OECD Food and Agricultural Reviews

Innovation, Agricultural Productivity and Sustainability in Sweden

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BETTER POLICIES FOR BETTER LIVES

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Foreword

Innovation, Agricultural Productivity and Sustainability in Sweden is part of the OECD Food and Agricultural Reviews series. This review was undertaken at the request of the Swedish Ministry for Enterprise and Innovation and it examines the conditions in which farms and businesses undertake innovation in the food and agriculture sector to become more productive and environmentally sustainable.

The review begins with an overview of developments in the food and agriculture sector and outlines the challenges and opportunities it faces (Chapter 2). The range of policies which influence the incentives and conditions for innovation are then examined: economic stability, governance and trust in institutions, the regulatory and tax system, and investment framework (Chapter 3); the capacities and public services that enable business development, including infrastructure, rural development, labour market, and education and skills policies (Chapter 4); agricultural policy (Chapter 5); and the operation and functioning of the agricultural innovation system (Chapter 6). The findings from the review are summarised in Chapter 1 and policy recommendations are advanced.

The analysis of this review follows the framework developed by the OECD Trade and Agriculture Directorate in response to a request from the G20 in 2012 under the Presidency of Mexico to evaluate the extent to which a range of policies can facilitate productivity growth and sustainability in the food and agriculture sector. This framework has been applied to studies on Australia, Brazil, Canada, the Netherlands, Turkey, the United States, and Estonia. Additional reviews are underway or planned.

This review was prepared by Dimitris Diakosavvas, with contributions from Michael Ryan (Chapter 3), Clara Frezal (Chapter 4) and Catherine Moreddu (Chapter 6). It draws heavily on a comprehensive background report prepared by experts from the Swedish Board of Agriculture, led by Joel Karlsson. Lena Lind from the Ministry for Enterprise and Innovation was the overall co-ordinator. At the Swedish Board of Agriculture, Mari Andersson, Lina Bjerke, Helena Elofsson, Knut Per Hasund, Johan Holmer, Joel Karlsson, Pasi Kemi, Cecilia Koch, Karin Lothigius, Svante Nilsson, Lars M. Widell, and Karolina Åsman provided the information for the background report.

Valuable comments from OECD colleagues were greatly appreciated, including those from Carmel Cahill, Charles Cadestin, Jared Greenville, Olga Melyukhina, Emily Gray, Morvarid Bagherzadeh, Urszula Ziebinskaf, Franck Jesus, Julien Hardelin, Frank van Tongeren, Christophe André and Jose Enrique Garcilazo. Theresa Poincet provided secretarial assistance. Michèle Patterson prepared the report for publication and co-ordinated its production. Wilfrid Legg, formerly OECD staff, provided editorial assistance.

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This review was declassified by the Working Party on Agricultural Policies and Markets in March 2018.

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Acronyms

AIS	Agricultural Innovation System
AWU	Annual Work Unit
BPS	Basic Payment Scheme
CAP	Common Agricultural Policy
CO_2	Carbon dioxide
CDI	Challenge Driven Innovation programme
CMO	Common Market Organisation
EFAs	Ecological Focus Areas
EC	European Commission
EPA	Environmental Protection Agency
EPS	Environmental Policy Stringency
EFSA	European Food Safety Authority
EIP	European Innovation Partnership
EIP-Agri	European Innovation Partnership for Agricultural Productivity and Sustainability
EU	European Union
EU15	European Union countries prior to 1 May 2004
EU-N13	The 13 countries that joined the European Union from 1 May 2004
EU28	European Union
FAO	Food and Agriculture Organization of the United Nations
FORMAS	Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning
FVO	Food and Veterinary Office
FDI	Foreign Direct Investment
FORTE	Swedish Research Council for Health, Working Life and Welfare
FTE	Full-time equivalent
GMOs	Genetically Modified Organisms
GCI	Global Competitiveness Index
GDP	Gross Domestic Product
GEDI	Global Entrepreneurship and Development Institute
GHG	Greenhouse gas
GSSE	General Services Support Estimate
GVC	Global Value Chains
GOS	Government Offices of Sweden
ICT	Information and Communications Technology
IEA	International Association for the Evaluation of Educational Achievement
IIASA	International Institute for Applied Systems Analysis
IP	Intellectual Property
IPP	Intellectual Property Protection
IPR	Intellectual Property Rights
JPI	EU Joint Programming Initiatives
kg	kilogramme
LU	Livestock unit
KemI	National Chemicals Inspectorate
LRF	Federation of Swedish Farmers
MPS	Market price support
MEI	Ministry for Enterprise and Innovation
MISTRA	Swedish Foundation for Strategic Environmental Research

NGO	Non-Governmental Organisation
NKJ	Nordic Committee for Research in Agriculture and Food
OIE	World Organisation for Animal Health
OECD	Organisation for Economic Co-operation and Development
PCT	Patent Co-operation Treaty
PIAAC	Programme for the International Assessment of Adult Competencies
PISA	Programme for International Student Assessment
PMR	Product Market Regulation
PPP	Public-Private Partnership
R&D	Research and Development
RIA	Regulatory Impact Assessment
RISE	Research Institutes of Sweden Holding AB
RCA	Revealed Comparative Advantage
RDP	Rural Development Programme
SME	Small and Medium Sized Enterprise
SIA	Strategic Innovation Agendas
SIO	Strategic Innovation Areas
SIP	Strategic Innovation Programmes
SPP	Sustainable Public Procurement
SBA	Swedish Board of Agriculture
SFS	Swedish Code of Statutes
SCA	Swedish Chemicals Agency
SIS	Swedish Innovation System
SLU	Swedish University of Agricultural Sciences
SNFA	Swedish National Food Agency
SVA	National Veterinary Institute
SEC	Swedish Environmental Code
SEPA	Swedish Environmental Protection Agency
SOU	Swedish Government
SSIC	Swedish Species Information Centre
STA	Swedish Tax Agency
TIMSS	Trends in International Mathematics and Science Study
TFP	Total Factor Productivity
UAA	Utilised Agricultural Area
UN	United Nations
UNFCCC	UN Framework Convention on Climate Change
USDA	United States Department of Agriculture
VAT	Value Added Tax
VINNOVA	Swedish Governmental Agency for Innovation Systems
VISS	Water Information System Sweden
WBG	World Bank Group
WEF	World Economic Forum
WGI	Worldwide Governance Indicators
WTO	World Trade Organisation
WWA	Public Water and Wastewater Plant Act

Executive summary

The Swedish food and agriculture sector has achieved steady growth in productivity and sustainability, but significant challenges remain

Since joining the European Union (EU) in 1995, Sweden has promoted EU and domestic agricultural policy reforms to move towards a more market-oriented and sustainable agricultural system. These policies are aimed at achieving high levels of environmental performance and animal welfare while also ensuring high productivity and financial viability for farmers, and lowering government expenditures. Over the years, these policies have led to a high level of confidence by Swedish consumers and citizens in the overall performance of their agricultural and food system.

Agricultural total factor productivity (TFP) has increased since 1995 – growing at a slightly higher rate than the EU28 average over 1995-2016 – due mainly to structural changes including the concentration of production on fewer but larger and more efficient farms. Efforts to accelerate this trend are being made through more targeted research and education to facilitate adoption of new, state-of-the-art technologies. This can help overcome the inherent disadvantages of location and climate in Sweden, in addition to the country's high labour costs, taxes and the costs associated with compliance to strict domestic rules with respect to environmental and animal welfare standards.

Sweden was one of the earliest OECD countries to raise awareness of environmental issues and develop environmental policies. Farmers are required to undertake and pay for environmental impact assessments for a wide range of agricultural activities, in particular for intensive poultry and animal husbandry. The result has been progress in decoupling environmental pressures from agricultural production as measured by reduced intensity of nutrient surpluses and of GHG emissions even while total agricultural production has remained relatively stable.

Framework conditions are enabling innovation and entrepreneurship

Sweden's economy is innovation-oriented and competitive resulting in excellent performance. Making growth more sustainable, inclusive and green is a key overall objective. The Swedish Innovation System (SIS) benefits from a strong and stable macro economy and institutions, along with a high quality of life and significant gender equality. The SIS also benefits from strong human resources and its science base, high investment in R&D and good positioning in international networks.

Sweden is one of the world's leading economies in exploiting opportunities of digitalisation through the Information and Communications Technology (ICT) infrastructure. Public institutions facilitate a sound business environment through protection of property rights, an independent judicial system, and low level of business and administrative corruption. Moreover, there are few barriers to trade or foreign direct investment.

Untapped potential to further improve productivity and competitiveness throughout the food and agriculture sector provides challenges and opportunities

Some sectors in the agriculture and food system need to improve productivity growth in order to become competitive: Sweden does not have a comparative advantage in food and agriculture production, although there is a high degree of heterogeneity and some sectors, such as vegetables and the downstream food supply chain, perform relatively well. The food supply chain functions well, but

there are concerns about the high market concentration in the Swedish retail food industry. Achieving sustainable TFP growth for the agricultural sector requires continued structural adjustments and well-targeted investments, so that farmers can adopt new or improved technology to help offset high production costs.

The Agricultural Innovation System (AIS) is mostly integrated in the SIS framework, but *research is not well connected with the needs of the agriculture and food sector*. The rate of innovation is estimated to be lower in agriculture and food processing than elsewhere in the economy. Government efforts, however, to strengthen education, research and innovation are on-going to encourage the adoption of new cost-reducing technologies, while at the same time maintaining high environmental sustainability, food safety and animal welfare standards.

Regulations are more stringent than EU requirements. National legislation sets norms and standards for food safety, environment and animal welfare that are well above EU requirements in many areas of agriculture and horticulture, particularly in relation to the types and permitted uses of pesticides, the use of antibiotics in animal production and welfare requirements (housing, space, and husbandry) associated with livestock production. These regulations are complex and costly to implement. They reflect consumer and citizen preferences, and Swedes are willing to pay a premium to partly offset the additional administrative and financial costs of producers. A high priority for the government is to simplify their implementation, and reduce the administrative burden and compliance costs that fall to farmers.

A *coherent national rural policy* is needed as existing programmes and investments are not effectively mobilised to improve well-being or promote growth in rural areas. There is no clear framework or mechanism to adapt national policies to the needs and circumstances of the diversity of rural areas. The national governance and funding arrangements of the 2014-20 Rural Development Programme (RDP) also differ from many regional growth policies, thereby impeding smooth co-ordination of investments between national and regional growth policies.

Key recommendations

Overall agri-food strategy

Accelerate implementation of the Swedish Food Strategy platform to better account for the knowledge and innovation needs in agriculture.

Agri-food policies and regulations

Sweden should continue to promote modern technologies in the food and agriculture sector and engage with stakeholders to raise productivity while maintaining high environmental, food safety, animal health and welfare standards that reflect societal preferences for a balanced and sustainable regional development within an open trading system.

Identify appropriate policy measures that target the development of agricultural activities that are potentially financially viable, as well as those that ensure the provision of sufficient collective or public goods (environmental, cultural, social values) provided by agricultural activities.

Advocate the implementation of performance-based, national agricultural policies that reflect the diversity and uniqueness of Sweden's agri-environment, within the broad guidelines agreed to at the EU level.

Reduce government support of agricultural incomes and increase farmer returns from the market by investing in more research and development, encouraging further integration of agriculture into SIS.

Reduce administrative and compliance costs by simplifying domestic environmental, animal and crop health, and animal welfare regulations that go beyond EU regulations.

Assess whether concentration in the food retail markets impedes competition through, for example, the Swedish Competition Authority.

Establish a scientific council on animal welfare as suggested in the 2017 Food Strategy.

Environmental sustainability

Ensure that environmental and climate change concerns continue to be taken into account when developing and assessing policies that can contribute to productivity and competitiveness.

Encourage performance-based evaluation of policies and implement measurable indicators of performance.

Apply the polluter-pays-principle more systematically to hold farmers accountable for all harmful environmental effects from crop and livestock pollution; for example, by adding taxes on fertilisers and issuing penalties where these contribute to water pollution.

Strengthen efforts to provide targeted and tailored advice to farmers on sustainable technologies and practices.

Capacities and services to boost innovation

Implement and facilitate pro-active skills policies, life-long learning, and labour mobility to alleviate shortages of high-skilled workers in the agro-food chain, and to better identify current and future skill requirements of the sector.

Prioritise inter-generational renewal in agriculture by developing tailor-made schemes that target young Swedish farmers. Assess the extent to which land regulations, taxation, inheritance law, territorial planning and agricultural policies impede generational renewal.

Establish a mechanism to engage with stakeholders with the aim of improving the coherence of rural development policy.

Strengthen the socio-economic foundation of the rural economy by stimulating the bio- and circular-economy in sustainable agricultural, forestry and agri-forestry business models.

Fully connect farmers and rural population to the digital economy by ensuring reliable high-speed internet access across all rural areas and upgrading the people's skills and business practices so that they can fully benefit from these new technologies.

To counter the declining number of students enrolled in agri-food courses strengthen the co-ordination between agricultural educational institutions and the agri-food industry, and facilitate discussions between education and knowledge institutions and the industry so as to identify the skills needed for future development.

Agricultural Innovation System (AIS)

Strengthen linkages between basic research, applied research and the industry by undertaking the following actions.

- *Develop a long-term strategy for research and innovation in the food and agriculture* chain by clarifying the institutional roles of SBA, SLU and RISE, establishing a platform to co-ordinate their tasks, or by merging them within RISE (the Research Institutes of Sweden Holding AB); creating a national council to monitor R&D policies of institutions; setting up a national agricultural research institute to carry out applied R&D; and assessing the effectiveness of current funding allocations to research councils and universities.
- *Encourage active participation by stakeholders, producers and the industry* in RISE, EU EIP-Agri and international networks to transfer innovation in agricultural practices, which focus on agri-food research and innovation on knowledge-intensive high-tech areas.
- *Ensure that farm advisors* are well-trained, and are in possession of the most up-to-date practical knowledge and skills.
- *Strengthen research evaluation* by improving the internal system for quality assurance.
- *Develop indicators and tools* to evaluate performance and monitor the rate and quality of innovation in the food and agriculture sectors. In addition to traditional indicators on efforts (e.g. R&D expenditures) and outcomes (e.g. number and quality of patents), such indicators should include impact (e.g. the rate of innovation adoption, total factor productivity (TFP) and environmentally adjusted TFP growth, and agri-environmental indicators).

Chapter 1

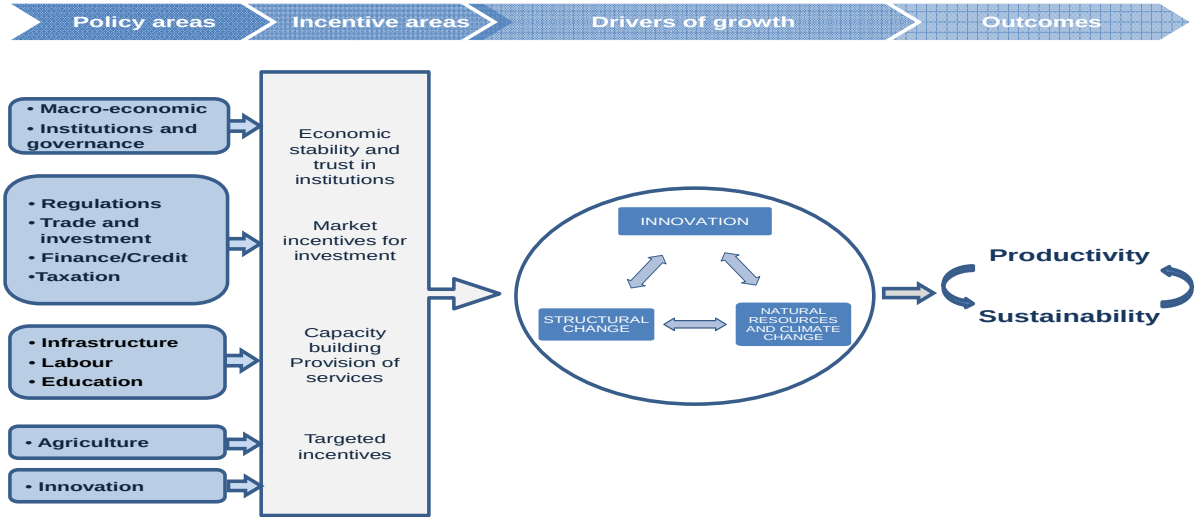
Overall assessment and recommendations

This chapter summarises the findings of the review and presents policy recommendations to foster productivity and sustainability in the food and agriculture sector in Sweden. Policies are examined using a framework developed by OECD to analyse the extent to which a country's policies support innovation, productivity growth, structural change and sustainable use of natural resources in the food and agriculture sector.

A framework for analysing policies for innovation, productivity and sustainability in the food and agriculture sector

Improvements in agriculture productivity growth are required to meet the growing demand for food, feed, fuel and fibre, and these must be achieved sustainably by using natural and human resources more efficiently. A common finding is that a wide range of economy-wide policies affect the performance of the food and agriculture sector, and need to be considered alongside agriculture-specific policies. The framework used to review policies in Sweden considers policy incentives and disincentives to innovation, structural change, and environmental sustainability of agriculture and climate change impacts on agriculture, all of which are key drivers of productivity growth and the sustainable use of natural resources (Figure 1.1).

Figure 1.1. Policy drivers of innovation, productivity and sustainability in the food and agriculture sector



Source: OECD (2015).

This review begins with an overview of the characteristics and performance of the food and agriculture sector and the challenges that it faces (Chapter 2). A wide range of policies is then considered according to the main channels or incentives through which productivity growth and environmental sustainability are impacted. These include: economic and institutional environment (Chapter 3); capacity building, including provision of essential public services (Chapter 4); agricultural policy, domestic and trade related (Chapter 5); and the agricultural innovation system (Chapter 6).

Challenges and opportunities to increase productivity and competiveness of the food and agriculture sector

The key challenges for the Swedish food and agriculture sector are to ensure that innovations strengthen productivity in ways that maintain high standards of environmental sustainability, and balanced regional development within an open trading system.

Since joining the European Union (EU) in 1995, Sweden has endeavoured to support and implement EU and domestic agricultural policy reforms to move towards a more market-oriented and sustainable agricultural system aimed at achieving high levels of environmental performance and animal welfare, while also ensuring high productivity and financial viability for farmers, with lower government

expenditure. As a result, Swedish consumers and citizens have high confidence in the quality and safety of food within their country.

While Sweden does not have a comparative advantage overall in food and agriculture production, there is a high degree of heterogeneity and some sectors, such as vegetables and the downstream food supply chain are competitive. Although there is untapped potential to improve agricultural productivity to supply the domestic market, innovation is estimated to be lower in food and agriculture businesses than elsewhere in the economy. In this respect, efforts to strengthen education, research and innovation are on-going to encourage the adoption of new cost-reducing technologies, while at the same time maintaining high environmental sustainability, food safety and animal welfare standards.

The food and agriculture sector is a small and decreasing part of the Swedish economy in terms of output and employment. Structural changes in agriculture over time have resulted in a sharp decline in the number of farmers, and farms have become larger and more specialised. The food supply chain is well functioning, but there are concerns about the high concentration in the Swedish retail food industry, although consumers benefit from the resulting economies of scale as well as from smaller specialist retailers supplying niche food markets.

Since Sweden joined the European Union, total factor productivity (TFP) for the agricultural sector as a whole has grown at a slightly higher rate than the EU28 average over 1995-2016. Labour productivity growth is the main source of TFP gains as labour has been increasingly substituted by capital, often embodying the latest technologies. Livestock production, particularly of pigs, milk and beef, has declined since 1995, while in other sectors such as vegetables, grains and poultry broiler, production has increased.

The growth in agricultural TFP is mainly due to structural changes such as the concentration of production in fewer, larger and more efficient farms, and the government is making efforts to accelerate this trend through more targeted research, education and the adoption of new, state-of-the-art technologies. This can help to overcome the inherent disadvantages of location and climate in Sweden. Achieving sustainable TFP growth for the agricultural sector requires a continuation of structural adjustments and well-targeted investment, so that farmers can adopt new or improved technology to help offset high production costs that otherwise impact on financial viability and the ability to invest in innovative techniques.

Input costs are largely determined outside the food and agriculture sector and the low productivity growth in some agricultural sectors in Sweden is due to the high share of input costs in production. Sweden's disadvantages in agricultural productivity relative to other EU Member states are linked mainly to the constraints related to climate and location, large capital investment costs in infrastructure – such as housing and stables for animal husbandry – labour costs and taxes. High labour costs are nevertheless driving forces to incentivise investment in new technology. The difference in cost of production between Sweden and other EU Member states is also important, due to the specific domestic rules with respect to environmental and animal welfare standards that require corresponding infrastructure, auditing and certification of farms, although they are partially offset through price *premia* paid by consumers. These factors explain why Sweden's trade deficit of agro-food products has grown over the years, mainly due to an increase in imports of processed foods. The European Union and, in particular, Nordic countries are the biggest markets for Swedish agricultural products. With the exception of grains, Sweden is a net importer of agricultural products.

Overall policy recommendation

- ***Accelerate implementation of the Swedish Food Strategy platform*** to better account for the knowledge and innovation needs in agriculture.

Framework conditions are enabling innovation and entrepreneurship

Sweden's economy is innovation-oriented and competitive

Sweden has a highly sophisticated and well-educated population that places high importance on environmental and animal welfare issues. It is a knowledge-driven economy with a strong and stable macroeconomic environment and well-functioning markets for goods, labour and capital. Inclusive and sustainable growth over the past two decades has underpinned a high quality of life for Swedes. Being well integrated into international markets has enabled the country to overcome the constraints of a small domestic market and peripheral geographical location.

Sweden is relatively open to trade and foreign direct investment, contributing to a competitive and business-friendly environment. However, there are some restrictions on the ownership of agricultural land by companies, as regulations and customs in Sweden favour farm ownership by individuals and families. Sweden encourages private sector R&D through a number of economic incentives, in the form of special grants and allowances specifically for employment in R&D activities. While social security contributions are reduced substantially for R&D employees, tax allowances for R&D only apply to employment in the private sector.

In Sweden labour taxes accounts for about 60% of total taxation, the remainder accounted by capital and consumption taxes. Farmers are subject to the same rules on taxation and social security as the rest of society. In addition there is an energy and carbon tax which is aimed at reducing fuel consumption, and, thus, improving the environment. The tax on agricultural diesel is amongst the highest across EU Member states.

The value of farmland in Sweden has been increasing due to rising demand (including from urban sources), the capitalisation of support into higher land values and low interest rates. There is a perceived need in Sweden to raise private investments in agriculture not only to increase food supplies, but also to raise the amenity value of the countryside for the urban population. The Swedish Land Acquisition Act favours the purchase of agricultural land by individual farmers rather than by "legal entities" so as to preserve the private ownership of farmland. However, due to low profitability in farming and the need for greater investment in the sector, the rules for land acquisition are under review to encourage a greater involvement of such "legal entities".

Regulations in Sweden are more extensive and complex than those in other EU Member states

The regulatory environment for entrepreneurship, including the food and agriculture sector, is governed by both EU and national legislation. Over time, Sweden's environmental policies have become very strict, as reflected in the OECD's environmental policy stringency indicator, now amongst the highest in the OECD area.

Sweden's environmental policy is defined by the "Generational Goal" framework, which sets out 16 environmental quality objectives. Its main purpose is to achieve a clean and healthy environment within one generation. In agriculture, the focus is to ensure a "varied agricultural landscape", reduce climate change impact and achieve zero eutrophication with specific guidance on the management of agricultural resources.

The Swedish Environmental Code and the EU's Environmental Impact Assessment Directive govern environmental standards for agricultural production. An environmental impact assessment is required for a wide range of agricultural activities, in particular, for intensive poultry and animals produced for food. The cost of the assessment is borne by the farmer. Although the number of regulations has declined over the last decade, the level and complexity of the regulations in Sweden are still onerous and well above those in other EU Member states.

National legislation tends to set norms and standards for environmental and animal welfare well above EU requirements in the food and agriculture sector, particularly in relation to the types and permitted

uses of pesticides, and the use of antibiotics in animal production, as well as animal welfare requirements such as housing, space, and husbandry practices. The Swedish Board of Agriculture (SBA) has recognised these concerns, and is currently reviewing these specific regulations with a view to simplifying them and reducing costs to farmers.

While Swedish regulations on the environment, crop production and chemical use, as well as animal health and animal welfare, reflect citizens' preferences and their willingness to pay, they are complex and costly to implement. In effect, the administrative and operational costs of implementing these higher standards are an additional burden on agriculture and food producers compared to farmers in other EU Member states.

While specific environmental, animal health and welfare requirements raise costs to producers, they can also act as a spur to the transfer of knowledge, technical know-how and innovations, which are aimed at encouraging a more resilient and sustainable agriculture and food sector. Nevertheless, a high priority of the Government is to simplify and relax the implementation of these regulatory measures, with a view to lowering both the administrative burden and compliance costs on enterprises in the food and agriculture sector. Greater acceptance of mutual recognition agreements across European countries, such as those on pesticides, is also likely to contribute to reducing the relative cost impact on Swedish farmers.

In Sweden, Genetically Modified Organisms (GMOs) are strictly regulated by a number of agencies. In agriculture, the SBA has primary responsibility for land-based genetically modified plants, animals, and the use of GMOs in animal feed. As regards the food sector, the Swedish Food Agency is primarily responsible for approving all new food products and validating the source of these products.

