, for agricultural and non-agricultural businesses

As a percentage of all respondents

	Lack of capital	Lack of credit	Lack of competence	Difficulties related to subsidies and public support for innovation	Lack of collaboration partners	Lack of innovation support	Uncertain demand for the innovation ideas	Too much competition in the market
Non-agricultural								
Large	11	5	4	7	4	5	6	7
Medium	7	5	10	6	9	6	11	10
Small	11	13	13	12	14	11	12	14
No significance	63	68	65	59	63	61	57	58
Agricultural								
Large	13	7	4	8	7	4	6	8
Medium	13	8	12	9	9	11	11	11
Small	8	9	14	8	11	11	11	12
No significance	61	70	63	60	66	62	59	61

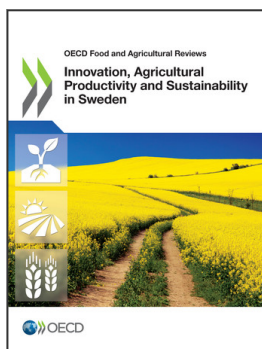
Source: SBA innovation survey.

Table 6.B5. Environmental benefits of the innovations during 2012-15

As a percentage of all respondents

	Non-agricultural			Agricultural		
	Yes	No	Do not know	Yes	No	Do not know
Less use of material and/or water	34.7	63.2	2.1	48.3	50.2	1.5
Reduce use of energy	45.9	51.7	2.3	62.7	36.5	0.7
Reduce emissions of greenhouse gases	37.8	58.9	3.3	55.1	42.4	2.5
Less emissions to air, water and soil, less noise	36.8	60.7	2.5	58.1	40.0	2
Substituted fossil fuels with renewable sources	23.6	73.6	2.7	43.4	55.4	1.2
Reuse waste, water or material for own use or for sale.	29.8	68.2	1.9	42.9	56.4	0.7
More sustainable products	40.3	56.8	2.9	41.9	54.9	3.2
Reduce leakage of nutrients	20.5	75.0	4.5	57.8	40.4	1.7
Promote biodiversity	23.4	72.3	4.3	60.3	37.5	2.2
Less use of plant protection, more safe use thereof	18.6	78.7	2.7	52	46.6	1.5
Increase visibility of cultural heritage	18.4	77.7	3.9	51.2	46.1	2.7
Other	22.1	75.6	2.3	24.5	73.5	2

Source: SBA innovation survey.



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