Regulations on products and processes in Sweden are largely determined at the EU level, whilst implementation, as in all EU Member states, is at the national level. In the food and agriculture sector, most of the legislation is harmonised with other EU Member states; in some cases, Swedish legislation takes precedence. Sweden has a long tradition for having higher standards than other EU Member states with respect to animal health and has a special “guarantee” in relation to salmonella standards and the use of antibiotics in agriculture. As a result, Sweden is salmonella “free” due to both its strict National Control Programme in production of animals for human and its favourable cool climate and low population density. Sweden has the lowest use of antibiotics in animal for human food production in the European Union and low incidence of resistant bacteria. Nevertheless, further reducing the need to use antibiotics and mitigating the increase in antibiotic resistance is a high priority for Sweden, as it is for the European Union and across the world.

In the area of plant health, Swedish regulations on plant protection products are stricter than the harmonised EU legislation. Some products used in the European Union are currently banned in Sweden due to environmental concerns. However, a 2014 audit by the Food and Veterinary Office (FVO) concluded that the system of mutual recognition is not correctly applied in Sweden, as Sweden does not accept the assessment of other EU Member states. With fewer plant protection products authorised in Sweden, the lack of access to important pesticides has increased the cost of production of some crops and has thus put Swedish producers at a cost disadvantage compared to farmers’ in other EU Member states. On the other hand, from a consumer perspective, food may be safer for human health in Sweden as a consequence.

Sweden maintains one of the highest standards on animal welfare in the European Union and globally. These standards cover all aspects of animal production ranging from housing to husbandry, transport and exercise space. While these requirements create additional demands and costs on livestock producers, they are a highly important aspect of food production in Sweden reflecting societal preferences. The Animal Welfare Act 1988 is very stringent, and in some cases, may impede opportunities for developing and adopting new innovations in livestock production. A new Animal Welfare Act is under discussion, and one of Sweden’s priorities is for stricter EU requirements on animal welfare across all member states.

Public institutions facilitate a sound business environment through protecting property rights, an independent judicial system, and a low level of business and administrative corruption

Sweden's governance model is recognised by the OECD for its efficient legal system in settling disputes, for government spending that is well targeted, and its transparency in decision making. Decentralisation in Sweden has largely been successful and beneficial to rural entrepreneurship and agri-food businesses; local governments are able to provide high-quality services and sub-national authorities are sufficiently equipped financially to undertake their tasks and meet expenditure responsibilities while ensuring equity in public service provision and welfare to all. There are nevertheless concerns about the availability and quality of rural services which are linked to the need to improve policy coherence.

Recommendations to improve incentives for private investment

- ***Efforts to simplify domestic regulations*** related to the environment, animal and crop health, and animal welfare that go beyond EU regulations by reducing administrative and compliance costs should be continued to be a priority. In particular, there is a need for better policy integration and collaboration between businesses in the food and agriculture sector, policy makers and regulators, so as to ensure that encourage the development and adoption of innovations and improve productivity and competitiveness of the food and agriculture sector.
- ***Strengthen efforts to focus agri-food research and innovation*** on knowledge-intensive high-tech areas including biotechnology, green energy, and food waste, and shorten and improve food and agriculture supply chains. Sweden, which does not have a comparative advantage in extensive agricultural systems, but has a highly developed knowledge economy, is well placed in this regard.
- ***Improve technology transfer across in the food and agriculture system***, in particular with the aim of enhancing access in remote regions.
- ***Assess competition and functioning of the food production and food retail markets*** through, for example, the Swedish Competition Authority.
- ***Consider establishing a scientific council for animal welfare*** as suggested in the 2016 Food Strategy.

Capacity and services for sustainable productivity growth could be further improved

The overall quality of transport infrastructure in Sweden compares well with other OECD countries. There are, however, major differences between types of transport. While the quality of port infrastructure is among the highest of OECD countries, the railway infrastructure needs to be improved – which would benefit the food and agriculture sector. In this regard, the government is currently engaged in a massive investment programme in transport infrastructure, mainly in roads and rail operations and maintenance. New infrastructure is generally funded by State grants. However, co-funding from counties, municipalities, companies, the European Union, and user fees or congestion taxes are also used.

Sweden aims to take a leading role in digital transformation. Almost all people in Sweden already have wired or wireless access to the Internet. However, for fast broadband, accessibility to 100 Mbit/s Internet is still lower in rural areas than in urban areas (which is not unique to Sweden). Regarding telephone ownership, the number of cellular telephones is above the OECD average.

A major strength of Sweden is the quality of its electricity supply, which is considered one of the best in the world. Over 50% of Swedish electricity is produced using renewable energy (mainly hydro power, biomass and wind power) with the objective to have an entirely renewable electricity system by 2040.

Agricultural land improvement infrastructure in Sweden mainly consists in drainage systems that cover around 80% of arable land. Upgrading the drainage system, which is in poor condition on a third of all arable land, is an important component in raising agricultural productivity and sustainability.

Labour market efficiency in Sweden is estimated to be above the OECD average. However, there is a clear lack of flexibility, as reflected by business analysts and leaders who perceive restrictive labour regulations as the second most problematic factor for doing business.

An important challenge faced by the Swedish labour market is the integration of new migrants and asylum seekers. Early migrants generally have a low level of education and literacy proficiency, which has resulted in high unemployment rates for this segment of the population. The government has already taken some steps in order to tackle this issue. Increasing the accessibility of the food and agriculture sector to immigrants has the potential to increase productive migrant employment and assimilation.

The quality of higher education and the training system is among the best across OECD countries. However, enrolment rates in tertiary education have been declining, mainly reflecting the homogeneity of employment rates among educational attainment level and the low earnings advantage of tertiary education.

Encouragingly, the trend of declining learning outcomes in Sweden over the past decade seems to have been reversed. The mean Programme for International Student Assessment (PISA) scores for 2015 has been above the OECD average. Swedish adults also recorded high scores in the Programme for the International Assessment of Adult Competencies (PIAAC) survey and exhibit some of the strongest ICT skills among OECD participants. Science and engineering play an important role in formal education in Sweden and are the main areas of studies in higher education and research.

Agricultural education is mainly provided through vocational and higher education programmes. However, the interest for agricultural studies is low and has been decreasing over the years. Some of the students with agricultural or food-related education end up working in other sectors. Nevertheless, there is a shortage of high-skilled workers in the agro-food chain: agriculture, horticulture, plant breeding and food processing. There is an increasing need for high-skilled workers with both theoretical and practical knowledge as well as entrepreneurial and managerial skills, especially in large agri-businesses. Workers need to be able to adapt to new technologies and rapid development in the industry. There is thus a need to better connect and integrate the labour skills and needs of the agro-food chain with the courses and training in the educational system.

Sweden has a long-standing tradition of environmental education, which starts at pre-school level and extend until higher education and research. This interest for environmental issues is also reflected in agricultural education where fields such as environment and natural resources have taken an increasing share of curricula.

Sweden needs to further improve the coherence of its national rural policy

About 70% of the Swedish population lives in urban areas. Rural areas are facing important challenges, such as an ageing workforce and economic outcomes that are generally lower than their urban counterparts. Availability and access to basic services has been decreasing in the most remote parts of the country, where the population is declining and provision of such services is more costly.

While the intention is to achieve greater equity in service provision across rural and urban areas – and there has been some success in this endeavour – there is a need for better policy and programme coherence to facilitate investment and promote growth in rural areas. There is lack of clarity in policies and no clear mechanism to adapt those delivered through sectoral ministries to the needs and circumstances of rural areas. The governance and funding arrangements for the Rural Development Programme (RDP) also differ from regional growth policy in many regions. This separation reduces opportunities to co-ordinate investments delivered through the regional growth policy and the RDP at the regional level. Moreover, the challenge of the very large regional diversity in rural conditions requires localised policy targeting, rather than across the board policies at the national level.

While Sweden has a well-developed regional growth policy framework, with a main focus on promoting equity between regions, the development of a new rural policy provides opportunities to improve the conditions for growth in rural areas.

Recommendations to improve capacities and services to boost innovation

- ***Implement and facilitate pro-active skills policies*** – through for example the creation of education councils for the sector to promote life-long learning, and labour mobility to alleviate shortages of high-skilled workers in the agro-food chain and to better identify current and future skill requirements of the sector.
- ***Prioritise inter-generational renewal in agriculture*** by developing tailor-made schemes that target Swedish young farmers. Assess the extent to which land regulations, taxation, inheritance law, territorial planning and agricultural policies such as direct payments impede generational renewal.
- ***Place greater focus on training and skill needs*** for the existing agricultural workforce, including paid workers.
- ***Assess the support needs of new entrants to farming*** and identify their potential business and organisational models, such as which knowledge they manage and how they acquire it, the use of technology, their access to capital (including land) and financial management, their marketing strategies, and co-operation initiatives.
- ***To counter the declining number of students enrolled in agri-food courses*** strengthen the co-ordination between agricultural education institutions and the food and agriculture industry, and facilitate discussions between education and knowledge institutions and the industry so as to identify the skills needed for future development.
- ***Establish a mechanism*** to engage with stakeholders with the aim of improving the coherence of rural development policy.
- **Strengthen the socio-economic foundation of the rural economy** by stimulating the bio- and circular-economy in sustainable agricultural, forestry and agri-forestry business models.
- ***Fully connect farmers and rural population to the digital economy*** by ensuring reliable high-speed internet access across all rural areas and upgrading the people's skills and business practices so that they can fully benefit from these new technologies.
- ***Identify market failures in land markets*** to design better targeted policies to facilitate structural adjustment.

The agricultural innovation system is mostly integrated in the general innovation framework

The food and agriculture sector consists of numerous small actors that face challenges in co-ordinating and communicating research needs. Research – applied and basic – relevant to the food and agriculture sector is conducted by a number of universities and research institutes. Applied research is also conducted and funded by private actors. There is a debate as to whether the mix of basic and applied research is the most suitable, if there is enough funding, if the research undertaken suits the needs of the food and agriculture sector and if the organisation of the research providers is well functioning.

Both the public and private sectors in general invest strongly in research, but not significantly in agriculture and the agri-food chain. The main focus of research activity related to agriculture and food is in developing new technologies and green energy sources, and reducing food waste. Budget expenditure on agricultural R&D accounts for a smaller share of agricultural gross value added than in many neighbouring countries, including EU Members.

Funding of R&D is complicated because of its multiple sources, although it is simpler for agriculture because the main funder is the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (Formas), which also includes environment-oriented research. In addition, farmers' organizations fund some of the applied research on agriculture.

The government allocates the task of evaluating research to higher education institutions and research councils. 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. In 2012, the OECD identified the lack of evaluation as a weakness in the Swedish Innovation System. As formulated and regulated in the Government appropriations for each council, according to the OECD, evaluations should cover the quality of research and its effects from a diverse perspective. However, the lack of a central system of standards and practices for the evaluation of research results in variations in interpretation.

Sweden encourages private sector R&D through a number of economic incentives. The Government provides incentives in the form of special grants and allowances for employment specifically in R&D activities. In addition, the social security contributions are reduced substantially for R&D employees. However, the R&D allowances only apply to employment in the private sector and public sector employees are ineligible, including those working in the agro-food sector.

Public research mainly takes place in universities, with the Swedish University of Agricultural Sciences (SLU) carrying out most agriculture-related research. Swedish universities achieve research excellence (according to global rankings) but linkages between basic research, applied research and the industry need to be strengthened. In the agricultural innovation system, there is also potential to improve the weak link between basic research, applied research and the advisory services.

Recent efforts to strengthen the general innovation system have focused on improving governance and linkages: methods include strategic programming, co-operation programmes, funding mechanisms, the creation of a research institute (RISE, the Research Institutes of Sweden Holding AB) to connect researchers and users, and the implementation of the European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-Agri). Efforts have been made to improve technology transfer and commercialisation of agri-food products, in particular through closer collaboration between industry and academia, which is an integral part of the Strategic Innovation Areas and Challenge Driven Innovation programmes.

Programmes of the Swedish Governmental Agency for Innovation Systems (Vinnova) aim to support targeted collaboration between research and development providers and industry. Several schemes continue to support centres of excellence at universities, which seek to create excellent academic research environments in which industry actively participates. However, the low number of patents filed by universities is often seen as a consequence of “professor's privilege”, which entitles researchers (instead of institutions) to patent their own inventions.

Public research institutes, which were grouped into a single holding entity (RISE) in 2009, have received further government funding and have undergone major restructuring since 2014 in order to achieve a consolidated and internationally competitive sector. 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 research and development projects. International co-operation in public research is mainly within EU programmes and the Nordic Council, with a high share of food and agriculture research results published in collaborative projects with foreign researchers.

These developments are expected to facilitate research collaboration on agriculture-related topics in the future. For example, the implementation of EIP-Agri, which is only in the early stages, should offer opportunities for further collaboration along the value chain. The SLU created a Green Innovation Park, and a strategic programme on the circular and bio-based economy was launched in 2016. There are currently a number of green networks and clusters at the national and EU levels. On the other hand, there is no agricultural research institute charged with carrying out more applied R&D, and the RISE network only includes small agriculture-related activities.

Public and private organisations in the farm advisory system include several large consulting companies, as well as the SBA, which is the main public actor. Recent efforts have aimed at increasing the role of universities in knowledge transfer. Recent evaluations of the advisory system outline the need to better understand users' needs, which vary by sub-sector, and to develop a general strategy for upgrading skills that involves all education, research and advisory actors.

Recommendations to strengthen incentives to innovation

- ***Develop a long-term strategy for research and innovation in the agriculture and food sector*** by clarifying the institutional roles of SBA, SLU and RISE, or by establishing a platform to co-ordinate their tasks, or by merging them within RISE. Create a national council to monitor R&D policies of institutions and assess the effectiveness of the allocation of funding from research councils and universities.
- ***Strengthen research evaluation*** by improving the well-established internal system for quality assurance, and strengthen research evaluation through an external and impartial evaluation of their research quality and impact.
- ***Improve the research infrastructure*** by establishing a national agricultural research institute to carry out more applied R&D.
- ***Prioritise policy coherence*** through more and better policy co-ordination, integration and collaboration between innovators in agriculture, regulators, and across ministries, such as the Ministry of Education, in order to increase agriculture's visibility in the Swedish innovation system to facilitate a faster and more effective adoption of new technologies.
- ***Maintain and strengthen efforts*** that focus on agriculture and food research and innovation on knowledge-intensive high-tech areas, including the bio- and circular economies.
- ***Facilitate the organisation of producers and the industry*** to enable them to contribute more effectively and efficiently to AIS, including through participation in networks or articulation of their needs.
- ***Encourage producers, researchers and the industry*** to actively participate in RISE, EU and international networks.
- ***Fully explore the opportunities that arise from the EU EIP-Agri*** to transfer innovation into agricultural practice through participation of famers, stakeholders and researchers.
- ***Develop indicators and tools*** to evaluate AIS performance and monitor the rate and quality of innovation in the food and agriculture sectors. In addition to traditional indicators on efforts (e.g. R&D expenditures) and outcomes (e.g. number and quality of patents), consider including indicators on impact (e.g. the rate of innovation adoption, TFP, environmentally adjusted TFP growth and agri-environmental indicators).
- ***Continue developing information systems***, including market intelligence (big data). On data ownership, data governance principle should be agreed with the providers of technologies and farmers.
- ***Ensure that farm advisors are well-trained***, and are in possession of the most up-to-date practical knowledge and skills.

Rebalancing agricultural policy towards long-term productivity growth and sustainability

Sweden strongly favours policies that allow the food and agriculture sector to respond to market signals, within the context of EU membership

Income support to farmers is one of the primary instruments intended to ensure financial viability and to compensate for, or partly offset, variations resulting from differences in agri-environmental conditions and regional agricultural potential across the country. Although the objectives of EU farm policy are common across all EU Member countries, the effect of support payments on farm productivity is variable and context specific. The available evidence suggests that dependence on support linked to commodity production in total farm revenue generally has a negative impact on farm efficiency and productivity. However, although the effects of decoupled income support payments on farm efficiency and productivity appear to be mainly positive, they are small. In this context, it should be noted that access to farm credit is, in general, not a constraint in Sweden.

In principle, whether agricultural policy reform boosts or impedes productivity growth depends on the policy instruments chosen. While increased market orientation can be associated with a drive towards more production efficiency, increased regulation might generate the opposite effect in the short run. However, in Sweden, environmental and animal health and welfare regulations and policies are significant, so they serve to conserve the natural resource base for future production, and can be a positive force for increasing production efficiency in the longer term. Moreover, measuring production

efficiency only in *quantitative* terms needs to be adjusted in the light of Swedish consumer and citizen preferences for the *quality* and methods of production. Whether the positive or negative effects dominate is an empirical question that should be evaluated against a wide range of criteria, not just focusing on trends in the input/output ratio in assessing efficiency.

Further reduce the share of government support in farmers' incomes: Government support is one of the primary instruments used to drive farm profitability and intended to compensate for variations resulting from differences in agri-environmental practices and regional agricultural disparities. Although farm decoupled payments are provided in all EU Member countries to achieve similar objectives, the impact is variable on farm efficiency and productivity. Research has in fact shown both positive and negative influences of farm support on farm efficiency. These findings are related to specific countries, production specialisation and methodological application. However, research shows that, overall, dependence on government support, or a large share of support in total revenue, has a negative impact on farm efficiency.

Explore possibilities to reduce input costs. Consider the possibility to reduce input costs to improve productivity, for example, through an improvement of the supply of capital to agriculture; changes in farm structures to benefit from economies of scale, recognising heterogeneity in regional factor endowments and encouraging further diversification of on-farm activities.

Facilitate generational renewal in agriculture: Explore ways and means to facilitate generational renewal in agriculture because as many as a third of farmers are now over the age of 65. Young farmers have a key role to play in structural adjustment. Farms managed by younger farmers are often found to be more efficient. This is mainly associated with their higher level of education, implying knowledge of more advanced technology, interest in making structural adjustments and investments and enthusiasm. Older farmers tend to have less up-to-date knowledge on advanced technologies and be more resistant to structural changes. Adjustment assistance should be considered as a way to facilitate and smooth the process of structural change.

Recommendations to making agricultural policy more conducive to innovation

- ***Prioritise further reform of agricultural policies*** by advocating the implementation of results-based, nationally specified agricultural policies (devolution) that reflect the diversity and uniqueness of Sweden's agri-environment, within the broad guidelines agreed at the EU level.
- ***Identify appropriate policy measures*** that target the development of agricultural activities that are potentially financially viable, as well as those that ensure the provision of sufficient collective or public goods (environmental, cultural, social values) provided by agricultural activities.
- ***Reduce the relative importance of government support*** in agricultural incomes and increase farmers' returns from the market through investment and strengthening the knowledge-based for farming through more research and innovation by encouraging further integration of agriculture in SIS.
- ***Assess investment needs*** and enhance the effectiveness of public investment support by focusing on areas where financial markets fail to provide funds for the provision of public goods, and better integrate business advice and synergies with research and innovation.
- ***Boost investments*** into innovation, modernisation, farm restructuring, diversification and uptake of new technologies and digital-based opportunities such as the use of big data, precision farming and clean energy. New business models as well clarity around the rules on data sharing will be necessary before the full potential of these technologies can be exploited.

Improving sustainability

While Sweden is well advanced in developing policies addressing the agri-environment…

Sweden was one of the earliest OECD countries to raise awareness of environmental issues and to develop environmental policies. Protecting biodiversity and cultural landscapes (ensuring a balance between open landscapes associated with agricultural activity, and forests) while reducing pollution have risen progressively to the top of the policy agenda. Sweden has also been a leader in improving animal health and welfare. More than 60% of the 2014-20 RDP budget is allocated to ecosystem management, reflecting the traditional government emphasis on environmental sustainability issues. Payments for environmental service provision and some far-reaching regulations on polluting activities (e.g. taxes on pesticides) are the result of the increased integration of environmental concerns in agriculture. These schemes have contributed to the good progress that has been made in decoupling agricultural production from environmental pressures.

Several measures are used to encourage the adoption of sustainable management practices and technologies. Education and the provision of information to individual farmers are pivotal in attaining environmentally sustainable agriculture. Sweden is one of the few countries to apply the polluter-pays-principle (developed and agreed to by the OECD in 1972) through the use of pricing instruments such as taxes on pesticides in order to reduce environmental externalities of water pollution and GHG emissions, to promote the adoption of "cleaner" farm management practices and technologies, and to make farmers responsible for the adoption of "cleaner" farm management practices and technologies.

Long-term projections of climate change suggest several potential benefits for Sweden: vegetation and cultivation periods will be prolonged, yields will be increased, and new crops may be introduced. There are, however, risks such as the possibility of crop and animal diseases associated with warmer temperatures. In order to capitalise on the opportunities and challenges posed by climate change, it is imperative that adaptation strategies be prepared to take advantage of these new conditions.

… further improvements in environmental sustainability from cross-compliance and greening of policies are likely to be small

Most of the cross-compliance requirements have existed within Swedish legislation for a long time, pre-dating those introduced by the European Union. The greening requirements of the CAP 2014-2020 are very broad and do not take into consideration the varying geographic context and the specific problems of managing biodiversity and nutrient leakages into water courses in Sweden or managing biodiversity.

Sweden faces the challenge of land abandonment, especially of grazing land in forest regions, both in the north and the south, which risks jeopardising the achievement of its main environmental objective of varied agricultural landscapes, especially the preservation of cultural heritage values and biodiversity. In broad terms, agricultural activity in the north-forest regions is associated with the provision of environmental (biodiversity, ecosystems) and landscape benefits – whereas, in the southern lowland plains with intensive crop production, the main issue is environmental pollution. Due to heterogeneity in environmental impacts and costs, more targeted actions and regional adaptation of greening measures, particularly for Ecological Focus Areas, and agri-environmental schemes to address the landscape requirements and biodiversity, and strengthening the application of the polluter pays principle, are therefore critical.

Recommendations to enhance the environmental sustainability of agriculture

- ***Ensure that environmental and climate change concerns*** continue to be taken into account when developing and assessing policies that can contribute to productivity and competitiveness.
- ***Strengthen efforts to assess the feasibility of implementing performance-based agri-environmental payments***, which are steps towards increasing the cost-effectiveness of such programmes. Such payments, in addition to increased flexibility provided to farmers, achieve greater environmental benefits than practice-based measures. In this regard, payments to remunerate farmers for the provision of environmental standards that the Swedish public and politicians want, yet go beyond what is expected of farmers to provide (reference levels), need to be made available, assessed in terms of costs and benefits, and transparent, within the constraints of overall budgetary provision.
- ***Establish measurable indicators of performance*** to regularly monitor and evaluate the achievements of agricultural policies in meeting objective, and to make course corrections when outcomes fail to meet the objectives of policy.
- ***Apply the polluter-pays-principle*** more systematically to hold farmers accountable for all harmful environmental effects from crop and livestock pollution by considering, for example, taxes on fertilisers and penalties where these contribute to water pollution. ***Intensify efforts to provide targeted and tailored advice*** to farmers on sustainable technologies and practices by paying more attention to supporting activities, such as technology monitoring, training advisors and production, collection and storage of technical knowledge.

Chapter 2

Context and challenges facing the Swedish food and agriculture sector

This chapter outlines the overall economic, social and environmental context in which the food and agriculture sector in Sweden operates, and the natural resource base upon which it relies. It discusses the challenges and opportunities for the sector; describes the natural and economic context; shows the importance of the agricultural sector in the economy; outlines the main structural characteristics of the sector; and analyses the main trends and performance in agricultural productivity and environmental sustainability

Key points

- The main socio-economic challenge facing the Swedish food and agriculture sector is achieving sustainable growth and employment, and maintaining high environmental and animal welfare standards, given the relatively weak competitiveness in several parts of the sector.
- Agriculture accounts for less than 10% of total land area, predominantly located in the south of the country, but about half of all farmland is located in areas with natural constraints, and its direct contribution to the economy and employment is less than 2%.
- The number of agricultural holdings has sharply declined over the last three decades, leading to larger farms, with average farm holdings of 43 ha compared to 16 ha in the EU28; most farms are pluriactive family businesses, with approximately one third of farm household income originating from off-farm sources. Livestock production in most sectors has declined since 1995, while production in some sectors such as grains, vegetables and poultry has increased.
- Sweden will need to raise investments in agriculture not only to increase food supplies, but also to raise the amenity value of agriculture for the urban population.
- Growth in agricultural Total Factor Productivity (TFP) has been in line with the EU28 and its main competitors, driven primarily by high labour productivity resulting from a sharp decline in agricultural labour.
- The food supply chain seems to function efficiently as the Swedish retail food industry is concentrated to a relatively small number of players, together with specialist niche food markets. The majority of Swedish agro-food trade is with other Nordic countries (Norway, Finland and Denmark).
- Sweden has made good progress in decoupling environmental pressures from agricultural production as the adjustment of farmers to changed business conditions and Common Agriculture Policy (CAP) reforms are contributing to enhancing the positive environmental impacts of farming (such as protecting cultural landscapes and biodiversity) and reducing environmental pressures (such as reduced use of inorganic fertilisers, ammonia emissions, eutrophication and GHGs).
- Sweden is considered a global leader in public policy and farm practices to improve animal welfare.

2.1. Key challenges and opportunities

Sweden has a robust innovation-oriented economy with relatively high taxes resulting in a well-developed welfare state system. Making growth more sustainable, inclusive and green is a key overall policy objective. The country has an impressive track record in sustaining a high level of wellbeing of its citizens. The country performs above the OECD average in all dimensions of the OECD's Better Life Index, and these outcomes are typically shared widely across the population. Being well integrated into international markets has enabled the country to overcome the constraints of a small domestic market and a peripheral geographical location (Chapter 3).

In 2017, the government launched a National Food Strategy. The overall objective is to develop a competitive food supply chain that increases overall food production of both conventional and organic food, corresponding to consumer demands, while achieving environmental and animal welfare objectives, generating growth and employment, and contributing to sustainable development throughout the country.

All three dimensions of sustainability (economic, environmental and social) are covered in the National Food Strategy. This constitutes a change as the public sector, which has, since the 1990s, focused on environmental sustainability and on collective public goods produced by the sector, while the economic dimension has largely been left to the market. But given it is a sector largely dominated by small and medium enterprises (SMEs), this has been a challenge for the food sector to meet food security objectives. Swedish producers have taken the opportunity to produce environmentally sustainable food to a large degree, but the key in the future to increasing national production in Sweden to contribute to a more sustainable food chain in a global context is to focus more on the economic dimension.

Sweden is one of the largest countries in Europe in terms of land area, but is sparsely populated. Even though part of its area lies north of the Arctic Circle, much of its area enjoys a temperate climate. Agriculture thus faces very different conditions in the north compared to the south: the crop growing season is almost 100 days longer in the southern province of Skåne compared to Norrland in the north, with the latter region focused on livestock.

Agriculture accounts for a small part of the Swedish economy in terms of GDP, jobs, land and water use, although is an important source of greenhouse gas emissions (GHG), while also protecting biodiversity. Agricultural land use is strongly dominated by cereals (mainly wheat) and pasture. Livestock production is dominated by milk. In most livestock sectors, particularly for pigmeat, milk and cattle, production has declined since 1995, while for some sectors such as vegetables, grains and poultry, production has increased. Overall, agricultural production has remained relatively stable over time.

Most farmland is in the south and middle of the country which have comparatively large arable farms with relatively high yields; in the four northern-most counties livestock and small farms dominate. Structural changes in agriculture have resulted in a sharp decline in the number of farms, while these have grown larger. Farmers have made large investments in machinery and have become increasingly specialised. Organic farming is expanding rapidly and is generally more profitable than conventional farming, but this is largely due to high government support.

Regional differences in farm performance are a common feature of Swedish farms. Grain and dairy farms are generally found to perform better in southern Sweden. Farms in less favoured areas are on average less efficient than the corresponding farms in other parts of the country. Even support to such areas does not generally compensate for the competitive disadvantages arising from natural handicaps.

If Sweden does not have an overall comparative advantage in agri-food production, as revealed by international trade flows, there is a high degree of heterogeneity and some sectors and regions, such as horticulture in the south, are competitive. Although exports are growing, Sweden's trade deficit of

agro-food products has increased over time, mainly due to high imports of processed foods. European Union (EU) and especially Nordic countries are the biggest markets for Swedish agricultural products. With the exception of grains, Sweden is a net importer of agricultural products.

Since EU-membership in 1995, input use has been decreasing, while total agricultural output has remained relatively stable, which explains the positive TFP growing at a slightly higher rate than the EU28 average over 1995-2016. Labour productivity growth is the main source of TFP gains, at the expense of capital productivity as labour has been substituted by capital.

The country is a leader in many fields of environmental policy. Sweden was one of the earliest OECD countries in raising awareness of environmental issues and developing environmental policies. Protecting biodiversity and cultural landscapes while reducing pollution have risen progressively up the policy agenda. Sweden has also been a leader in improving animal welfare (Chapter 4).

Achieving sustainable TFP growth for the agricultural sector requires continuation of structural adjustments, whereby farmers expand their business, adopt new or improved technology that can compensate for high labour costs or a less favourable climate, target investment, and take into account regional natural factor endowments. Nevertheless, relatively low profitability, productivity and competitiveness are the main socio-economic challenges facing the Swedish agricultural sector as a whole. The beef sector is among the lowest performing sector in terms of productivity and profitability, even with support payments coupled to production. The beef sector is to a large extent driven by the environmental goal of retaining semi-natural pastures.

Low productivity growth in some sectors is due to a high share of input costs in production. Sweden's disadvantages in agricultural productivity relative to competitor countries are linked mainly to its high agricultural production costs (feed and labour) originating from the constraints related to climate, large capital investment costs in infrastructure such as housing and stables for animal husbandry, land prices and taxes. The difference in cost of production between Sweden and other EU Member states is also due to the specific state rules with respect to environmental and animal welfare standards that require corresponding infrastructure, auditing and certification of farms. The high production costs impact on financial viability and the ability to invest in innovative techniques.

The continued rise in land prices could be an incentive to increase capital investment in agriculture. The fact that there has been strong growth in the value of agricultural properties despite the low profitability of agricultural production indicates that factors other than profitability are driving the upward trend in prices. The capitalisation of agricultural support in agricultural land has probably contributed to the growth in value of agricultural land in recent years, as the income from farming would have been even lower without these subsidies. The on-going urbanisation process has also influenced land prices. As land prices increase, this has led to the development of farming activities at farms located further away from urban centres, where there is less competition for land, fewer opportunities for alternative employment and less concern about issues such as farm odours and noise. A key question is whether the profitability of agricultural production will be increased by an improvement of the supply of capital to agriculture.

Other possibilities for input cost decreases and improvements in productivity may be expected from changes (economies of scale) in farm structures, consideration of regional factor endowments and diversification. Feed costs represent the highest share of total costs in livestock production. Given that feed prices are largely determined in international markets, large savings could be made with a better combination and application of feeding practices in livestock production. While further improvements in labour efficiency are possible, the availability of a large area of semi-natural pasture might be preconditions for improved profitability of Swedish beef production. Pasture-based feeding could save costs and is beneficial to animal welfare, the environment, biodiversity and rural landscape values. Thus, for the beef sector policy measures are more likely to be successful if targeted towards the establishment of beef farms in pasture-based regions and improving feeding practices.

Encouraging on-farm diversification in terms of the mix of agricultural products produced might be crucial in improving profitability and making Swedish agricultural production more efficient. Increased diversification activities on farms specialising in a specific agricultural activity (crop, dairy, beef, pigs etc.) could help farms to buffer the price shocks of inputs (e.g. lower risk of feed shortages and high production costs), generate income from other activities and increase utilisation of under-used inputs.

An on-going challenge is to bring about generational renewal in agriculture because as many as a third of farmers are now over the age of 65. Young farmers have a key role to play in structural adjustment. Farms managed by younger farmers are often found to be more efficient. This is mainly associated with their higher level of education, implying knowledge of more advanced technology, interest in making structural adjustments and investments and their enthusiasm. Older farmers tend to have less up-to-date knowledge on advanced technologies and be more resistant to structural changes.

Further reducing the relative importance of government support in agricultural revenue is a major policy challenge. Government support is one of the primary instruments used to drive farm profitability and intended to compensate for variations resulting from differences in agri-environmental practices and regional agricultural potential (Chapter 5). Although farm decoupled payments are provided in all EU Member countries to achieve the same objectives, there is no single confirmed impact of this type of decoupled support on farm efficiency and productivity. Research has shown both positive and negative influences of farm support on farm efficiency (see Chapter 5). These findings are related to specific countries, production specialisation and methodological specification. However, it is a common finding that dependence on government support, or a large share of support in total revenue, has a negative impact on farm efficiency.

On natural resources the broad challenges such as reducing eutrophication, biodiversity loss and addressing climate change are still present, although environmental challenges are very context specific. For example, nutrient leakage, contamination of river waters by pesticides, and biodiversity loss due to monoculture are largely found in the south, while homogenous landscapes of forest and grasslands are typical in the north. However, Sweden has made progress in decoupling environmental pressures from agricultural production as measured by the reduced intensity of nutrient surpluses and of GHG emissions while agricultural production has remained relatively stable.

Concerning the impact of climate change, long-term projections suggest a number of potential benefits in that vegetation and cultivation periods will be considerably prolonged, yields will be increased and new crops could be introduced. However, in order to capitalise on these opportunities, adaptation strategies to the new conditions would be required, in particular because climate change could also risk an increase in plant and animal diseases.

2.2. General natural resources and economic context

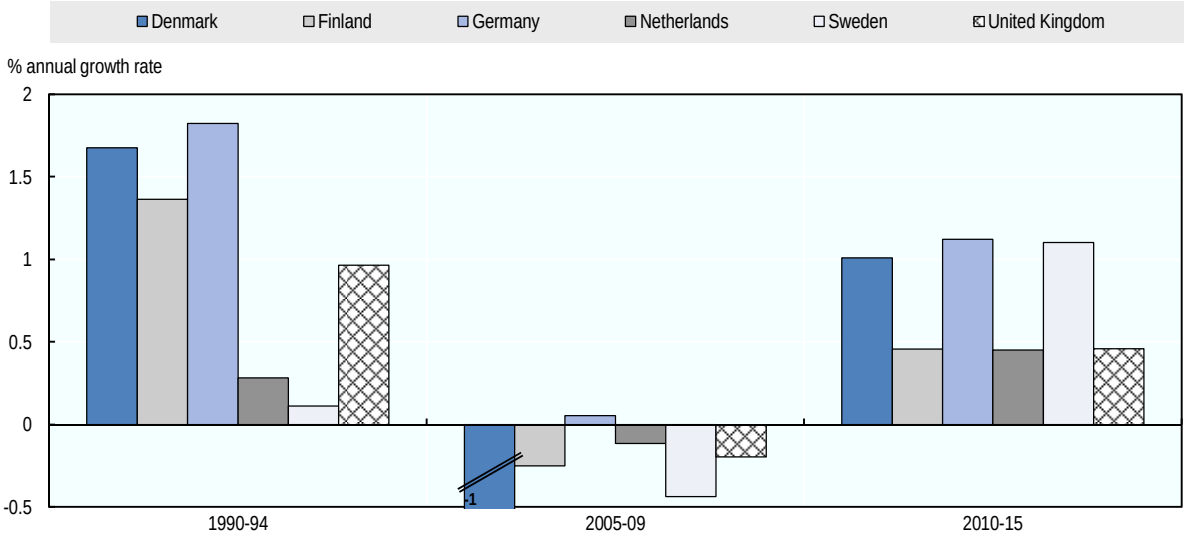
Sweden is the third largest country in the European Union in terms of land area, with only France and Spain covering a greater area, but it has a relatively small population.[1] Sweden is characterised by its large geographical and climatic contrasts due to its north-south orientation. With around 10 million inhabitants, Sweden has a low population density of 24.5 inhabitants per square kilometre, with the highest concentration in the southern half of the country, with a relatively high rate of urbanisation. In Norrland, the nine most northern counties in Sweden, which cover approximately 60% of Swedish area, population density is below five inhabitants per square kilometre.

Two-thirds of the land area is covered by forests making Sweden one of Europe's most heavily forested countries, whereas built-up land comprises less than 3% of the land area, mainly used for transport infrastructure, such as railways, airports and harbours. Regionally, while agricultural land dominates in the south, in the north forests are the most important use of land.

Sweden has achieved a high standard of living under a mixed system of a high-tech economy and extensive welfare benefits, to which the 20th century experience of peace and neutrality has contributed. Sweden has an efficient domestic distribution system, excellent internal and external communications, and a highly skilled labour force. Timber, hydropower and iron ore constitute the resource base of an economy heavily oriented toward foreign trade. Privately owned firms account for the vast majority of industrial output, of which the engineering sector accounts for about 50% of output and exports.

The Swedish economy is among the best performers among OECD countries with per capita GDP 23% higher than the average for the EU28, and 16% higher than the OECD average. Sweden's economy has experienced the highest growth rates in the OECD and the EU28 between 2014-16 (Chapter 3). Moreover, Sweden is one of the countries that have recovered well from the 2007 financial crisis, and since then it has tended to extend the gap in terms of economic growth and productivity compared with other countries of the EU28 and the OECD area (Figure 2.1), due to the diversification of the economy, adoption of high tech, skilled workforce, and an increase in the labour force linked to immigration.

Figure 2.1. Multifactor productivity of the economy, selected countries, 1990-2015



Source: OECD database on Multifactor Productivity, OECD.stat.

StatLink http://dx.doi.org/10.1787/888933709204

2.3. The role of agriculture in the economy

Agriculture's contribution to the economy and employment is small (Table 2.1). Moreover, these shares have been declining steadily. While agriculture accounts for a relatively small share of GDP on average, rural areas have a substantial weight in the economy: indeed, predominantly rural areas account for 44% of total land area, 16% of the population, 14% of gross value added, and 15.4% of employment (Eurostat, 2016). In terms of international trade, agriculture accounts for 4% of exports and 8.3% of imports.

Swedish agriculture is not a large user of natural resources, in particular land and water, as compared to other EU Member states (Table 2.1). It occupies less than one tenth of total land area, predominantly located in the southern parts of the country principally because of climatic conditions that are more favourable to agricultural activities.[2] The vast majority of agricultural land is arable (85%) and the rest consists of pastures. Most agricultural land is classified as nitrate sensitive according to the EU Nitrate Directive. The predominant crops in Sweden are cereals, particularly

wheat, oats and other grains, together with leys or grass. Agriculture, mainly livestock and fertiliser use, is responsible for generating 12% of total GHG emissions in Sweden.

Table 2.1. Importance of agriculture in Sweden and selected economies (%)

	Gross value added	Employment	Exports	Imports	Total land area	Total water withdrawals
Sweden	**1.3**	**2.0**	**4.0**	**8.3**	**7.5**	**3.6**
Denmark	0.9	2.5	18.5	12.8	61.8	25.2
Finland	2.7	4.3	4.4	8.5	7.5	0.8
Norway	2.4	2.3	0.6	8.6	2.7	28.8
France	1.6	2.5	13.7	8.7	52.7	9.5
Germany	0.6	1.7	6	8	47.8	0.6
Italy	2.1	3.7	8.5	10.3	46.7	44.1
Netherlands	1.8	2.1	17.8	13	54.6	1.1
Spain	2.8	4.3	14.7	9.7	53.9	63.5
United Kingdom	0.6	1.3	5.5	9.9	71	9.2
EU28	1.4	5.8	6.7	6	43.0	19.2
OECD	**1.9**	**5.2**	**8.6**	**7.6**	**39.5**	**30.6**

Note. Data refer to 2016 or more recent year.
Source: OECD System of National Accounts, OECD Annual Labour Force Statistics, UN COMTRADE, FAO FAOSTAT, FAO AQUASTAT, 2017.

2.4. Characteristics of agriculture and agro-food sectors

Swedish agriculture is marked by significant diversification

The fertile soils in the South and comparatively poor soils in North as a result of the climatic conditions affects the growing seasons and patterns of production. However, production in value terms is evenly distributed between livestock and crops, together with agricultural services.

Agricultural production

The heterogeneous natural conditions favour diverse agricultural activities: grassland based and intensive livestock farming, arable farming, open field horticulture and greenhouse horticulture (Table 2.A.1). In addition to agricultural and horticultural products, farms produce energy, fibre and pharmaceuticals. Other business activities have also become more important, especially services such as tourism and contract work. About one third of all enterprises combine agriculture with other gainful activities related to agriculture. The agricultural sector also generates public goods, such as biodiversity and landscape amenities, and provides valuable ecosystem services (SOU, 2015).

Swedish crop production is dominated by cereals, mostly barley, oats and wheat, as well as by grassland. In the north, crop production mostly comprises forage and coarse grains. Bread grain is mostly grown in the plain districts of south and central Sweden. Oilseed production, mostly rapeseed, is also located in the southern and central areas. Potatoes are grown throughout Sweden.

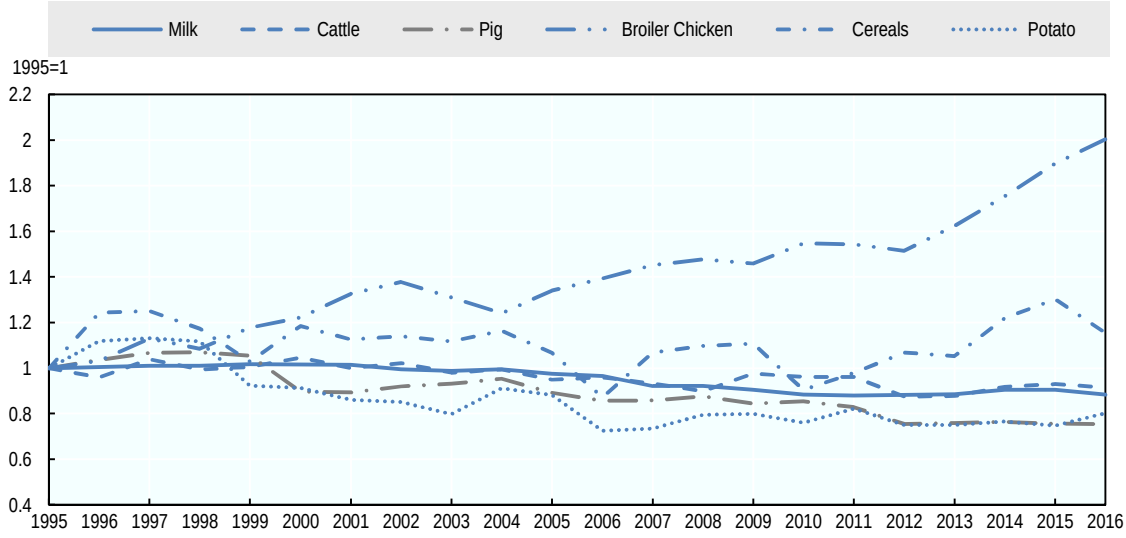
The highest crop yields are found in southern Sweden, while the yield for some crops in northern Sweden can be around half those levels. On the other hand, the long days with the midnight sun in the

north during the summer months makes the growing period intensive and allows for the production of high-quality potatoes, berries and vegetables (SOU, 2015).

Milk production is an important sector in Sweden and about one-third of milk production is for drinking. While the volume of cereal production has been stable during the last few decades, milk, cattle and especially pig production (currently the dominant meat in volume terms) have declined (Figure 2.2). Broiler (chicken) production has increased rapidly during the period 1995-2016, and has more than doubled in volume during the period.

Figure 2.2. Evolution of agricultural production by sector

1995-2016 (1995=1)



Source: SBA, Statistical Database.

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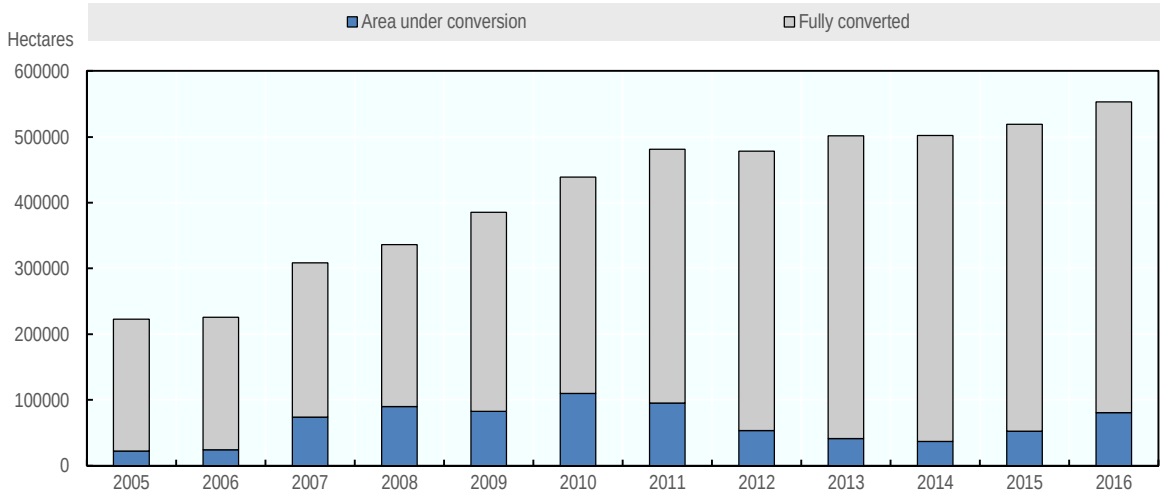
Organic farming is well established in Sweden, driven by increased demand and government support. Organic-certified areas account for more than 17% of the area of agricultural land in Sweden, which is much higher than the EU average (6%). Among the countries of the European Union, only Austria has a larger share (20%). The growth rate of organic farming areas increased very strongly between 2005 and 2016 (Figure 2.3) with the area converted to organic farming more than doubling.

Organic production has increased in most types of agricultural production by over 20% since 2005. Production of organic eggs and winter wheat has doubled during this period. Organic livestock farms are, on average, larger than other farms with the same type of livestock. The two exceptions are laying hens and broiler chickens, where organic farms are on average smaller. The share of organic food and non-alcoholic beverages also increased over time – from 2% in 2004 to 4.3% in 2013 (SBA, 2015c). Large food retailers, such as ICA and Coop have increased their sales of organic products from 40% to 60% during the same period.

The comparison of environmental performance between organic farming and "conventional" farming remains complex (OECD, 2016). The reduced use or even the prohibition of certain inputs can reduce polluting emissions (including GHGs), but the result may be a reduction in the efficiency of input use and productivity. Moreover, where organic farming requires more land to produce a given output, there is an opportunity cost in terms of land use.

Figure 2.3. Organic agricultural land, fully converted area, area under conversion (2005-16)



Source: SBA, Statistical Database.

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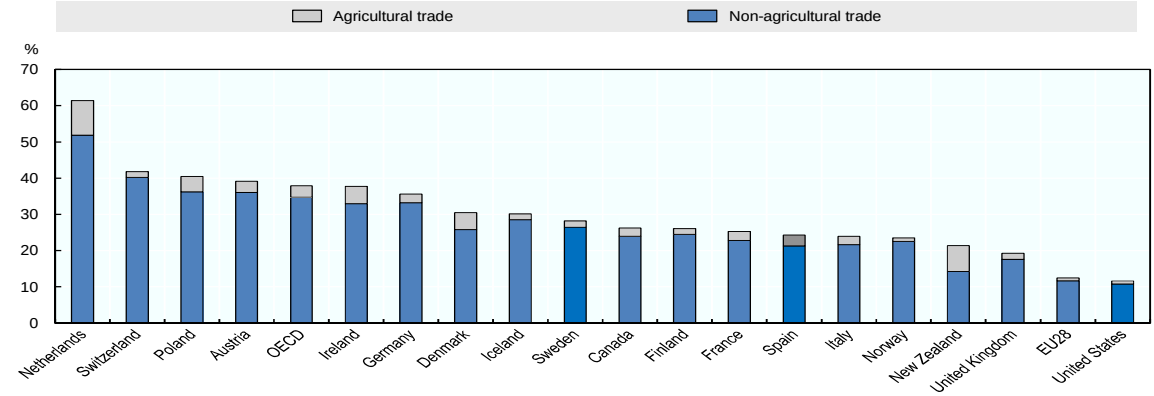
The Swedish agriculture and food sectors have a limited exposure to global trade

Sweden is an open economy that is thus highly dependent on international trade. As measured by the percentage of overall trade in Swedish GDP (i.e. exports plus imports divided by GDP), "openness to trade" in Sweden is significantly higher than the EU28 average, but comparable to other EU15 member states, such as Germany, Denmark, France, Finland or Norway (Figure 2.4). However, the Swedish agricultural sector has a limited exposure to global trade (1.7% of the 28% overall economy-wide exposure), which is in line with the limited share of agriculture in GDP of the Swedish economy, and typical of almost all OECD countries.

Sweden is a net importer of food and agricultural products. The trade deficit is increasing, but has stabilised somewhat in recent years (Figure 2.5). Trade in agricultural and agri-food products is mainly within the European Union (and Norway), which accounts for 89% of Swedish agricultural exports and 93% of Swedish agricultural imports (Eurostat, 2016; Table 2A.2).

Figure 2.4. Exposure to trade, selected economies, 2015 or latest available year

Average of exports and imports as a percentage of GDP



Note: GDP = Gross domestic product, national currency, current prices.
Source: UN COMTRADE 2016, OECD National Accounts, 2016.

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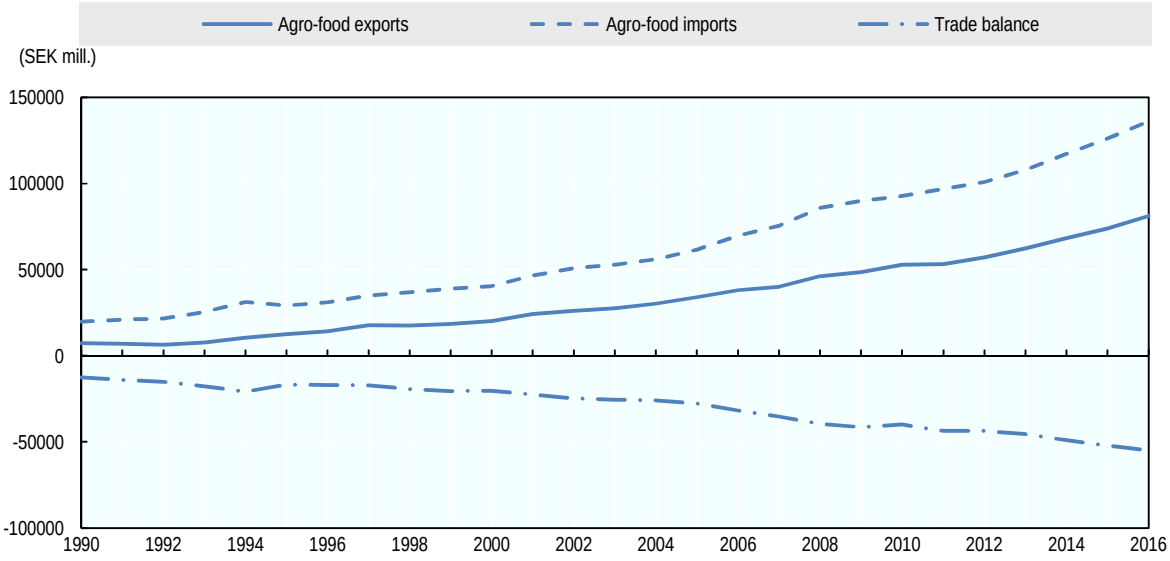
Figure 2.5 Agri-food trade, 1995-2016

SEK million



Source: Statistics Sweden. Unadjusted values for imports and exports by SITC product groups.

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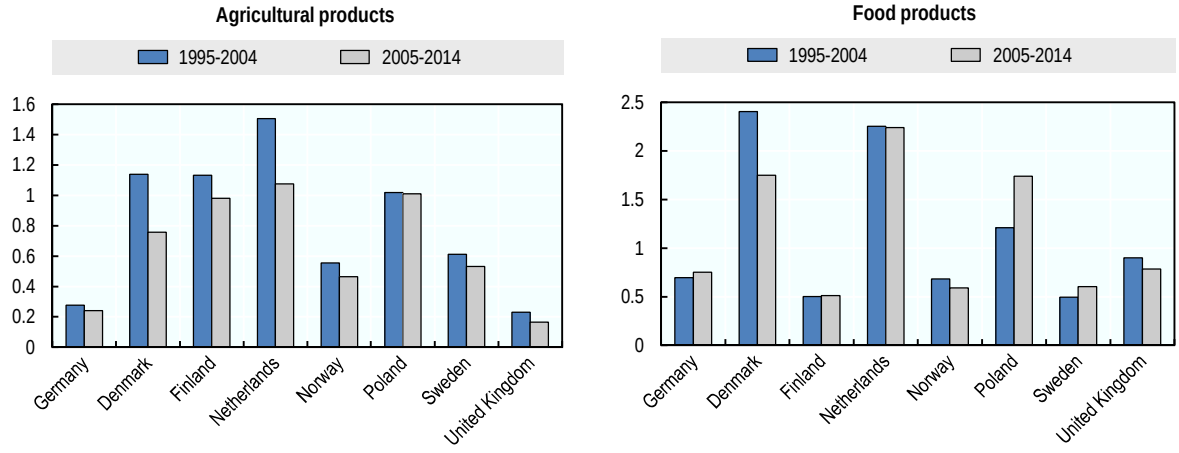
International trade does not reveal Sweden's comparative advantage in agri-food production. The Revealed Comparative Advantage (RCA) indicator compares the country's share in world agro-food exports with its share in world exports of all goods – ratio above unity indicates a comparative advantage of a country and vice versa.[3] Sweden's RCA is estimated at 0.5 for agricultural goods and 0.6 for food products (2005-14) suggesting that Sweden does not have a competitive stance overall. Moreover, since 1995 the value of Swedish RCA has remained rather constant (average RCA index of 0.5) indicating a stable position in the EU agricultural and food market (Figure 2.6). However, the RCAs estimated for individual commodities show that Sweden has an advantage in some sectors (Figure 2.16).

Of Sweden's total exports of food and agricultural products, exports of processed agricultural products make up one third. Net trade in processed agricultural products is negative but less so than for food and agricultural products in general. Spirits, processed fish products and processed cereals, various preparations and chocolate account for 70% of total exports of processed agricultural products. Sweden's largest export market for processed agricultural products is Norway. Imports are more evenly distributed among product groups, but processed meat, game, poultry, fish and beverages predominate (SBA, 2016d).

The role of trade in enhancing a country's competitiveness and innovation can also be revealed by the degree of its participation in global value chains, and thus its exposure to globally competitive productions and processes. Participation in Global Value Chains (GVC) can be analysed through the import content of exports (backward participation) and the extent to which domestic value added from an industry in a given country form part of the value of another country's exports (forward participation) (Greenville, Kawasaki and Beaujeu, 2017.

Figure 2.6. Revealed comparative advantage of agricultural and food products



Note: Revealed comparative advantage (RCA) is first calculated in value-added terms. The value-added RCA is defined as the share of value-added originating from a given service sector in a country's exports divided by the share of value-added originating from this service sector in world exports. As with the traditional RCA, a country has a comparative advantage in a service industry when this share is above one (i.e. when the value-added coming from this service sector represents a higher share for this country as compared to the world average).
Source: OECD WTO Trade in Value-Added Database, 2017.

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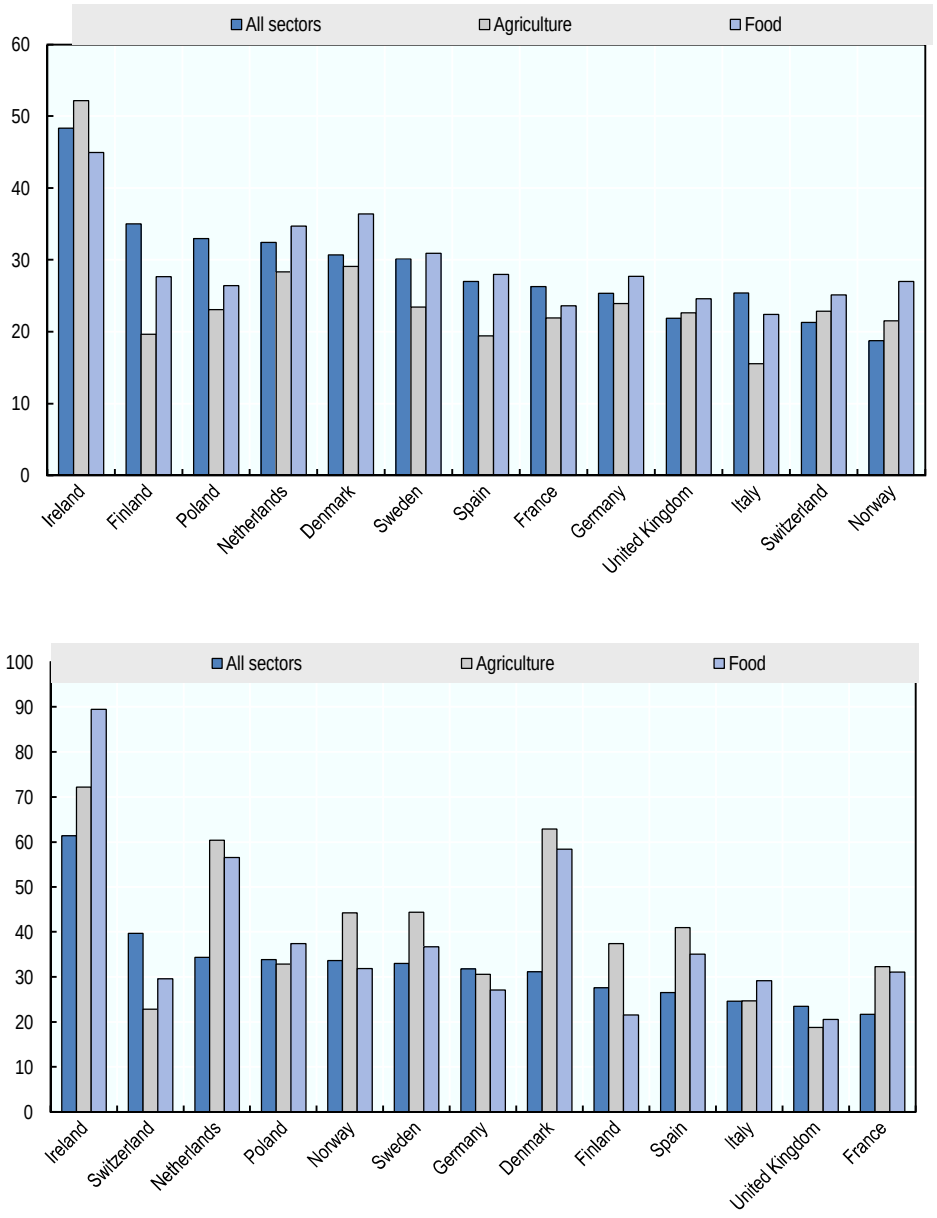
Figure 2.7 suggests that participation rates are lower for Sweden than some other European countries, both for all national exports and the agro-food group. This may suggest that some opportunities across the economy to increase competitiveness by increasing its engagement in global production remain unexploited.[4] For Sweden and some other countries, agriculture has high level of forward participation compared with relatively low levels of backward participation, suggesting that the sector is linked to GVCs more as an upstream provider of materials used in other production processes (Figure 2.7). On the other hand, the food sector is more a downstream user of materials with many food-manufacturing industries sourcing inputs internationally but selling their products domestically or directly to foreign consumers.

The distributions of GVC participation reveal significant differences across agri-food sub-sectors. Differences exist across sectors, the GVC measures explored (forward and backward) and between Sweden and the EU28 (Figure 2.8**)**. Overall, the results point to significant structural differences between sectors driven largely by the nature of the product produced. The backward participation seems to be relatively similar across the food and agriculture sectors than the forward participation. In general, food and agriculture sectors with higher forward participation have lower backward participation, suggesting a high degree of export orientation of some sectors and high import sourcing for others. Backward participation is lower in Sweden than in the European Union for all food and agriculture sectors, except for vegetables and wheat, while forward participation is higher in Sweden than in the EU28 for most food and agriculture sectors, particularly for livestock sectors.

Figure 2.7. Sweden's agro-food sector integration into global value chains



1. Backward and forward participation correspond, respectively, to the shares in a country's gross exports of foreign value added and domestic value added embedded in in foreign final demand.
2. Agriculture refers to TIVA sector C01T05 (includes hunting, forestry and fishing). Food includes food products, beverages and tobacco.
3. Data are for 2014.
Source: OECD-WTO Trade in Value Added (TiVA) database, Nowcast estimates 2017.

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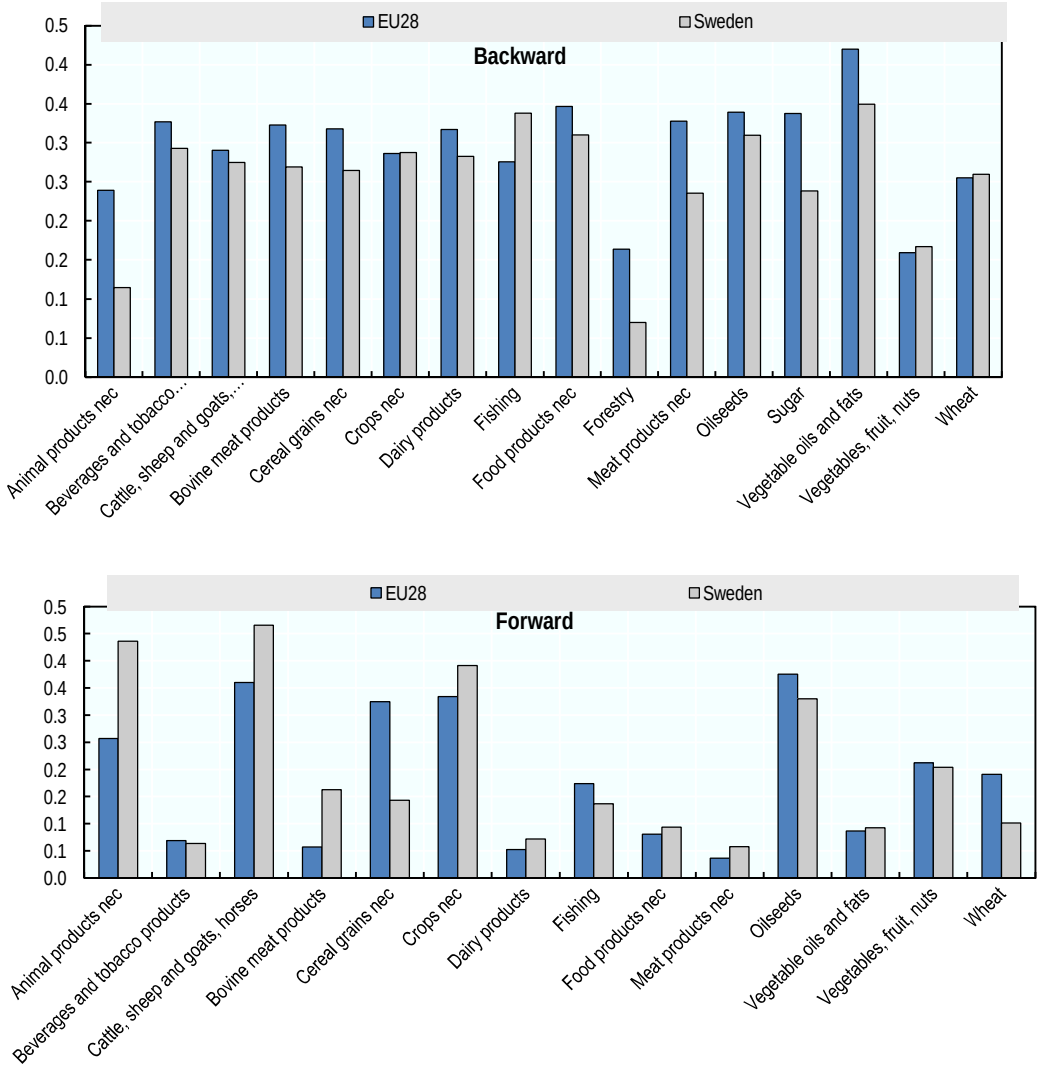
Figure 2.8. Sweden's forward and backward participation varies across agro-food sectors, 2014



1. Backward and forward participation correspond, respectively, to the shares in a country's gross exports of foreign value added and domestic value added embedded in in foreign final demand.
2. Data are for 2014.
Source: OECD-WTO Trade in Value Added(TiVA) database, Nowcast estimates 2017.

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Swedish diets are gradually changing over time

Swedish diets have changed considerably in recent decades, as is the case in many other developed economies. Increasingly, in addition to prices the food market is also influenced by consumer awareness of health, environmental and social issues. Consequently, consumption of foods with organic and "fair trade" labels has increased. There is also an increased consumption of locally produced foods, as well as "ethnic" foods from other countries, partly reflecting the diverse ethnicity of the population.[5] In 2016, about 9% of total consumer food expenditure was on organic foods. Another recent trend is online sales of food. In 2016, one in four households bought food online, and sales correspond to about 4% of total retail sales (Swedish Trade Federation, 2016).

During the period 1980-2015, meat (mainly poultry and beef) consumption per capita increased by 40%, fresh vegetables by 116%, and fruits, berries and nuts by 28%. The consumption per capita of milk decreased by 39%, of edible fats by 25% and sugar and syrups by 67%. Consumption of frozen ready-cooked food increased by over 42% during the period, but after 2011 there has been a trend of decreasing consumption per capita.

Structural changes in agriculture mean fewer, larger and more specialised farms

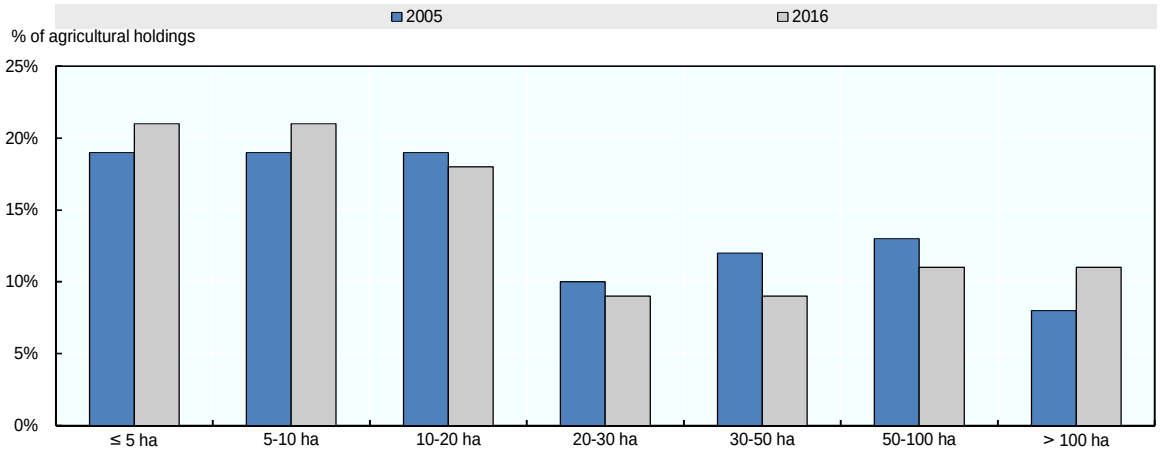
Farm structures

There are about 67 000 farms in Sweden, of which 75% can be considered commercial farms. They are predominantly pluriactive, with approximately 30% of farm household income originating from off-farm sources, resulting in different size farms earning approximately equivalent incomes.

Structural changes in agriculture have resulted in a sharp decline in the number of farms in recent decades, so that farms have grown larger, accounting for a larger share of production. Farmers have made substantial investments in machinery and become more intensive and specialised in cereals, dairy or the rearing of pigs and bovine animals. While farms are generally moving towards more specialised production, the majority still produce a range of commodities. However, about half the number of farms are less than 20 hectares. The biggest changes in size and number of farms can be observed for large and mid-size farms. While small farms have recorded a slower decline in numbers the median farm size has grown marginally during the period (Figure 2.9; SBA, 2017).

The trend towards fewer and larger agricultural holdings has been in continual progress for many decades. The number of agricultural holdings decreased by 1.9% per annum over the 2000-16 period. In general, the rate of decline has been somewhat higher in the central and northern part of Sweden. In horticulture – a sector that is relatively capital, labour, and knowledge intensive – the number of holdings has halved since 1990 while the utilised area has remained more or less constant. Likewise, major structural changes in size are evident for all livestock sectors, and all sectors except pigs have experienced a concentration of production into relatively large farms. While the number of dairy cows has decreased sharply, due to increased productivity, the decrease in milk production has been less.

Figure 2.9. Structure of agricultural holdings



Source: Eurostat, Farm Structure Survey 2005 and 2016.

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Box 2.1. Major changes in livestock farm size structure

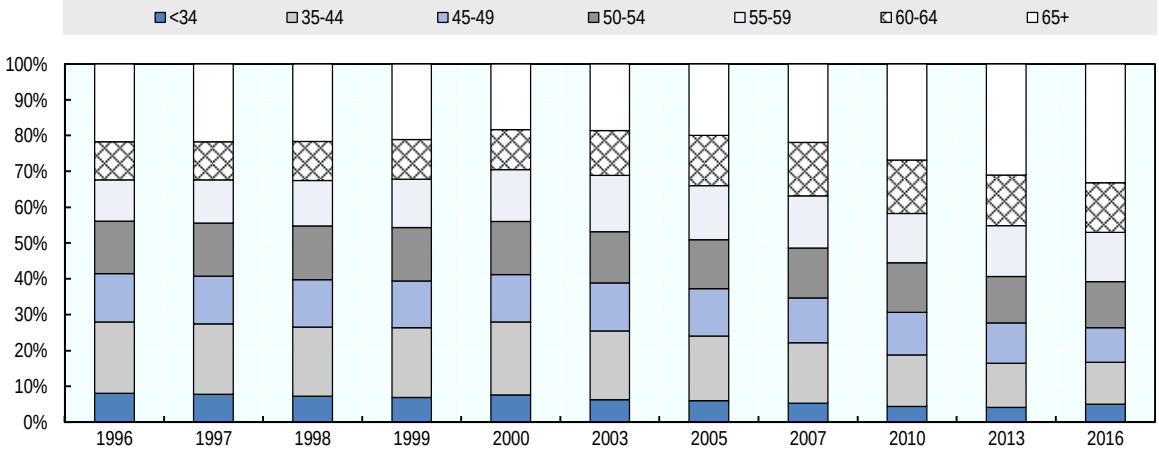
In 1990, half of all milk cows were on farms with no more than 24 cows. Twenty-five years later, that midpoint was at 73 cows. The change in the pig sector was even more dramatic as it underwent a wide-ranging and comprehensive set of structural changes. In 1990, half of all pigs were on farms with no more than 119 pigs. The midpoint for pig farms had increased to 657 by 2015. The mid-point size for egg farms grew from 18 000 in 1990 to 32 600 in 2015. It is not possible to calculate the mid-point size for broiler farms before 2000, due to changes in how the statistics are collected, but in 2000, half of all chickens were reared in farms with at least 92 000 chickens. By 2015, the midpoint for broiler farms had grown to 110 000.

Farm labour is getting older and is increasingly reliant on younger, temporary workers

Most farms are family businesses in which the family itself does most of the work and combines farming with employment in other activities. Less than 8% of farms are operated by limited companies, and at least 70% of those employed in agricultural holdings are family members of the owner(s). Thus the number of employed people in agricultural holdings has declined, predominantly of permanent employees, while those temporarily employed has been increasing.[6] Growing perennial crops is the sector with the highest proportion of immigrant labour (25% in 2013), while the lowest proportions are observed for animal production, mixed farming and the supporting activities to agriculture. The number of women in agricultural enterprises is also growing and in 2015, 29% of all those employed in agriculture were female. Almost 50% of employment is in holdings with more than 50 ha of arable land.

The age structure in Swedish agriculture is quite uneven and differs from the average of EU28 as only 4% of agricultural farm holders were under 35 years old (7.5% in EU28) in 2013. Moreover, the average age of employees as well as farm holders has been increasing. In 2013, the average age of employees in the industry was more than 55 years, compared to 50 years in 2007. Mixed farming and growing of non-perennial crops are the industries with the highest average ages, 64.6 and 51.8 respectively. One-third of managers in 2016 were 65 years or older, which is more than ten percentage points higher than in 2000 (Figure 2.10). Another 28% of Swedish farmers will reach retirement age within coming decade, according to data from 2013. An ageing workforce is a challenge to the future development and innovation capacity of the agricultural sector.

Figure 2.10. Age distribution of farm holders (1996-2016)



Source: SBA, Statistical Database. All farm holders occupied in the agriculture sector.

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Better educated and trained farm managers are more likely to make successful changes to farm-management practices and be more innovative (OECD, 2014). The agricultural work force is far less educated than the total working population of Sweden. In 2016, while 41% of the overall working population have graduated from tertiary education, and thus had a high level of education attainment, only 17% of those in agriculture have reached this level (Eurostat, 2017). Learning by doing is the main form of training for the majority of Swedish farmers as the majority of the farm managers have acquired agricultural experience through practical work on an agricultural holding (69% in 2013) and only 19% of farm managers have completed full agricultural training.

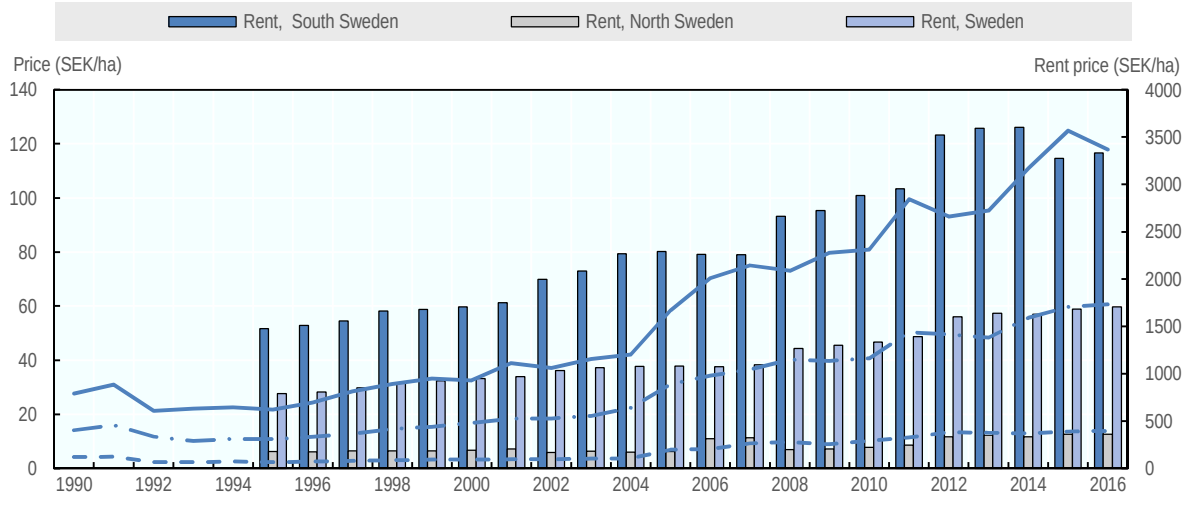
Land use

A large proportion of agricultural land is rented (39% in 2013), but the proportion differs between different forms of agricultural production. The largest share of rented land is found in dairy production and the lowest share among small farms. Farmers younger than 25 years old rent about 68% of their land, but as they age, farmers are able to buy more of their total agricultural land.

The price of agricultural land has increased since Sweden's accession to the European Union throughout the country (Figure 2.11). The increase in land prices is due to increased demand for land, land productivity and capitalisation of subsidies at least in central and southern Sweden (where the most productive agriculture land is located). In areas with less productive agriculture land the increased demand is mainly related to rural amenities (recreation, tourism and seasonal homes) and accessibility (housing, industry and transportation) (Karlsson and Nilsson, 2014; SBA, 2015b; Nilsson and Johansson, 2013).

Historically, large agricultural estates leased land to small farmers. The landowner was the dominant party in the contractual relationship, and current legislation reflects this. Today, it is not unusual for a property owner to be a small farmer who leases agricultural land to a large-scale farmer who also leases additional land from other small farmers. Therefore, the landowner might no longer be the dominant party in the contractual relationship. A government inquiry on leasing proposed several changes to the present legislation (SOU, 2014). The inquiry into the competiveness of the agricultural sector further proposed that full liberalisation of contracts should apply when establishing rents (SOU, 2015).

Figure 2.11. Average price and rent price for agricultural land, 1990-2016



Note: Based on NUTS2 classification.
Source: SBA, Statistical Database.

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Concentration in the food supply chain is compatible with competition to address consumer preferences

Farms are part of the food chain of processors, retailers and input providers. Most of the non-farm businesses in the food chain are large corporations, and few directly operate farms – there is little vertical integration between agriculture and other parts of the food system and intra-industry trade is weak in Sweden. However, farms are often closely linked with other firms in the food system through various types of contractual relationships and co-operatives. Food manufacturers and retailers tend to be large undertakings operating in highly concentrated markets. It should be noted that there is also a strong emerging trend in small-scale production and innovations (Food and Bioscience, 2016). The increasing health consciousness is altering consumer behaviour while "food tech" is creating conditions for new foods for consumers, with implications for value chains. This is leading to possibilities for different business structures. However, in some parts of Sweden, especially in the north, the long distances between farms and input providers with higher transport costs reduces the competitiveness of those farms (SOU, 2014).

The most extensive system of contractual arrangements is in broiler chicken production, where almost all broilers are raised under production contracts. The pig sector is less tightly controlled, but is still dominated by contract production. In other commodities, farmers can enter into contracts with buyers that tie prices to commodity attributes, and they may have longstanding but less formal ties to specific buyers.

An examination of competition in the food supply chain by the Swedish Competition Authority in 2011 found that market concentration is high in some parts of the food supply chain (Swedish Competition Authority, 2011). Both the food industry and the retail food trade are sectors where a small number of undertakings account for a significant proportion of sales. However, consumers benefit from lower prices due to economies of scale, despite high market concentration.

The overall assessment of the Swedish Competition Authority was that competition in the food supply chain is essentially functioning efficiently. Swedes pay no more for their food than consumers in comparable EU Member states, regardless of whether prices are compared directly or whether prices are compared to income. Swedes, however, pay less than consumers in other Nordic countries. Nor have prices in Sweden increased more rapidly over the past decade than they have in comparable countries. The margins in the Swedish food supply chain are no higher than in other EU Member states, nor have they increased over the past decade.

Co-operatives

Co-operatives between producers are not normally permitted under competition rules, but within agriculture and forestry they are exempt, as they are not expected to harm competition. On the contrary, there is good reason to believe that both farmers and consumers benefit from the economies of scale in agricultural co-operatives that function according to traditional co-operative principles (Swedish Competition Authority, 2011).

Co-operatives play a significant role in the Swedish food chain, particularly in the dairy sector, where they account for almost all market share (Box 2.2). However, some of the most important Nordic co-operatives are based in either Denmark or Finland, reflecting a Nordic-wide consolidation process. The largest ones especially look for economies of scale in international markets, whereas the smaller ones concentrate on regional markets (Cogeca, 2015). Forestry co-operatives play a major role in the Swedish forestry industry as about half of the Swedish forest area is privately owned, most often by farmers (Nilsson et al., 2012).[7]

Box 2.2. Co-operatives play an important role in the Swedish agro-food system

Co-operatives dominate the dairy sector in Sweden. Arla Foods is a clear market leader, with a 64% proportion of milk purchases in Sweden. Arla merged in 2000 with Danish MD Foods. Arla Foods is an international co-operative with its headquarters in Denmark and with members in seven countries. Arla Foods, as well as other co-operative dairies, is active in the entire chain from purchasing to processing and marketing its products to retailers and for export (Nilsson et al., 2012).

Producer co-operatives account for a small market share in that Sweden imports 48% of the beef, 30% of the pork and 34% of the poultry consumed in Sweden (2015). Processing is also decentralised compared to Sweden's neighbours, where the market shares of the two biggest processors are high (more than 80% both in Denmark and in Finland) (Nilsson et al., 2012).

In Sweden, the meat market leader is HK Scan, although Swedish farmers are not co-operative members. The majority owner of HK Scan is the Finnish co-operative LSO. Competitors in the market are the Finnish Atria and Danish Crown. All of these co-operatives have made acquisitions in Sweden during recent years. In addition to those large co-operatives, there are many processors in Sweden and it is estimated that more than half of players in the meat processing industry are small (turnover less than EUR 50 million) private companies (Nilsson et al., 2012). In the sheep meat sector, there are – in addition to the big slaughterhouses – several small, newly created co-operatives specialising in organic or local meat, with their customers being very close to the farms.

The cereal trade is generally a part of the business of input suppliers. There are several operators in the Swedish market. The largest one is Lantmännen a farmers' co-operative, which also has a few local co-operatives as organisational members. Lantmännen accounts for about 40% of total cereal trade (Nilsson et al., 2012). The second largest player is Svenska Foder owned by Danish DLG. The other co-operative group consists of regional co-operatives, mainly in Southern Sweden, which are members of the Danish DLA Agro.

In the egg sector, the role of co-operatives has traditionally been quite strong. However, there is now only one Swedish co-operative, namely Norrlandsägg. The other co-operative, Kronägg, has merged with the Danish Danæg into a transnational co-operative. Kronägg's market share is less than 20%, and Norrlandsägg is much smaller. Their aggregated market share is less than 25% (Nilsson et al., 2012).

The food industry sector

Profitability is at a relatively constant level in the food industry as a whole when compared with other major manufacturing sectors. However, the sub-sectors closest to agricultural production (meat processing and dairy, slaughtering, milling and baking) are the least profitable (SBA, 2012). Industries that have shown a high growth rate include manufacture of tobacco, fruit and vegetable juice, flour, macaroni, noodles, couscous and similar farinaceous products.

A relatively small part of production in the industry is exported and large enterprises and companies that are part of multinational corporations mainly undertake exporting. Moreover, these firms are the best performers in the sector, in terms of employment and productivity growth. The growth in the industry has mainly been located in rural areas, since it is less dependent on being close to domestic markets and it is more economical to be close to the agriculture sector (SBA, 2016b).

Firms (often multinational) with production in Sweden are leading players in dairy and beverage processing, coffee roasting, fish and meat processing, and milling and baking. The food industry is Sweden's fourth largest manufacturing sector (SBA, 2012). Based on turnover, the largest food industry is meat and meat products (including slaughterhouses), while the bread and flour industry has the largest number of enterprises and employees. Most food industry companies are small, with fewer than ten employees, although the larger companies account for most production. In total, the number of companies in the food industry is increasing while the number of employees is continuing to decline, especially in larger companies. The food industry creates jobs throughout the country, unlike the other three major manufacturing industry sectors (i.e. motor vehicles, chemicals and machinery equipment).

Retail sector

The retail sector currently accounts for 68% of consumer food expenditures, most of which consists of supermarkets, and specialised food and convenience stores (Delfi, 2013). A state monopoly has the sole right for over-the-counter retail sales of alcoholic beverages stronger than 3.5% by volume. There are retail co-operatives and one of the three large groups (COOP) is a consumer co-operative.

Market concentration is high in the Swedish retail market, with few large players. In general, the Swedish food-retailing sector is characterised by a relatively high degree of vertical integration between the wholesale and retail trades. Three large groups and one smaller group are responsible for about 90% of retail sales of food and other everyday commodities. Since 2013, the ICA Group – which is the largest group accounting for 51% of retail sales – and the Federation of Swedish Farmers have been co-operating to increase awareness of Swedish food to consumers.

2.5. Farm sector and farm household financial performance is under stress from low profitability

Profitability trends within different activities in the agricultural sector are an important indicator of how the conditions for entrepreneurship and investment are changing within the agricultural industry. Profitability trends are, in turn, dependent on the development of a number of factors, including price trends for products and the means of production, and productivity and efficiency trends within agriculture.

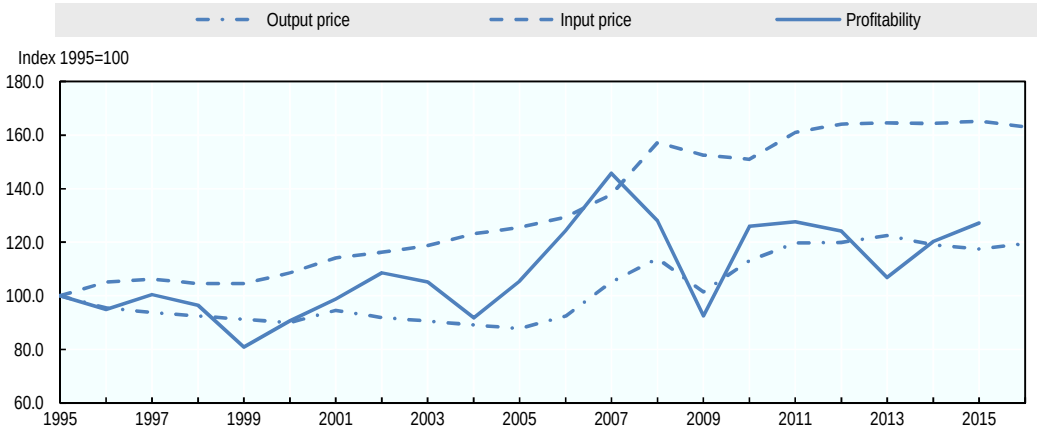
Profitability, measured at current prices, rose by around 27% between 1995 and 2015 (Figure 2.12). During the same period, input prices increased much faster than output prices (output prices rose by around 19% and input prices by around 63%). Thus the profitability trend has been possible due to improved production efficiency and enhanced productivity. Such a relatively weak profitability trend, which also assumes strong growth in efficiency and productivity, in turn places significant overall demands on those entrepreneurs who intend to set up agricultural operations.

Profitability in the agriculture sector is low, especially without support payments (on which farmers depend heavily). During the years 2005-13 only 60% of farms had an average production value larger than the production cost. Only 17% of farms had a production value that could also provide a return on own labour and land, at the same level as the cost of employed labour and cost of renting land. Larger farms with high capitalisation and intensive production are generally more profitable and productive, and are relatively less dependent on support payments. However, these farms are, generally, more indebted, more dependent on employed labour, and rent a higher share of their land (SBA, 2016c).

Profitability has varied considerably between farms, over time and according to location and specialisation, but about half of the profitability variability is farm dependent (i.e. size and management). The variable profitability due to location and specialisation is largely smoothed out by support payments (SBA, 2016c). Profitability also varies by sector. For example, profitability in the beef sector is among the lowest in the European Union, both with and without considering the production-linked support payments (EC, 2013).

Farm-level decomposition of profitability change in four farm specialisations (dairy, beef, pigs, specialised cereals, oilseeds and protein crops) during the period 2005-13 indicates that profitability change is mainly dependent on input and output prices and productivity, and to a lesser degree on output growth (Table 2.A.2). Changes in productivity are the main cause of differences of farm profitability between farms: farms experiencing positive profitability changes are likely to have positive productivity changes (SBA, 2016c).

Figure 2.12. Agricultural profits are low



Note: Profitability is measured "operating surplus" at current prices in accordance with Economic Accounts for Agriculture.
Source: SBA, Statistical Database.

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2.6. Agricultural productivity

Productivity is growing

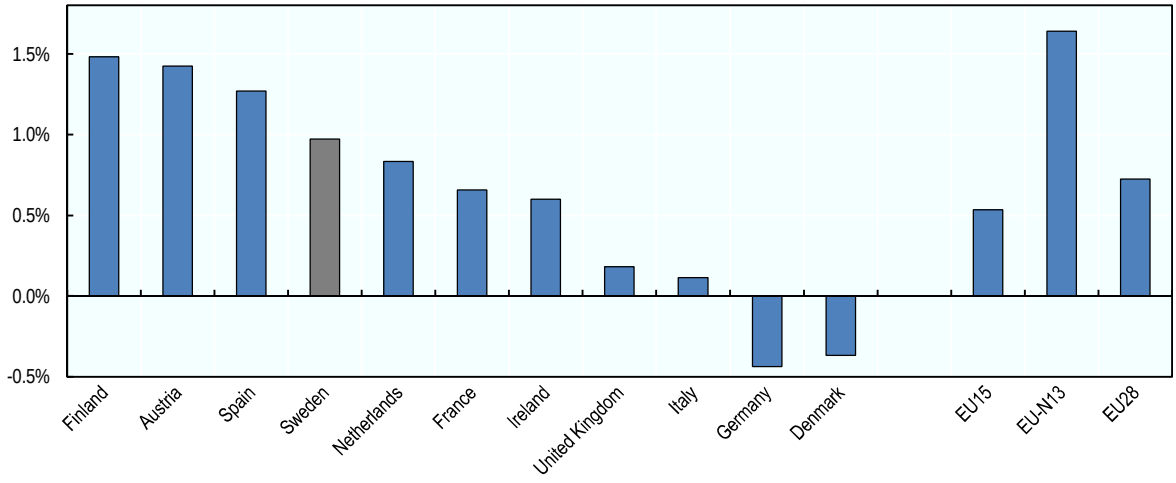
Farm productivity is a performance measure showing the ability of the farm to produce more outputs with the same or fewer inputs. TFP measures the change in output that is not directly originating from a change in input use, but from changes in technology, managerial skills, efficiency and organisation of production.

In terms of TFP growth (the differences between the growth in aggregate outputs and aggregate inputs), TFP in Swedish agriculture grew by 1% per year between 2005 and 2016, which is higher than the EU28 (0.7% annually) (Figure 2.13). From the time of Sweden's accession to the European Union until around 2006, annual productivity growth in agriculture was higher than the EU15 average of 1.3% (EC, 2016).

Figure 2.14 compares Sweden's agricultural productivity trends with its main competitors in agricultural markets since 1995.[8] Over the whole period, Sweden has been performing well, with TFP steadily growing, at a rate comparable to the Netherlands.[9] The growth in TFP in Sweden is mainly due to a strong decline in labour input. Labour productivity growth is the main source of productivity gains, at the expense of capital productivity, which evolved negatively (Figure 2.15). From the early 1990s to 2005, the total workforce in agriculture (in AWU) declined by 38% and by 21% between 2005 and 2016, in line with the restructuring of the sector towards fewer and larger farms.

As labour has been substituted by capital, productivity per unit of capital has decreased. Capital productivity shows an overall decreasing trend prior to the financial crisis, indicating that investments in machinery and buildings have played a major role in output growth and the substitution of labour. After the financial crisis, capital productivity growth recovered, mainly linked to this slowdown in investment growth (Figure 2.15). The growth in intermediate inputs use has remained largely in line with overall TFP growth, while land productivity growth improved, particularly after the financial crisis, as outputs grew while the Utilised Agricultural Area (UAA) declined by 1.7%.[10]

Figure 2.13. Average annual total factor productivity growth in Sweden and selected EU countries between 2005 and 2016



Note: Average growth calculated as compound annual growth rate. To smoothen out the effect of weather variability, the three-year moving average TFP is used: TFP 2005 = average (203, 2004, 2005); TFP 2016 = average (2014, 2015, 2016).
Source: European Commission, DG AGRI based on Economic Accounts for Agriculture, January 2018, https://ec.europa.eu/agriculture/cap-indicators/context/2017/c27_en.pdf.

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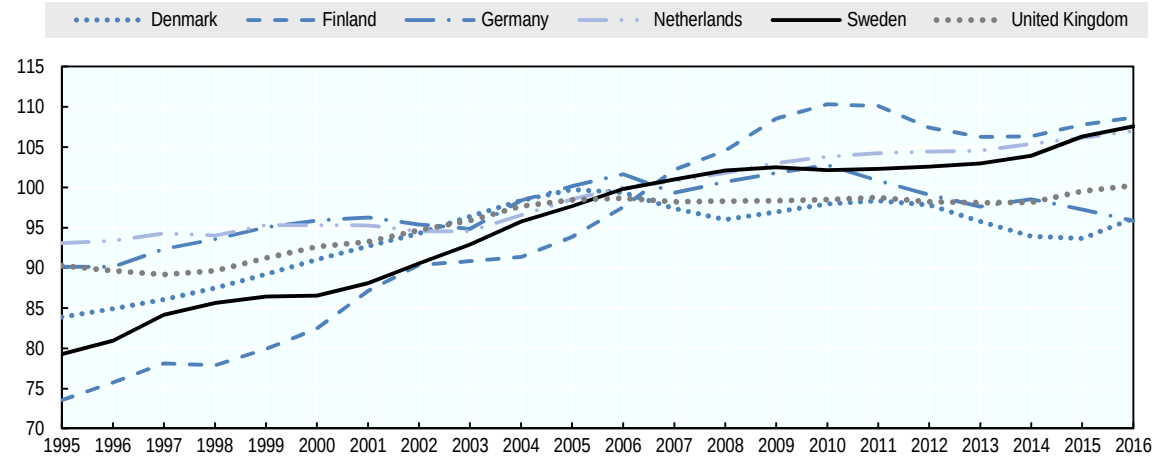
Figure 2.14. Trends in total factor productivity growth in Sweden and selected EU countries, 1995-2016



Source: European Commission, DG AGRI based on Economic Accounts for Agriculture, January 2018, https://ec.europa.eu/agriculture/cap-indicators/context/2017/c27_en.pdf.

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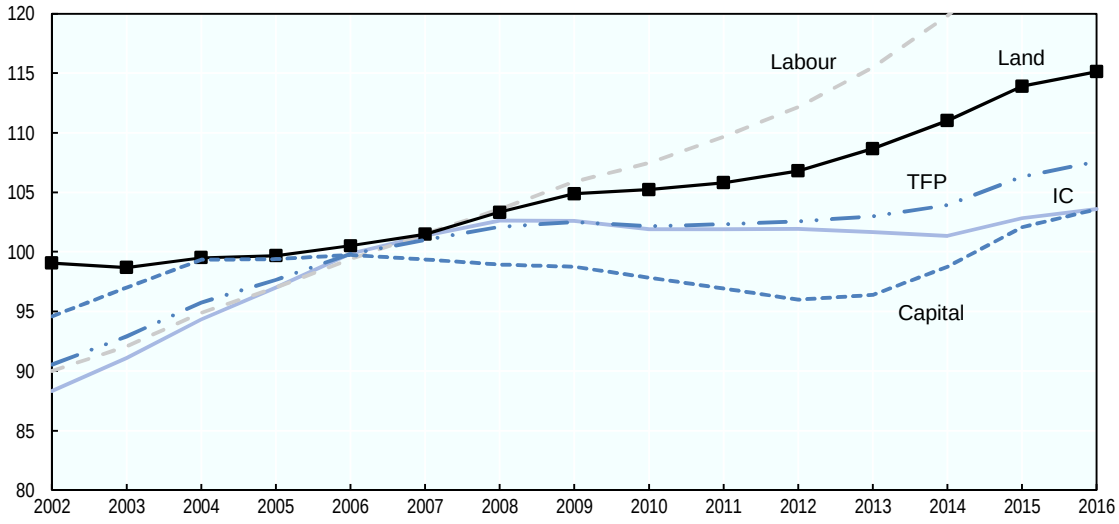
Figure 2.15. TFP and partial productivity growth in Sweden



Notes: IC = intermediate consumption; to smoothen out the effect of weather variability, three-year moving average is used.
Source: European Commission, DG AGRI based on Economic Accounts for Agriculture, January 2018, https://ec.europa.eu/agriculture/cap-indicators/context/2017/c27_en.pdf.

StatLink http://dx.doi.org/10.1787/888933709470

In addition to high TFP growth, Sweden benefits from the relatively good technical efficiency of its farms. Farm-level decomposition analysis of productivity growth for the period 2005-13 indicates that productivity growth is mainly related to change in technical efficiency and in the allocation of inputs (SBA, 2016c). Technical change had a positive impact on productivity growth in several subsectors, including the pig and beef sectors.

Although the technical efficiency of Swedish farms is relatively high, it is estimated that it could be further increased by about 10% (Agrifood, 2013). The highest potential for improvements is on beef farms (17%), which are less efficient and less profitable at both national and international level than other commodity sectors. Table 2.2 summarises the annual average change in outputs, inputs and productivity at the sub-sector level. Estimates for the average productivity and profitability change at farm level in the four subsectors can be seen in Annex 2A (Table 2.A3).

While both output and input use decreased in two subsectors (pigs and milk), input use has declined faster (Table 2.2). The crop, oilseeds and protein crops (COP) subsector is the only one of the with a negative average annual productivity change, due to an increased use of inputs on more land. Concerning the development of land productivity, COP farms (mainly located in south and central Sweden), cattle and milk farms have increased land productivity during the period 2002-14.

In the pig subsector, the productivity change is mainly due to more efficient use of materials and services. The milk subsector has increased the use of capital while enhancing both capital and labour productivity. The cattle subsector has become more extensive, with less use of capital and materials and increased use of labour, land and services.

Compound feed and seeds, which are produced in Sweden, account for a large share of the costs of inputs (Table 2.3). The production of compound feed and seeds are largely dependent on imported commodities as are other inputs, such as mineral fertilisers, pesticides and fuels. The market for inputs is highly concentrated, especially at local level, due to transport costs and economies of scale.

Input costs have followed similar trends as in the rest of the European Union. Fertiliser and energy costs have increased less than other countries in the European Union, partly due to the removal of the

tax on nitrogen content in mineral fertilisers in 2010. Costs of seeds and pesticides have developed less favourably, probably due to Sweden's relatively small market size (SOU, 2014). Costs for some inputs such as fuel are higher than in some countries in northern Europe (SOU, 2015).

Table 2.2. Annual average change in output, input and productivity (%)

	Pigs	Cattle	Milk	Cereals, oilseeds and protein crops
	2002-13	2002-14	2002-14	2002-14
Productivity	2.1	1.3	1.7	-0.9
Output	-3.6	1.4	-1.3	6.7
Input	-5.7	0.1	-3.0	7.6
Partial productivity				
Labour	0.8	1.1	4.0	-1.4
Land	-1.5	1.0	2.0	1.5
Capital	0.6	2.3	0.5	-1.3
Material	2.2	1.6	1.0	-1.9
Service	5.1	0.0	1.1	0.1
Input use				
Labour	-4.4	0.3	-5.3	8.1
Land	-2.1	0.4	-3.3	5.1
Capital	-4.2	-0.9	-1.8	7.9
Materials	-5.9	-0.2	-2.2	8.5
Services	-8.7	1.4	-2.4	6.6
Capital/labour	0.2	-1.2	3.5	-0.1

Source: SBA (2017).

Table 2.3. Agriculture: Share of input costs, 2014

	SEK millions	%
Seeds	2 465	6
Electricity	1 170	3
Fuels and propellants	3 023	7
Fertilisers & soil improvers	2 876	6
Plant protection & pesticides	1 047	2
Animal feed	12 932	29
Maintenance of equipment	2 881	6
Maintenance of buildings	910	2
Veterinary costs	319	1
Financial services	709	2
Agricultural services	3 229	7
Other inputs	9 769	22
Compensation of employees	3 180	7
Total	44 510	100

Source: SBA, Statistical Database.

Box 2.3. Technical efficiency and structural change are the key drivers of productivity growth

Technological improvements are generally essential for increasing farm productivity and reducing production costs, but capital investments might not necessarily be beneficial for farm performance. A study of COP, cattle, milk and pig farms indicate that productivity change is related to structural change in Sweden (SBA, 2017). The milk and pig sub-sectors, which have experienced the largest change in the number of farms and farm size, have had the highest average annual change in productivity.[1]

Farm-level analysis of Swedish agricultural production (1998-2008) indicated that Swedish crop farms would need to grow in size, whereas beef and pig farms need technological improvements, in order to improve productivity (Manevska-Tasevska et al., 2013; Manevska-Tasevska et al., 2014). However, dairy farms were operating at optimal scale. Furthermore, a certain level of diversification activities on farms specialising in a specific enterprise helps them to buffer price shocks in production inputs, generate income from other activities, increase utilisation of under-used inputs, etc. Farms managed by younger farmers are more technical efficient. Technological improvements are generally essential for increasing farm productivity and reducing production costs, but capital investments might not necessarily be beneficial for farm performance. The beef sector appears to be overcapitalised and higher capital use on Swedish beef farms might not improve farm technical efficiency (Manevska-Tasevska et al., 2013; Manevska-Tasevska et al., 2014). Organic farms are, in general, less technical efficient without environmental payments.

Feed costs represent the highest share of the total costs of the livestock production (EC, 2013; Manevska-Tasevska et al., 2013), and feed is thus the main area where larger savings (in absolute terms) can be made. Swedish beef farms with large grazing area per animal and farms located in regions with a longer grazing period (implying low-cost feeding for the animals) are on average more efficient (ManevskaTasevska et al., 2014).

Regional differences in farm performance are common on Swedish farms. Cereal and milk farms in southern Sweden are generally better performing (LRF, 2012). Swedish farms in less favoured areas are on average less efficient than corresponding farms in other regions. Even with the support received, such areas are generally not compensated for the competitive disadvantages arising from the natural handicaps (Manevska-Tasevska et al., 2013; Manevska-Tasevska et al., 2014).

1. Similar results have also been found by Agrifood (2014).

Competitiveness of the food manufacturing industry varies across sectors

The food manufacturing industry achieved robust growth in production and labour productivity over the period 2005-15, which exceeded most EU Member states (Table 2.4). Export growth, while lower than most EU Member states, was higher than most Scandinavian countries However, the absolute size of the food industry is small and exports are limited. The share of the food industry in manufacturing is 9% by turnover and 10% by employment, which is lower than most OECD countries.

Sweden scores slightly above average on the overall competitiveness of its food industry (Figure 2.16), mainly due to the highest score for its labour productivity growth.[11] Although Sweden's share of food manufacturing on the world market increased, its comparative advantage declined. The growth rate of real turnover is also below the benchmark countries and its performance relative to overall manufacturing is weak as other manufacturing sectors grew faster.

The assessment of the competitiveness of nine sub-sectors in Sweden's food manufacturing industry shows the diversity of performance (Figure 2.17). The fruits and vegetables, bakery, meat, other food, and animal feed industries are found to be the most competitive food industries in Sweden, although these sectors do not necessarily account for large shares in the food industry. Labour productivity growth is higher than in the benchmarking countries. On the other hand, seafood, dairy, and beverages are found to be losing comparative advantage, have weak growth rate of real turnover and are losing shares relative to the whole manufacturing industry. While the dairy industry has experienced higher labour productivity growth than the benchmarking countries, both seafood and beverage experienced lower growth. Grain milling is slightly above average on overall competitiveness.

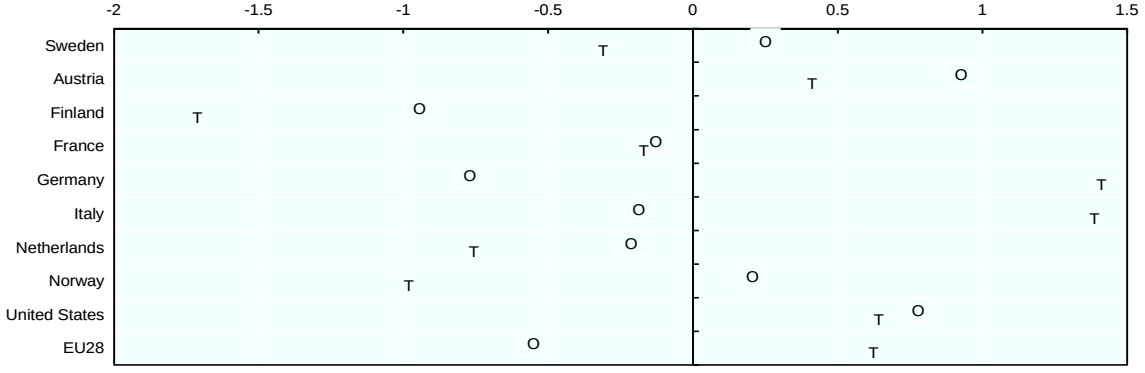
Table 2.4. Performance of food manufacturing industry in selected OECD countries, 2005-15

Country	Turnover			Exports		Employment			Labour productivity	
	Value (EUR billion)	Growth (%)	Share in manufacturing (%)	Value (EUR billion)	Growth (%)	Value (1000)	Growth (%)	Share in manufac-turing (%)	Value (EUR 1000 per employee)	Growth (%)
Sweden	18	2.4	9.1	5	4.0	54	-1.1	10.1	332	2.5
Austria	23	5.2	12.8	9	4.0	81	1.0	13.3	282	2.4
Finland	11	1.8	8.8	1	0.7	39	0.6	11.8	282	-0.4
France	184	2.4	21.3	42	2.9	545	-0.9	19.4	337	2.0
Germany	187	1.5	9.1	53	4.8	821	0.4	11.6	228	-0.1
Italy	132	2.3	14.9	29	4.6	346	-0.2	11.1	381	1.2
Netherlands	71	3.4	21.5	49	5.4	124	0.3	19.5	572	1.6
Norway	23	4.1	25.2	4	2.6	52	0.9	22.2	441	1.6
United States	775	3.4	16.0	67	7.6	1533	-0.2	13.7	506	1.8
EU28	1115	1.4	15.2	95	5.7	4210	-0.3	14.9	265	0.3

Note: Growth rate is average annual compound growth.
Source: Statistics Sweden, Eurostat, Census Bureau for United States and UNComtrade.

On the performance related indicators, the strongest growth in real turnover is observed for the fruit and vegetables industries, followed by bakery and meat in comparison with the other benchmark countries, while the relative performance of the dairy industry is the weakest of the subsectors. Fruit and vegetables and meat are the only industries where growth performance relative to the whole manufacturing industry is above the average of the benchmark countries. Other food and animal feed industries experienced weak relative growth performance even though they achieved higher overall growth, compared to the benchmarking countries.

Figure 2.16. Competitiveness of the food manufacturing industry in Sweden



Notes: The location of each indicator is based on the Z-score that compares the values for individual sub-industries to the overall average (Wijnands et al., 2015); O: Overall competitiveness; T: Difference in Relative Trade Advantage indicator between 2015 and 2005 (value in 2015 minus the value in 2005).
Source: Eurostat, Census Bureau for United States and UNComtrade.

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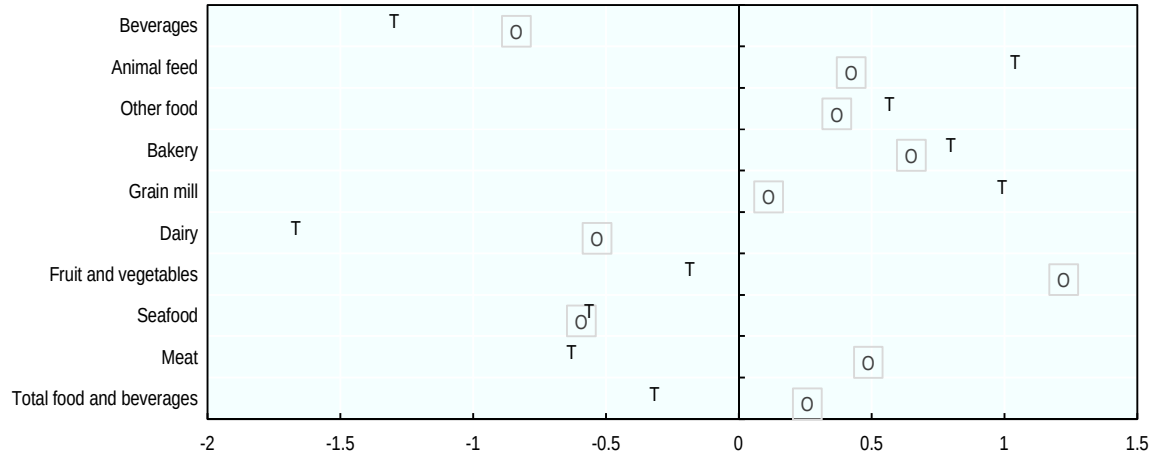
Figure 2.17. Competitiveness of the food and beverage sub-sectors in Sweden



Notes The location of each indicator is based on the Z-score that compares the values for individual sub-industries to the overall average (Wijnands et al., 2015); O: Overall competitiveness; T: Difference in the relative trade advantage indicator between 2015 and 2005 (value in 2015 minus the value in 2005).
Source: Statistics Sweden, Eurostat, Census Bureau for United States and UNComtrade.

StatLink http://dx.doi.org/10.1787/888933709508

The relative performance of labour productivity growth was above average for all industries, except for seafood and beverage. The strongest relative growth was estimated for the dairy industry and the weakest for seafood.

Based on the trade related indicators, the relative increase in world market share was above average in all industries except beverages. The relative performance growth was strongest in seafood and grain milling. The indicator of comparative advantage improved more than average for grain milling, bakery, other food, and animal feed. The loss of comparative advantage of the dairy industry was particularly large as imports of these products increased during the period.

Sweden has made progress in decoupling environmental pressures from agricultural production

Sweden has been one of the earliest OECD countries in raising awareness of environmental issues and developing environmental policies.[12] Sweden has set out 16 major environmental quality objectives covering a wide range of environmental issues. These comprise all economic sectors and range from combating climate change to landscape protection (Swedish Environmental Protection Agency, 2017). Agriculture is concerned with several of these environmental objectives, in particular for three of them: a Varied Agricultural Landscape; Zero Eutrophication; and a Non-Toxic Environment.

The main environmental issues related to agriculture in Sweden are eutrophication, landscape protection and biodiversity protection (Engström, Wadeskog and Finnveden, 2007; SBA, 2008; OECD, 2013). To this has been added more recently the role of agriculture in reducing GHG emissions. Water quality problems are related to the use of nutrients (nitrogen, phosphorus) through the use of mineral fertilisers and manure in livestock, which, when in surplus, can pollute soil, air, as well as surface and groundwater, and coastal areas. Excess nutrients can reduce the quality of drinking water (nitrates) and cause eutrophication, while also contributing to GHG emissions. Agricultural production, as in many OECD countries, is also a source of pressure on ecosystems and habitats and thus has an influence on the protection of biodiversity in Sweden.

Figure 2.18 compares trends in a selection of agri-environmental indicators for Sweden with those in the OECD, EU15 and EU28. The results for the decade 2004-14 clearly show that Sweden has experienced an important decline in environmental pressures exerted by agriculture: a small but

significant reduction in ammonia emissions; marked reductions in nitrogen and phosphorus surpluses related to livestock and mineral fertilisers; reduction in energy use by and share of agriculture; and a fall in agricultural water use. Moreover, these reductions in environmental pressures exerted by agriculture occurred at a much faster rate than the average for OECD, EU15 and EU28 countries.

A decrease in the volume of agricultural production, mainly pig, milk and cattle partly resulted in the decline in environmental pressures. Nevertheless, this decline in production volume is much lower in absolute value than the reduction in environmental pressures, which can indicate some decoupling of agricultural production and environmental outcomes in agriculture or, in other words, a measure of environmental productivity gains in the agriculture sector.

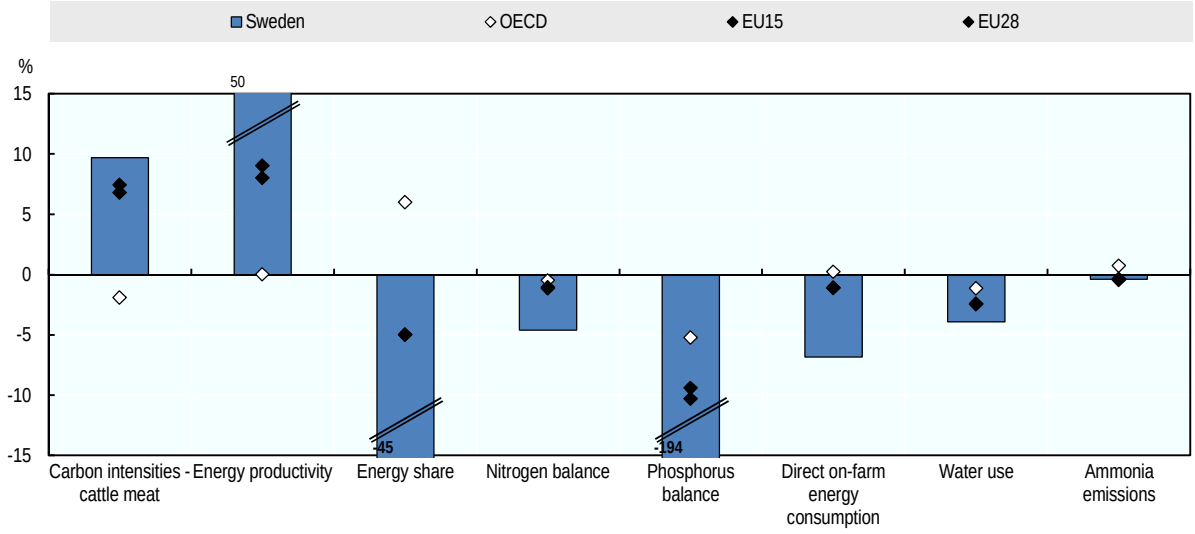
Nutrient surplus

Since 2000, nitrogen and phosphorus surpluses (as measured by the respective balances) have dropped significantly, at more than the OECD average, while agricultural production has remained relatively stable or even increased in recent years, indicating some decoupling of crop production from environmental pressures (Figure 2.19). This is partly due to declines in fertiliser use, although the amount of nitrogen fertiliser used per square kilometre of agricultural land is higher than the OECD average.

The rate of decline in agricultural nitrogen and phosphorus surpluses has been particularly remarkable since the early 1990s. Sales of commercial fertilisers to agriculture and horticulture have also fallen over time.[13] Reduction in nitrogen leaching is mainly due to reductions in cultivated field area, higher nitrogen efficiency in farming and environmental payments for reducing nitrogen leaching.

Figure 2.18. National agri-environmental performance compared to the OECD average

Average annual percentage change 2002-04 to 2012-14, or nearest available period



Note: For Sweden percentages changes for energy productivity, energy share and phosphorus balance are larger than the maximum and minimum limits shown in the graph.
Source: OECD Agri-environmental Indicators; Eurostat for nitrogen and phosphorus balance for EU Member states (2016), and OECD Environmental Database (2017) for water use. FAOSTAT for carbon intensities.

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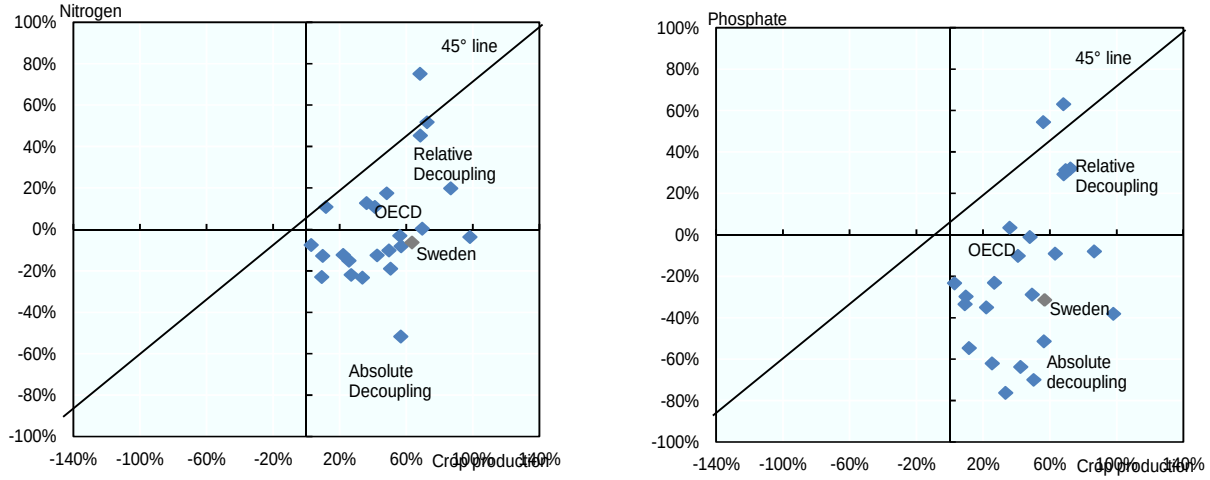
Figure 2.19. Sweden has decoupled fertiliser consumption from crop production



Notes: Consumption of commercial fertilisers is expressed in kg/ha of agricultural area. Crop production value is expressed in USD using 2010 prices and Purchasing Power Parities. OECD excludes the Czech Republic.
Source: Adapted from Figure 4.2, OECD (2017), *Green Growth Indicators 2017*.

StatLink http://dx.doi.org/10.1787/888933709546

However, the physical geographic conditions and the ecosystem vary substantially across the country. Heterogeneous soils, climate and topography together with geographical concentrations of crop production, animal husbandry and human population have led to regionally different eutrophication pressures. Sweden's land area is large relative to the small size of agriculture and the human population and thus national averages can be misleading. Moreover, agriculture and the human population are highly concentrated in the southern part of Sweden. Hence, some parts of Sweden might have high nutrient pressures in highly populated areas at a level comparable with many other regions of Western Europe.

Pesticides

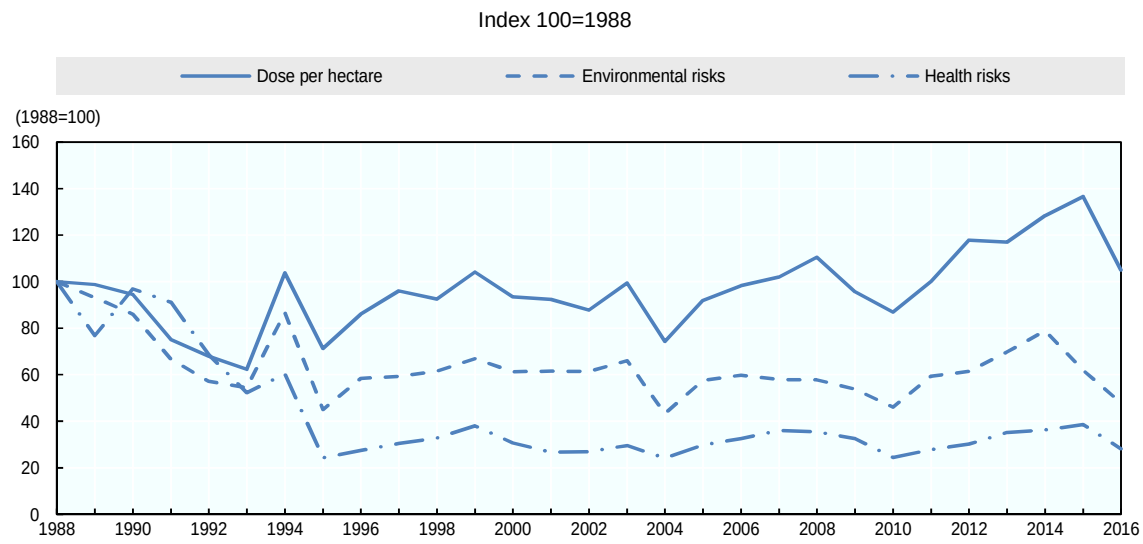
Viewed in a longer perspective, health and environmental risks from pesticides, expressed as indexes, have decreased (Figure 2.20). This is especially true for the health risk index.[14] Compared with the base year 1988, the estimated health and environmental risks for 2015 have fallen from 100 to 31 and 69, respectively. The main decrease in the risk index is at the beginning of the period (Swedish Environmental Protection Agency, 2017). The risk reductions are partially attributable to targeted information and advisory initiatives, successful regulation of certain problem products and product development that has resulted in lower risks, reinforced in 2014 by the requirement to apply Integrated Pest Management according to EU-legislation.

Efforts to ensure the environmental sustainability of crop protection and minimise the associated risks with pesticides are pursued under the National Action Plan on Sustainable Plant Protection, as required by the Directive on the Sustainable Use of Pesticides (Directive 2009/128/EC) (Chapter 4).

In terms of pesticide concentrations in aquatic environments, evidence from the national environmental monitoring exercise since 2002 suggest a declining concentration of pesticides in both surface and groundwater, although situations vary a great deal across locations, depending on the agricultural context (Swedish Chemical Agency, 2017). However, the risk that plant protection products used in agriculture leak to the surface water and negatively affect aquatic organisms has not decreased since 2002 according to the environmental monitoring (Swedish Agricultural University, 2015). However, since mid-90s achieving further reductions in the volume of sales is becoming difficult, as the national action plans have shifted from reduction to focus more on minimising of risks both regarding health and environment and the use of integrated pest management.

Although the goal that the level of plant protection products found in surface and groundwater should be close to zero has not been fulfilled, the levels found in groundwater is dominated by active substances of pesticides that are no longer in use in Sweden and most of them were applied outside the agricultural sector. Seen over three decades the levels have decreased both in ground and surface water (SBA, 2017). The risks for users of pesticides are small. In the study that was made in 2017, the results show that almost all professional users of pesticides use protective equipment, and have procedures in place to minimise risks.

Figure 2.20. Trend in pesticide risk index in Sweden, 1988-2016



Source: Swedish Chemical Agency (2017), "Risk indicators for plant protection products", webpage available at http://www3.kemi.se/en/Content/Pesticides/Plant-Protection-Products/Plant-protection-products-in-Sweden/Risk-indicators-for-plant-protection-products/

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Biodiversity

Much of the biodiversity of the agricultural landscape is found in meadows and pasture lands, which are among the lands with the richest variety of species in Sweden.[15] Biodiversity, cultural heritage qualities and landscape amenities of agricultural areas have declined mainly due to a reduction in semi-natural grasslands and decreasing animal production. The area of traditional meadows and permanent pastureland has fallen by 12% between 2003 and 2015 (SBA, 2016a). Moreover, it is projected that the area of pastureland will decrease by a further 25-30% by 2030, if the present agricultural policies are not altered (SBA, 2016d).

The area and number of grassland habitats is below the minimum level of good conservation status for 19 of the 22 habitat types of cultivated landscapes, with a negative trend for 16 of these habitats (SSIC, 2014). The green infrastructure of the cultivated landscape is not considered satisfactory in many regions due to the loss of area and field elements, and the subsequent fragmentation of grassland habitats (SEPA, 2012).

As a result of intensive farming – mainly in southern plain areas – there has been a decline in biodiversity, cultural heritage qualities and landscape amenities. About 50% of the threatened species are found in agricultural landscapes (SSIC, 2015). The long-term population trend is negative for many bird species, and also for several common species that contribute to the agricultural ecosystem (Green and Lindström, 2015). About 3% of agricultural land is legally protected by specific management plans, whether publicly owned land, or private land regulated by Natura 2000, or other nature reserve prescriptions.

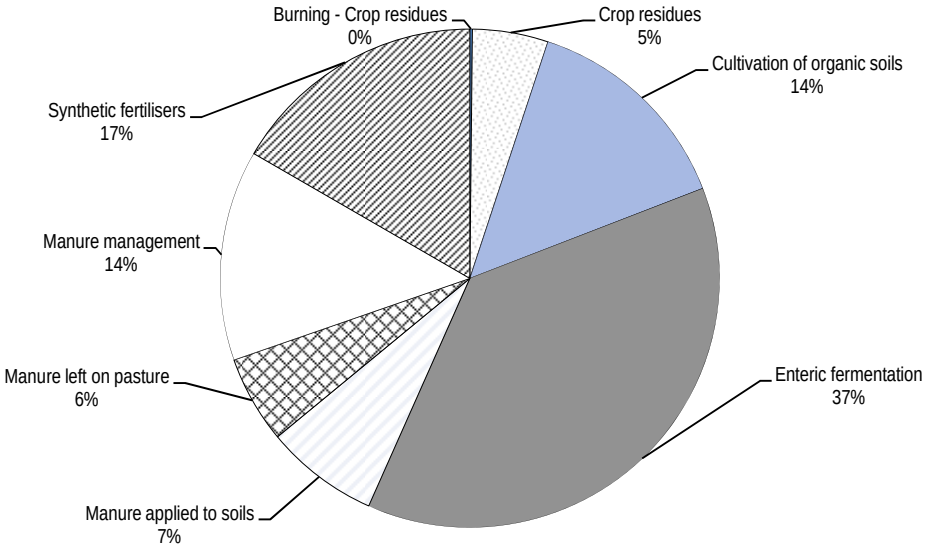
There are special interim targets related to conservation and management of meadows and pastures. All land areas must be conserved and the extent of particularly valuable areas such as meadows and pastures of the most endangered types must be increased. The latter include limestone pavements (*alvars*), forest pastures, summer pastures, heather moorlands and pastures in Norrland.

Greenhouse gas emissions

Agriculture accounts for around 12% of total GHG emissions (similar to the EU average). The main agricultural GHG emissions are CH_4 emissions due to the fermentation in ruminant digestive systems (37%), followed by the use of synthetic fertilisers (17%), manure management and cultivation of organic soils (14% each) (Figure 2.21). Over the period 1995-2014, total agricultural GHG emissions decreased constantly, while agricultural production has varied widely between years. Overall, the carbon productivity – measured as agricultural production per unit of CO_2 emitted – of Swedish agriculture has improved, as GHG emissions decreased at a higher rate than agricultural production (Figure 2.22).

The main drivers of this trend are a decline in the livestock population, particularly for pigs, cattle and dairy cows, and reduced use of fertilisers and animal manure. Sweden's main policies for addressing emissions from agriculture focus on switching away from fossil fuels to renewable energy and through greater energy efficiency in agricultural buildings. These policies include targeted agri-environment payments and investment support under the Rural Development Programme; energy and carbon dioxide taxes and support for biogas production (Chapter 6).

Figure 2.21. Emissions by source (CO2eq), average 1995-2014



Source: FAOSTAT.

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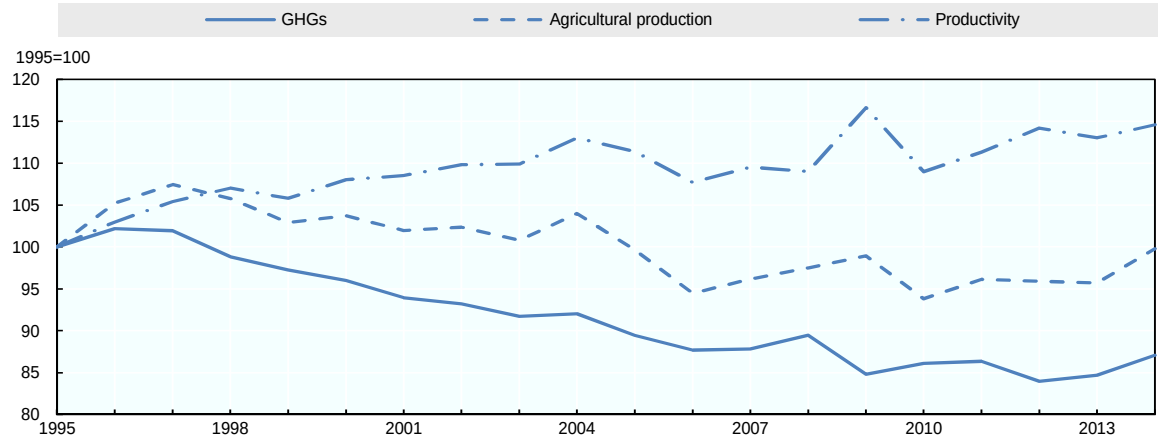
Figure 2.22. Decoupling GHG emissions from agricultural growth



Source: FAOSTAT.

StatLink http://dx.doi.org/10.1787/888933709603

Climate change and sustainable productivity

Climate change is expected to have significant effects on agriculture in Sweden. Atmospheric carbon dioxide is expected to double in concentration, and temperature to increase and become more similar to that of central and southern Europe of today. However, the extreme seasonal variations in day length and low solar elevations at Nordic latitudes will remain the same, and also in the future give low radiation levels during autumn, winter and spring, and high levels during summer, compared to more southern latitudes. Water conditions are also expected to change compared to present. Although it is more difficult to generalise this change, and large spatial differences might occur, a general expectation is that precipitation will increase.

Box 2.4. Impact of climate change on Swedish agriculture

The vegetation and cultivation period will be considerably prolonged according to the climate scenarios. Increased temperatures will lead to increased growth, particularly in the spring, when growth is currently severely restricted by temperature. By the end of the century, the vegetation period in the south may be up to 100 days longer compared with the period 1961–90 (Swedish Portal for Climate Change Adaption, 2016). The improved cultivation conditions present opportunities for increased harvests throughout the country. Yields of autumn-sown crops will increase, and new crops may be introduced. Conditions for livestock farming will be improved by a prolonged grazing season and increased harvests of forage crops.

The change of crop yield in 2080 compared to 1990 has been estimated based on several combinations of models and scenarios; the outcomes show an increase ranging from 20.4% – 36.4%. One estimate is that the yield will increase by 50% in Norrland, 30% in Svealand and 20% in Götaland. If prices, land area and choice of crops remain unchanged, this would result in increased grain harvests worth SEK 1 billion annually at today's prices and earnings will increased by approximately 60%, or SEK 2.8 billion annually.

However, increased production requires increased use of fertilisers. Problems with pests such as insects, fungi and viruses will increase in a warmer climate. If the use of pesticides were to rise to Danish levels, this would mean almost twice the present levels used. Access to water in the future climate will lead to more precipitation in winter time but less in summer time will make new demands on both drainage and irrigation. The increased temperatures in summer time may pose problems for the health and welfare of pig and poultry rearing in particular.

Source: Swedish Government (2007).

Crop suitability is likely to change throughout Europe, and crop productivity (all other factors remaining unchanged) is likely to increase in northern Europe. Longer growing seasons are already producing increased harvests and providing the potential for new crops. At the same time, more pests

and weeds are emerging, and new requirements for irrigation watering and drainage may arise due to the altered precipitation patterns (Swedish Government, 2007).

Despite the fact that the conditions for agriculture in Sweden will generally improve, the risk of extensive crop damage as a consequence of extreme weather events, such as drought, intensive rain and flooding, will probably increase (Swedish Government, 2007). The most serious consequence will be a threat to Saami culture if conditions for reindeer herding worsen. New crops, changed cultivation methods and systems, sowing and harvesting times as well as adapted fertilisation and control measures will be required in order for agriculture to draw full benefit from the fundamentally improved cultivation conditions that a changed climate will entail.

Notes

1. Sweden, with a total land area of 41 million hectares, accounts for nearly 10% of the total area of the EU28.
2. For example, in Skåne county, located in the southernmost part of Sweden, nearly half the land area in 2010 consisted of agricultural land, while the corresponding figure for Norrbotten county, in the far north, was less than 1%. Of the total agricultural land area in Sweden, about 16% was in Skåne county, even though it has less than 3% of the total land area of the country. The reverse situation applies to forests, which in Skåne county amounted to 37% of the land area, while the forested land area in Västernorrland and Gävleborg counties amounted to nearly 90%.
3. In general, RCA values greater than 1 indicate a comparative advantage and a country's specialisation in exports for that sector, meaning that the sector is competitive within the economic system of the country with respect to other sectors. Values less than 1 indicate that a country has not specialised in that sector and that it has no comparative advantage. RCA values less than 0.8 indicate weak comparative advantage.
4. It should be noted that forward and backward linkages are also determined by structural variables such as the size of the economy and remoteness. A country with an important domestic market will have low a backward linkage – as it already has the demand within its border to grow industries –, while the remoteness may exclude the country from the GVCs circuits.
5. In the 1980s, expenditure on food accounted for 18% of household expenditure, but fell to 12% in 2000 and has since then been relatively constant. During the same period the share of household expenditure spent at restaurants and hotels increased from 4% to 6% (SBA, 2015a).
6. In terms of Annual Working Units (AWU), the number of people employed in agriculture has declined from 72 000 AWU in 2005 to 57 000 AWU in 2015.
7. The largest forestry co-operative is Södra Skogsägare (Södra, which has international operations, owns paper pulp mills and saw mills, and is the world's largest exporter of paper pulp (Nilsson et al., 2012).
8. Manevska-Tasevska and Rabinowicz (2014) study finds low TFP for the Swedish agricultural sector as compared to its main competitors (Denmark, Germany, Netherlands, Finland, Ireland, Poland, and the United Kingdom), suggesting the existence of high input costs relative to production value. The study points to a range of factors explaining this low TFP, reflecting Swedish climatic conditions with higher costs of inputs compared to other countries, such as feed, labour costs and the weight of investments. After 2001, the TFP for Sweden increased to the level found for farms in Denmark and the United Kingdom (input costs still higher than production output).

9. Sweden was also among the countries showing high average TFP growth, especially for the period 2000-09. For the period 2004-08, Manevska and Rabinowicz (2014) report 3.7% for Sweden, 0.2% for Germany and 1.3% for Poland; Hansen et al. (2011) estimated that in 2000-09, TFP in Sweden grew at a rate of 2.3% per annum, which compares very favourably with the average growth of 1% for EU15 and 1.2% for EU25. USDA (2017) estimated TFP annual growth rates of 1.1% for the period 2001-14.

10. Between 2010 and 2015, agricultural land decreased by over 45 000 ha.

11. The competitiveness of Swedish food manufacturing and its sub-sectors has been estimated in comparison with its major competitors using the analytical framework developed in Wijnands et al. (2007) and Wijnands et al. (2015). The methodology is based on trade related indicators (market shares in the world market and trade specialisation) and economic performance indicators (annual growth rates of turnover in real terms, labour productivity and share in total manufacturing). The assessment of overall competitiveness is made based on the average of five indicators. The benchmark countries include Austria, Finland, France, Germany, Italy, Netherlands, Norway, United States, and EU28.

12. The fact that the Swedish Environmental Protection Agency is one of the oldest in the world illustrates how important this country's concern for environmental issues is in the Swedish national context.

13. About 77% of Sweden's arable land is fertilised. On this land, the fertiliser application was 107 kg N/ha and 23 kg P/ha per year on average in 2012/13, with a regional variation from 49 kg N/ha/year in Jämtland County to 129 kg N/ha/year in Skåne County (Statistics Sweden, 2016).

14. Sweden uses risk indicators to track risk trends associated with pesticide use over time. The system has been in use since 1997. Results are reported annually in an index with 1988 as the baseline year. It is based on a scoring system of the intrinsic properties of each active substance related to the operator health and the fate and impact on the ecosystems. Also exposure factors used for a reference product and data on use intensity are included. The index shows the trend in the number of hectare doses sold each year (black line), the risk to human health (red line) and the risk to the environment (green line). The number of per-hectare doses (use intensity) is calculated based on sales volumes and the recommended dose rates for each active substance. The number of hectare doses, which remained broadly unchanged for over 20 years, increased significantly during the period 2010 to 2015. A possible explanation can be attributed to an increase in the acreage of winter cereals in Sweden. However, over the long term health and environmental risks have been reduced significantly according to the index.

15. For example, the prescriptions of the Swedish Environmental Code state that: landscape elements such as alleys, cultivation cairns, ponds and stone walls must not be removed or damaged; trees that are valuable for biodiversity or have had a function in old land use must not be cut or damaged when clearing pastures and forest fringes for agricultural land; traditional meadows and semi-natural pastures must not be destroyed by soil cultivation or land reclamation; fertilisation is forbidden on semi-natural pastures and on landscape elements close to arable fields; stones and soil should not be dumped on landscape elements that are valuable for cultural heritage or biodiversity; and fallow fields should not be cut between 1 March and 30 June.

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Annex 2A

Tables

Table 2.A1. Value of agricultural production, 1990-2016 (EUR million)

	1990	1995	2005	2010	2015	2016
Cereals (including seeds)	515	395	452	358	529	469
Wheat and spelt	186	136	207	177	274	237
Soft wheat and spelt	186	136	207	177	274	237
Barley	160	139	136	95	135	123
Industrial crops	222	163	169	203	234	226
Forage plants	551	527	508	608	710	637
Vegetables and horticultural products	229	277	322	368	451	458
Potatoes (including seeds)	112	122	133	116	120	126
Fruits	20	25	50	49	78	69
Crop output	**1 620**	**1 471**	**1 638**	**1 744**	**2 208**	**2 056**
Animals	936	960	998	1034	988	1004
Cattle	371	340	392	402	386	387
Pigs	377	422	366	378	331	332
Poultry	44	74	98	111	134	146
Animal products	1 258	1 195	1 181	1 082	1 140	1 128
Milk	1 082	1 035	1 019	922	959	930
Eggs	114	99	95	104	119	131
Animal output	**2 187**	**2 154**	**2 179**	**2 120**	**2 133**	**2 142**
Agricultural goods output	**3 780**	**3 596**	**3 817**	**3 872**	**4 365**	**4 220**

Note: At constant prices.
Source: Eurostat, Economic Accounts for Agriculture, 2018.

Table 2.A2. Swedish agri-food trade: Top 10 import and export trade partners, 2015

Ranking	Origin of imports		Destination of exports	
		%		%
1	Norway	26	Norway	12
2	Denmark	12	Denmark	10
3	Netherlands	10	Poland	9
4	Germany	10	France	9
5	Italy	5	Finland	8
6	Spain	4	United Kingdom	8
7	France	4	Germany	6
8	Belgium	3	Spain	5
9	United Kingdom	3	United States	4
10	Poland	2	Netherlands	4

Source: Statistics Sweden.

Table 2.A3. Average profitability change and main components by specialisation, 2005-13 (%)

	Profitability	Output growth	Output prices	Input prices	Productivity
Cattle	2	0	2	-3	2
COP	-2	1	1	-2	-2
Dairy	-1	0	2	-4	0
Pigs	1	3	3	-4	1

Source: Swedish FADN, SBA, 2016c. Profitability change is measured in relation to total costs. Productivity change is calculated using production functions with technical inefficiency, one for each specialisation. The production function includes total production value including subsidies and four inputs: capital, land, labour and intermediate inputs.

Chapter 3

The economic and institutional environment for entrepreneurship and investment in Sweden

This chapter gives an overview of the performance of the overall economy, the macroeconomic developments and challenges, governance and institutions, and the incentives in Sweden for investment by firms, including farms, input suppliers, and food companies. The overall regulatory system and conditions for investment are described, in particular as they relate to agriculture and the food sector. Trade and investment policies are examined, as are the credit and tax incentives for R&D in the context of new technologies and innovations in the food and agriculture sector.

Key points

- Sweden is a knowledge-driven economy characterised by robust economic growth, a strong fiscal position, high employment and a well-functioning labour market.
- Inclusive and sustainable growth over the past two decades has underpinned a high quality of life for Swedes.
- In terms of global competitiveness, Sweden currently ranks 6th out of 138 countries.
- Although the overall performance is good, the quality of Sweden's infrastructure needs to be improved.
- Sweden benefits from high quality public institutions creating a sound business environment through strong protection of property rights, rigorous control of corruption, an independent judicial system and a high level of transparency in decision-making.
- Both European Union (EU) and national legislation govern the regulatory environment for entrepreneurship, including the agro-food sector. In general, national legislation sets norms and standards that are well above the EU requirements in many areas of agriculture and horticulture.
- However, the level and complexity of regulations in Sweden are still onerous for business and well above those in other EU Member states within the agro-food sector.
- The stringency of Sweden’s environmental policies is now amongst the highest in the OECD.
- In the food and agriculture sector, most of the legislation is harmonised with other EU Member states, although in some cases, Swedish legislation takes precedence.
- Sweden maintains one of the highest standards on animal health and welfare in the EU as well as globally.
- A special “guarantee” in relation to standards on salmonella and the use of antibiotics in agriculture is applied.
- Regulations on plant protection products are stricter than the harmonised EU legislation.
- Sweden is highly dependent on international trade and investment and there are few barriers to agro-food trade or Foreign Direct Investment (FDI).
- Farmers are subject to the same rules on taxation and social security as the rest of society.

3.1. Macro-economic policy environment and governance

At the broad level, sound macroeconomic policies, leading to high growth and low and stable inflation, play an important role in setting a favourable environment for investment and innovation on farms and in agri-food businesses, which contributes to higher productivity and sustainable use of natural resources. Overall macroeconomic policies and economic growth have implications for facilitating or retarding food and agriculture sector prospects.

Performance of the economy and medium term prospects for growth

Sweden performs well in many measures of well-being relative to other countries in the OECD Better Life Index. It ranks above the OECD average in almost all dimensions. In particular, Sweden is in the top 20% in terms of environmental quality, health status, civic engagement and governance, and work-life balance. In general, Swedes are more satisfied with their lives than the OECD average (www.oecdbetterlifeindex.org/countries/sweden/).

At the forefront of global competitiveness

The World Economic Forum (WEF) Global Competitiveness Index (GCI) for 2016-17 ranks Sweden sixth out of 138 countries (Figure 3.1). Compared with the OECD average, Sweden scores well on its *public and private* institutions; the *macroeconomic environment; innovation*; and having a *sophisticated private sector*. However, Sweden ranks lower on infrastructure, health, higher education and training, and labour market efficiency, and is at a competitive disadvantage in terms of domestic market size.

- Sweden's **innovation system** performs well: The country has a well-performing knowledge, innovative and competitive economy. Sweden's businesses are innovative (2th) and the country is well equipped to embrace the fourth industrial revolution, with a strong score on technological readiness (4$^{th)}$ and ranked within the top 10 in innovation. The higher education system produces world-class science which is reflected, *inter alia*, in the high relative number of patents filled by universities and public labs (2nd).
- **Macroeconomic environment** is very stable and scores very high (5th). Growth has been robust (4.3% in 2015 and 3.1% in 2016) and all the key macro-economic indicators are conducive to sustainable and inclusive growth, driven primarily by rising productivity, dynamic investments and strong domestic demand.
- **Public institutions** are considered to be of high quality (4th). For all aspects of governance – representation and accountability, political stability, absence of violence/terrorism, government effectiveness, regulatory quality, rule of law and control of corruption – Sweden scores above the OECD average. In particular, for the indicators: representation and accountability and rule of law Sweden gets a maximum score, and also very high for control of corruption, government effectiveness and regulatory quality. Political stability and absence of violence/terrorism is the dimension for which Sweden scores the lowest although significantly above the OECD average. Property rights, including financial assets and intellectual property rights are very well protected. In ethics and corruption the overall rank shows that illegal diversion of public funds, irregular payments and bribes are uncommon. The judicial system is independent from influences of the government, individuals or companies. Government effectiveness ranking is very high, reflecting efficient government spending, a well-functioning legal system in settling disputes and in challenging regulations, as well as a high degree of transparency in government policymaking. However, the relatively low ranking of the burden of government regulation suggests that it is not always easy for companies to comply with public administration requirements (e.g. permits, regulations, reporting).

- Infrastructure does not rank as high as other competitiveness indicators (20th), but the overall quality of transport infrastructure in Sweden compares well with the OECD average.

- The education system is considered to be reasonably good. It ranks 24th for primary education and 15th for its higher education and training (Chapter 4)

- The labour market functions relatively well and Sweden has a high employment rate, with a significant level of women's participation in the workforce. Nevertheless, there is still room for improvement in labour market flexibility as Sweden has dropped 26 places to 120th position. The effect of taxation on incentives to work and restrictive labour regulations are perceived as the two most important factors hampering businesses. The country also faces a difficult housing market as a continued increase in house prices could impede mobility and negatively impact labour market efficiency (OECD, 2017a).

- Markets are considered highly efficient and very supportive of business activity (ranked 11th).

Strong macro-economic performance to be sustained, but challenges have emerged

Economic growth has been robust, averaging 3.7% per year for the period 2015-16 (OECD, 2017b). Low interest rates, an improving global outlook and growing public spending are fuelling a booming economy. Growth is expected to remain solid over the coming years, albeit slowing somewhat as the economy is now operating near full capacity.

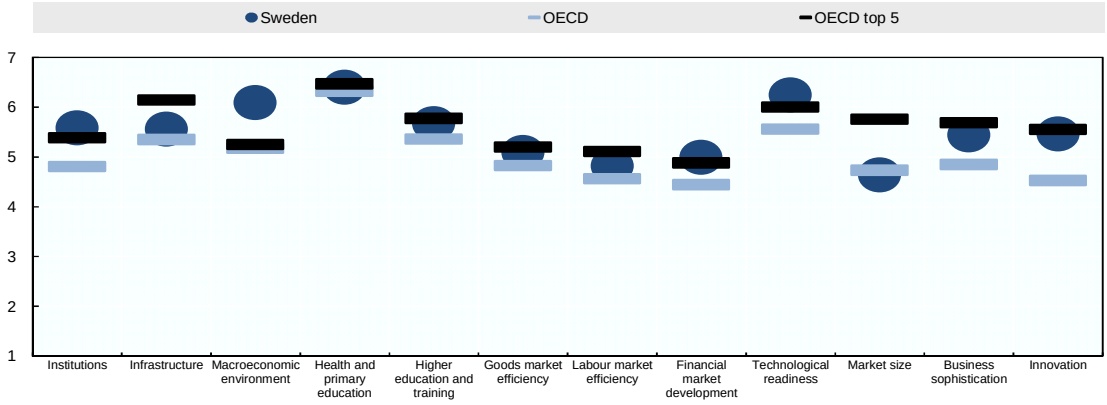
Sweden enjoys a strong fiscal position, with gross government debt (Maastricht definition) at 42.3% of GDP in 2016 (OECD, 2017b). Since 1995, inflation as measured by the consumer price index has been below 2%, on average. The Swedish economy recovered quickly from the 2008-09 financial crisis, and today it is one of the few countries where the GDP per capita is higher than in the pre-crisis period, currently 17% above the OECD average. Output growth has been primarily driven by strong domestic consumption, dynamic investment, labour force expansion, rising productivity and stronger international markets.

At the same time, the decoupling of carbon emissions (CO_2) from output reflects the fact that Sweden is among the most innovative OECD countries when it comes to environment-related technologies. The availability of water and wood, along with the policy choice to use significant amounts of nuclear- generated electricity have kept CO_2 emissions to almost one third of the OECD average and are declining (OECD, 2017a). Decreasing emissions and the adoption of cleaner technologies is also the result of an efficient system of environmental taxation, including both energy and CO_2 taxes (OECD, 2014a).

Figure 3.1. Indicators of Swedish global competitiveness and problematic factors for doing business

A. Global Competitiveness Index, score by component, 2016-17

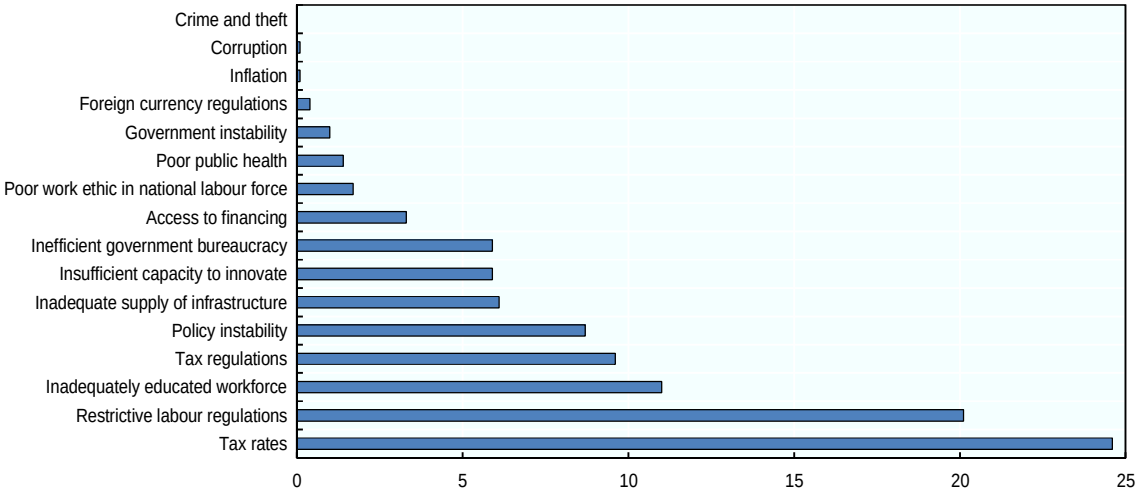
Scale 1 to 7 (best)



B. Global Competitiveness Index, rank by component, 2016-17

Global Competitiveness Index			
Basic requirements	7	Efficiency enhancers (50%)	12
Institutions	4	Higher education and training	15
Infrastructure	20	Goods market efficiency	11
Macroeconomic environment	5	Labour market efficiency	18
Health and primary education	24	Financial market development	10
Basic requirements (20%)	7	Technological readiness	4
Institutions	4	Market size	40
Infrastructure	20	Innovation and sophistication (30%)	5
Macroeconomic environment	5	Business sophistication	6
Health and primary education	24	Innovation	6

C. The most problematic factors for doing business in Sweden, 2016-17



Notes: From the list of factors above, respondents were asked to select the five most problematic for doing business in their country and to rank them between 1 (most problematic) and 5. The bars in the figure show the responses weighted according to their ranking. OECD Top 5 refers to the average of the scores for the top 5 performers among OECD countries for the overall index (Switzerland, Unites States, Germany, Netherlands and Japan). Indices for EU28 and OECD are simple average of member-country indices.

Source: World Economic Forum (2017), *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/10.1787/888933709622

Government measures for promoting economic growth and jobs

Although the Swedish economy is highly competitive among OECD countries, new challenges have emerged. Unemployment has been gradually declining since 2014, and now stands at 6-7%, close to the structural rate of unemployment. The unemployment rate is levelling off as shortages of qualified labour are intensifying, notably in construction. However, low-skilled workers, especially immigrants, face difficulties finding jobs, reflecting high skill requirements for most jobs in Sweden. Indeed, despite strong output growth, unemployment is increasing among some vulnerable groups. On the other hand, shortages of workers are appearing in some sectors, including construction, education and municipal services (OECD, 2017a). Nevertheless, it is unlikely that these challenges will affect innovation and productivity of the agro-food chain in a significant way.

Measures have been taken to favour a better environment for economic growth and jobs (OECD, 2017a). Regarding the labour market challenges, the government favours lowering labour costs for low-skilled workers through subsidies. The subsidy system will be simplified to increase take-up. This should help increasing the employment rate of vulnerable groups across the country.

Moreover, starting a business has become easier, as a company can be registered in five days. The government has also for some time been promoting women entrepreneurship through business development programmes. The most recent development is the National Strategy for business promotion on equal terms (for women, youth and foreign-born) for the period 2015-20. An increased participation of women and immigrants to the economy has been proven to contribute positively to the economy.

Governance and institutions

Good governance systems and effective institutions provide economic actors with the assurance that the government and its agencies are accountable, transparent and predictable. They are a fundamental pre-condition both to encourage public and private investment in the economy and to enable those investments to benefit investors, consumers and citizens. Moreover, governance systems play an important role in addressing market failure, influencing the behaviour of firms in terms of investment and compliance to regulations, as well as the efficient functioning of farm input and output markets in the food and agriculture sector. Addressing environmental issues and natural resource use are key components of the institutions in designing effective, efficient and publicly acceptable policy tools.

Transparency, accountability and predictability of governance

Every year the Government issues appropriation directions for government agencies. These set out the objectives of the agencies' activities and how much funding is available to them. The Government therefore has quite substantial scope for directing the activities of government agencies, but it has no powers to interfere with how an agency applies the law or decides in a specific case. The government agencies take these decisions independently and report to the ministries.

At the sub-national level, there are two tiers of general government with general competencies: counties (*landsting*) and municipalities (kommuner) (Box 3.1). Agricultural concerns have been under the responsibility of the "Ministry of Enterprise and Innovation'' since 2015. There are several other government agencies in charge of agriculture, food and environmental issues (Box 3.2).

Sweden ranks among the most decentralised countries in the world, in terms of public service delivery, taxation and public expenditure. Swedish sub-national government expenditure accounts for approximately 25% of the country's GDP. Sub-national governments account for about half of total general government expenditure, and enjoy extensive spending and taxing autonomy. An important challenge is to ensure co-ordination for investment across different sub-national entities (OECD, 2017c).

Box 3.1. Tiers of general government at the sub-national level

- The *20 county councils* are run by directly elected assemblies and are mostly responsible for health services (80% of their budget). They may also engage in promoting culture, education and tourism. The responsibility for regional and local public transport is shared between the municipalities and the County Councils (but accounts for less than 6% of County Councils' budgets). Ten County Councils have responsibility for regional development policy.
- The *290 municipalities* are responsible for basic and secondary education, kindergarten, elderly care, social services, communications, environmental protection, fire departments, public libraries, water and sewage, waste management, civil defense, public housing and physical infrastructure.
- The *County Administrative Board* is the representative of the Government in the region and the co-ordinating body for State activities in the county.

Box 3.2. Agricultural authorities

The Ministry of Enterprise and Innovation and the Minister of Rural Affairs handle all policy making matters concerning agriculture, fisheries, horticulture, animal health, food, seed control, agri-environmental concerns, hunting and game keeping that are determined at Government level.

The Swedish Board of Agriculture (SBA) is the implementing agency and the Government's expert authority on agriculture and is responsible for issues related to agriculture and horticulture. The Board is also the governing authority of the district veterinarians, and is responsible for food preparedness.

Agricultural units at the County Administrative Boards handle various forms of agricultural support and are responsible for extension services and training in their regions. They administer and inspect several of the agricultural subsidies at the regional level.

The Environmental Protection Agency (EPA) handles issues concerning environmental protection and conservation. The Agency ensures that decisions on environmental policy are implemented, and works both long-term and proactively for sustainable development. The Agency is an authority subject to the Ministry of the Environment and Energy.

The National Board of Forestry is the monitoring authority for all Swedish forests and ensures that the Government's forest policy is implemented. The authority strives to ensure that all forests are maintained and cultivated, and also emphasises the forest's recreational values.

The National Chemicals Inspectorate (KemI) is the central monitoring authority and handles matters concerning health and environmental hazards related to chemical products. KemI is an authority under the Ministry of the Environment and Energy.

The National Food Administration is the administrative authority for issues relating to food, including drinking water. It acts in the interests of consumers for safe, good-quality food, good practices in food handling and healthy eating habits. The Board monitors food quality and employs inspection veterinarians at slaughterhouses. The National Food Administration is an authority under the Ministry of Enterprise and Innovation.

*The National Veterinary Institute (SVA***)** provides authorities and private individuals with expertise and service in matters of veterinary medicine. One task of the SVA is to investigate the origin, cause, and spread of contagious animal diseases. The National Veterinary Institute is an authority under the Ministry of Enterprise and Innovation.

The Sami Parliament works for a thriving Sami culture based on sustainable reindeer husbandry and other Sami businesses. The Sami Parliament is both a public authority and a parliament elected by the Sami people. It is responsible for funds that promote sustainable reindeer husbandry.

The Swedish Agency for Economic and Regional Growth aims to promote growth in Sweden by increasing the competitiveness of firms, facilitating entrepreneurship and creating attractive environments for companies in the regions. It is responsible for disbursing EU funds to promote regional growth and employment. The Agency is an authority under the Ministry of Enterprise and Innovation.

Vinnova is Sweden's innovation agency to promote sustainable growth by improving the conditions for innovation, as well as funding needs-driven research. Vinnova is a Swedish government agency working under the Ministry of Enterprise and Innovation and is the national contact agency for the EU Framework Programme for R&D.

Ensuring equity in the provision of public services and local accountability in terms of quality and efficiency is a high priority, but funding arrangements may not always be effective in sparsely populated areas, discouraging social innovation and practical inter-municipal co-operation (OECD, 2017c).

Quality of public institutions

According to the WEF Global Competitiveness Index (CGI), Sweden performs very well in the quality of public institutions with an overall ranking of 5 out of 138 countries (Figure 3.2), and fourth amongst the OECD countries. Sweden scores above the OECD average in all categories and compares with the OECD top 5 average for all five dimensions.

The Swedish decentralised model has been proven successful and beneficial to rural entrepreneurship and agro-food businesses: local governments are able to provide high-quality services and subnational authorities are reasonably well equipped financially to deliver their task and meet expenditure responsibilities (OECD, 2017c).

Rural policy however is still defined quite narrowly, to a large extent around the parameters of the CAP Pillar 2 funding. Although recent advances have been made to broaden the focus of the Rural Development Programme, it is still insufficient for enhancing the long-term prosperity and well-being of rural communities. Against this backdrop, Sweden is currently conducting a Parliamentary Inquiry into rural policy and has a strategic opportunity to evaluate and improve its approach to rural development (Chapter 5). The OECD has recommended that Sweden strengthen the role of political bodies at a regional level in regional and rural development in order to help deliver a more integrated approach and realise policy complementarities for rural places (OECD, 2017c).

Mechanisms for ensuring transparency

Sweden has long placed regulatory simplification, and with it stakeholder engagement, at the centre of its Regulatory Reform agenda. Public consultation is a routine part of developing regulations. The principle of public access in Sweden entitles the general public to access official documents with a few exceptions, reflecting a high degree of transparency in decision making.

OECD Indicators of regulatory policy and governance from the OECD 2014 Regulatory Indicators Survey show that Sweden is performing highly (OECD, 2015a). The three composite indicators provide an overview of a country's practices in the areas of stakeholder engagement, Regulatory Impact Assessment (RIA) and *ex post* evaluation. Overall, Sweden scores 2 (out of 4) for RIA and stakeholders engagement, just below the OECD average. Regarding *ex post* evaluation, Sweden also scores 2, which is significantly above the OECD average. Transparency is high for *ex-post* evaluation but is quite low for RIA and stakeholders engagement. There is almost systematic adoption of RIA and stakeholders engagement whereas *ex post* evaluation needs to be more comprehensive.

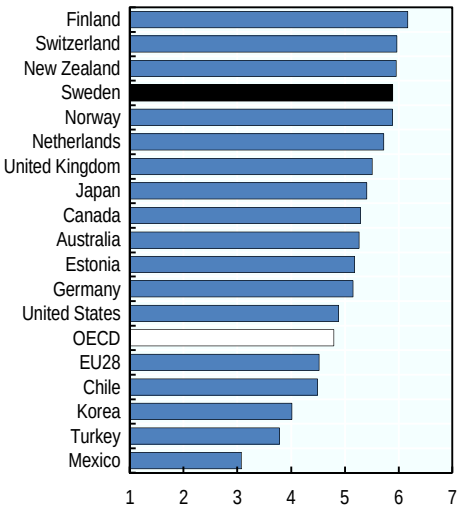
Sustainability criteria in public procurement

In Sweden, the government has taken actions to promote green procurement since 1995. The main output is the national tool for Sustainable Public Procurement (SPP), which has been developed and monitored by the Swedish Environmental Protection Agency (SEPA). This tool is available online and is organised as a database wizard where procurers can choose among sustainability criteria (both environmental and social for various goods, services and work contracts. Local authorities, county councils, government agencies and publicly owned companies all use the national SPP tool. Private purchasers and NGOs can also use the SPP criteria. Since 2014, all actions and information services supporting procuring authorities have been merged under the Swedish Competition Authority (OECD, 2014).

Figure 3.2. Global Competitiveness Index: Quality of public institutions, 2016-17

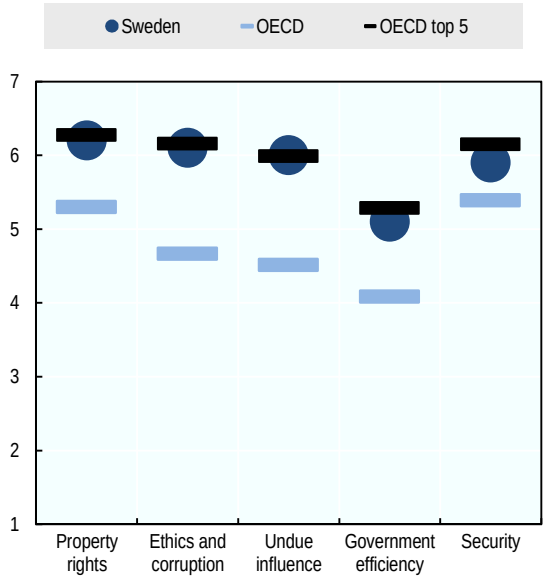
Scale 1 to 7 (best)

A. Total index, international comparison



Indexes for EU28 and OECD represent simple averages of member-country indexes.

B. Sweden's index of quality of public institutions by component



OECD top 5 refers to the average of the scores for the top five performers among OECD countries - Finland, Switzerland, New Zealand, Sweden, and Norway.

Note: Property rights refer to the average of the indices Property rights and Intellectual property rights. Ethics and corruption refers to the average of the indices: Diversion of public funds, Public trust in politicians and Irregular payments. Undue influence refers to the average of the indices for: Judicial independence and Favouritism in decisions of governmental officials. Government efficiency refers to the average of the indices for Wastefulness of government spending, Burden of government regulation, Efficiency of legal framework in settling disputes, Efficiency of legal framework in challenging regulations and Transparency of government policymaking. Security refers to the average of the indices for: Business costs of terrorism, Business costs of crime and violence, Organized crime and Reliability of police services.

Source: World Economic Forum (2016), *The Global Competitiveness Report 2016-2017: Full data Edition*, Geneva 2016. https://www.weforum.org/reports/the-global-competitiveness-report-2016-2017-1.

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3.2. Regulatory environment for entrepreneurship

The overall regulatory environment establishes the conditions under which all businesses, including farms, input suppliers, and food companies, operate and make investment decisions. Regulations that ensure competitive conditions in domestic markets, including low barriers to entry and exit, facilitate innovation and productivity growth, including through structural change. Regulations may enable or impede knowledge and technology transfer directly, contributing to more or less innovation, including in sustainability-enhancing technologies (OECD, 2014a).

National regulations

Sweden is a business friendly country with few barriers to starting and running a business. Swedish competition policy is required to be in compliance with general EU principles. According to the OECD's Product Market Regulation (PMR) index, Sweden is close to the OECD average in terms of its business friendly environment (Figure 3.3B). Over the last decade, Sweden has become less restrictive in terms of entrepreneurship and barriers to trade and investment, similar to the general trend in many OECD countries (Figure 3.3A). The administrative burden on business start-ups is relatively low as compared to other OECD countries. However, the complexity of the procedures and burden of compliance are more challenging (Figure 3.4).

Regulations translate into direct and indirect costs for business and, together with other factors such as the efficiency of the public administration, the degree of development of service sectors determine the conditions for doing business (Figure 3.5). Based on the assessment of key functions to operate a business, the World *Bank's Doing Business* ranks Sweden 10th among the 190 economies surveyed. The key regulatory aspects associated with the ease of starting a business and the adherence to the rules and regulations are ranked relatively high, but obtaining credit is more difficult.

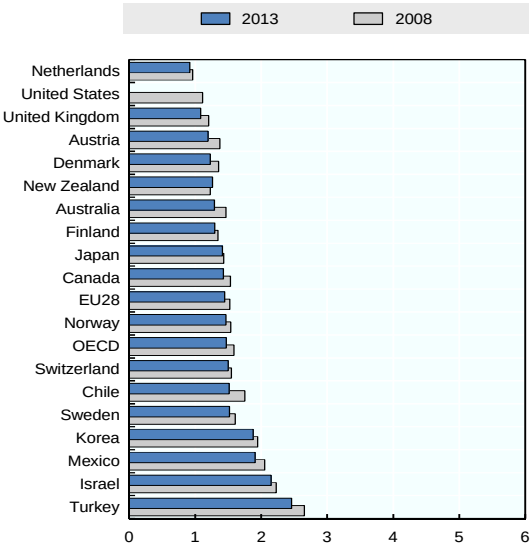
Agri-food enterprises are governed by a number of regulations and conditions. These include both legislation and the industry's own agreements or codes. Legislation is based on the common EU regulations, complemented by national regulations. Regulations and industry agreements provide rules for operating in the market, and involve not only direct costs such as increased administration, but also indirect costs of adapting to external EU regulatory requirements.

To enhance the competitiveness of agriculture, the Swedish Government Commission for Competitive Agriculture has undertaken an analysis of the regulations that are considered of high importance in terms of profitability and competitiveness (SOU, 2015). These include labour costs, animal protection legislation, and plant protection legislation, and permit approval with related environmental impact descriptions in accordance with the Swedish Environmental Code.

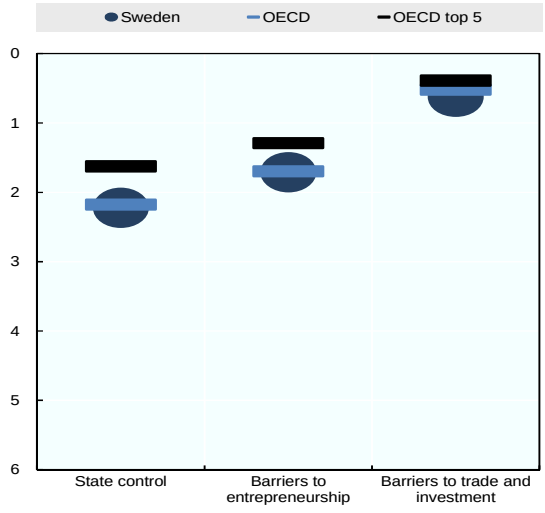
Figure 3.3. OECD Integrated Product Market Regulation (PMR) indicators, 2008 and 2013.

Scale from 0 (least) to 6 (most) restrictive

A. Trends in Integrated PMR index, by country, 2008 and 2013



B. Sweden's Integrated PMR index, by component, 2013



OECD top 5 refers to the average of the scores for the top five performers among OECD countries (Netherlands, United Kingdom, United States, Austria and Denmark), with US data referring to 2008.

Note: Indices for EU28 and OECD are the simple average of member-country indices. OECD PMR indicators measure key regulations in the areas of state control, barriers to entrepreneurship, and barriers to trade and investment.
The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.
Source: OECD Product Market Regulation Database, 2014. www.oecd.org/economy/pmr.

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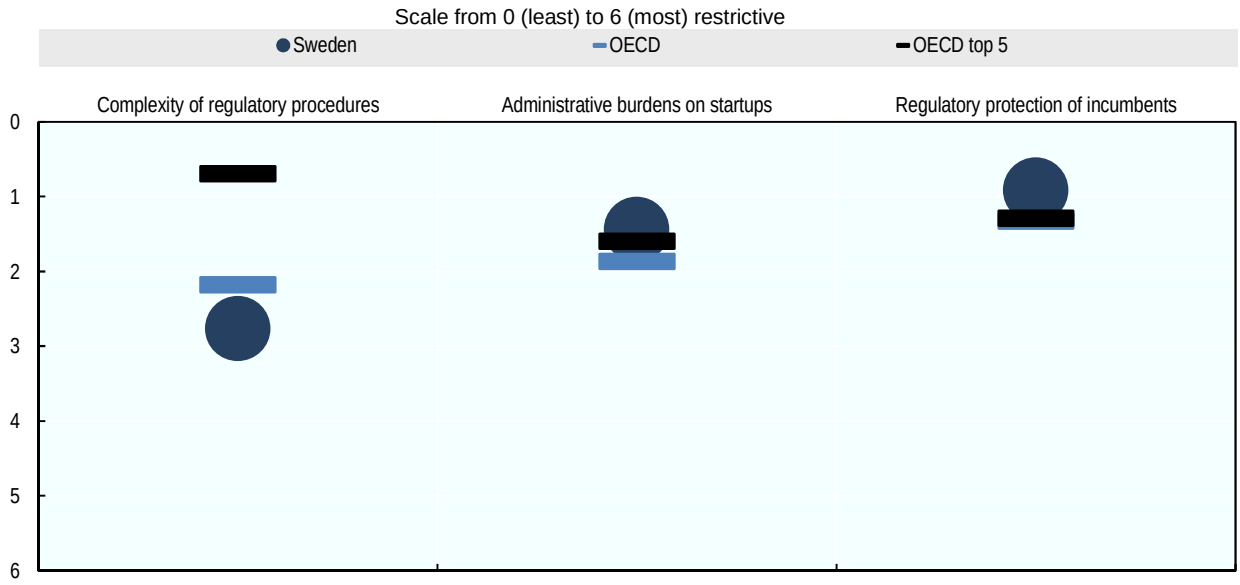
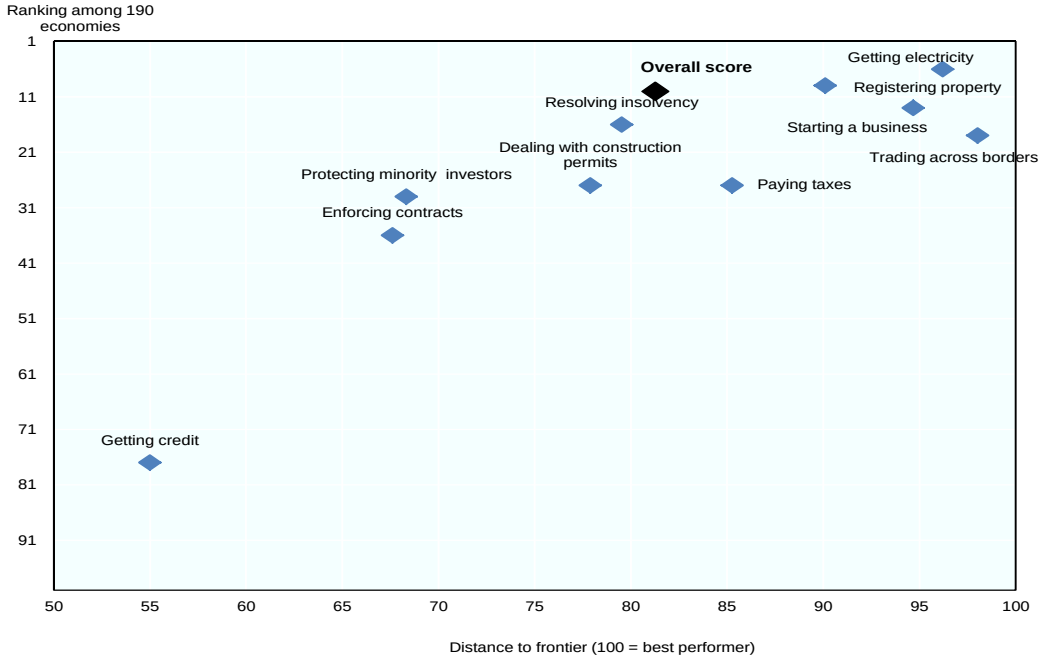
Figure 3.4. Barriers to entrepreneurship, by regulatory area, 2013



Notes. Indices for OECD all are the simple average of member-country indices.
OECD top 5 refers to the average of the scores for the top five performers among OECD countries (Slovak Republic, New Zealand, Netherlands, Italy and United States), with US data referring to 2008.
Source: OECD Product Market Regulation Database, 2014. www.oecd.org/economy/pmr.

StatLink http://dx.doi.org/10.1787/888933709679

Figure 3.5. Sweden's ranking in the World Bank's Ease of Doing Business Index, 2017



Note: The country ranking is computed on the basis of distance to frontier scores; the "distance to frontier" measure shows the distance of each economy to the "frontier", which represents the highest performance observed on each of the topics across all economies included in Doing Business. An economy's distance to frontier is indicated on a scale from 0 to 100, where 0 represents the lowest performance and 100 the frontier.
Source: World Bank (2017), Doing Business 2018: Measuring Reforming to Create Jobs, http://www.doingbusiness.org/reports/global-reports/doing-business-2018.

StatLink http://dx.doi.org/10.1787/888933709698

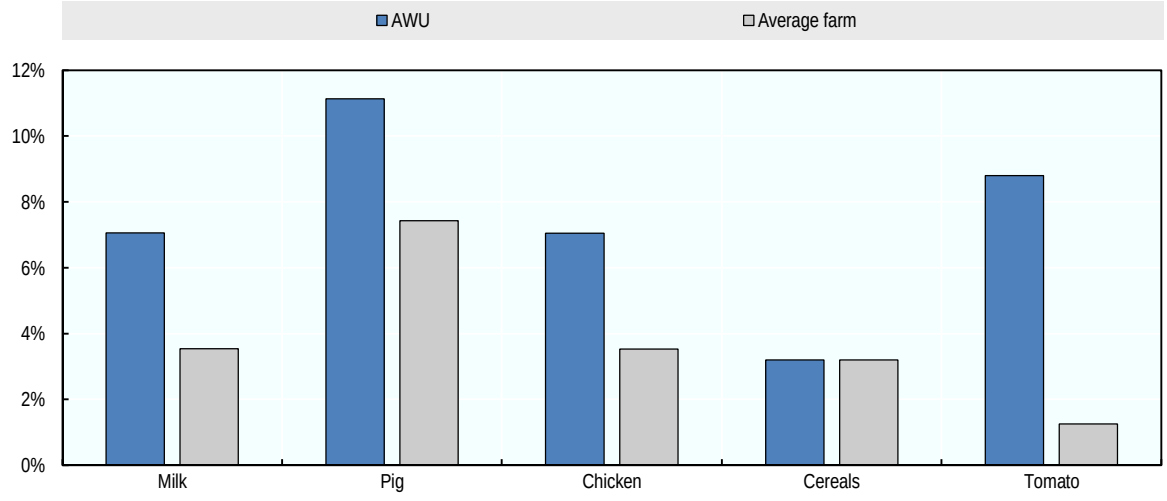
In 2015, the Commission submitted a proposal for changes in the legislation to the Government concerning approaches to developing a more competitive agriculture and horticulture sector (SOU, 2015). This Inquiry covered many areas and highlighted animal welfare as an area where there is a scope for reducing perceived administrative costs to improve the competitiveness of the Swedish agricultural sector. In addition, several initiatives are underway by the Swedish Board of Agriculture (SBA), in collaboration with the Federation of Swedish Farmers (LRF) to simplify the regulations (SBA, 2014a).

Providing an overall assessment of the costs and benefits of Swedish regulations is difficult, as they vary depending on the type of production and the production techniques available to businesses (SBA, 2010). Making comparisons across countries is even more challenging as individual countries have different average business sizes and economies of scale.

Figure 3.6 summarises the estimated administrative costs of meeting the requirements of government and industry regulations in the agricultural sector in recent years. The costs correspond to approximately 4-7% of one Annual Work Unit (AWU). More specifically, the cost for chicken producers is highest, followed by pigs for fattening. This survey shows that businesses often find it hard to distinguish between legislative requirements and other requirements, such as the industry's own requirements. Hence, the survey could not separate the administrative costs of regulations from industry requirements.

In those cases where specific Swedish regulations go beyond common EU regulations, the result can be higher production costs compared with competitor countries within the European Union, thereby having a negative impact on the competitiveness of Swedish production. But the costs of regulations have to be assessed against the benefits to consumers who, through their consumption choices, demand animal welfare standards that go beyond common EU regulations.

Figure 3.6. Administrative costs of meeting the requirements of authorities and industry requirements in different types of agricultural production



Note: AWU = Annual Work Unit
Source: SBA (2012), "Kraven kostar", Report 2012:31.

StatLink http://dx.doi.org/10.1787/888933709717

Regulations on natural resources

Regulations on natural resources are central to ensuring the long-term sustainable use of natural resources and biodiversity. They also impose limits on the impact of industrial and agricultural activities on the state of the natural resource (e.g. water pollution, soil degradation, GHG emissions). The design of natural resources and environmental policies can influence incentives for innovation and sustainable productivity growth (OECD, 2014a).

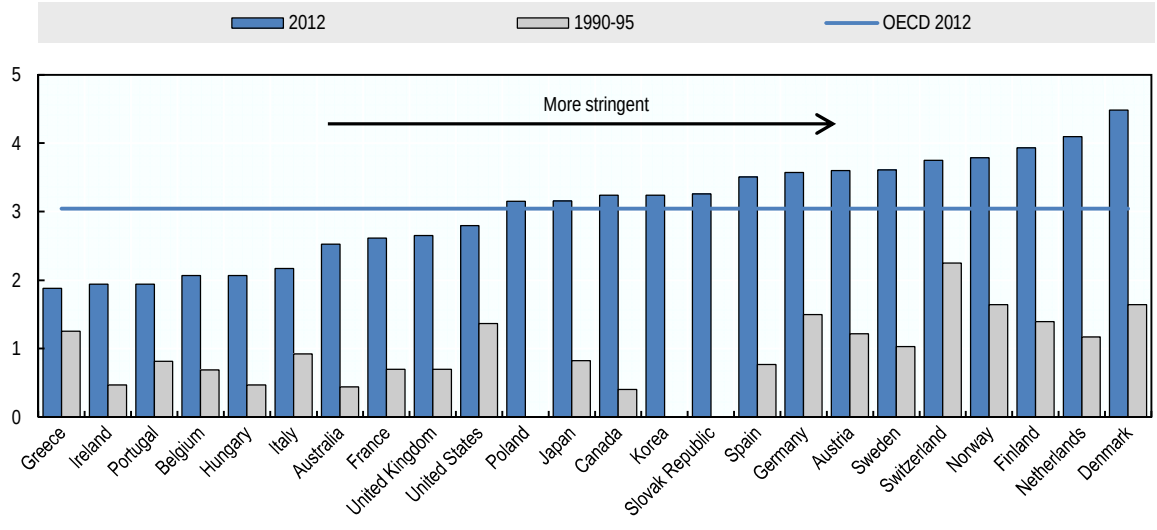
At the economy-wide level, Sweden has a relatively high level of environmental regulation compared to other OECD countries. Moreover, the stringency of Sweden's environmental policy has increased significantly since the early-1990s and, in 2012, was above the OECD average as measured by the Environmental Policy Stringency (EPS) indicator, which covers energy and GHG emissions. In this respect, the level of stringency in Sweden is about the same as in Austria, Germany, Norway, Spain and Switzerland (Figure 3.7).

Environmental regulations

Since 1999 all environmental legislation has been included under the Swedish Environmental Code (SEC). The five key areas of the SEC are: i) protection of the health of people and the environment; ii) protection and management of valuable habitats and cultural heritage environments; iii) conservation of biodiversity; iv) long-term sustainable management of land, water and the physical environment; and v) promotion of the re-use and recycling of products, raw materials and energy.

Most environmental regulations affecting agriculture are incorporated in the overarching framework of EU regulations. The most important EU environmental directives and frameworks for Sweden include: Nitrate Directive; Water Framework Directive; Birds and Habitat Directives; Directive 2000/29/EC on Plant Harmful Organisms; EU Biodiversity Strategy to 2020; EU Forest Strategy; Marine Framework Directive; and Directive on the Sustainable Use of Pesticides.

Figure 3.7. Environmental policy stringency in OECD countries, 1990-2012



Source: Botta and Kozluk (2014).

StatLink http://dx.doi.org/10.1787/888933709736

Sweden also subscribes to about 40 international conventions that relate to the environment of which some have a high relevance for agriculture: United Nations Framework Convention on Climate Change (UNFCCC); Convention on Biological Diversity; Convention on the Conservation of European Wildlife and Natural Habitats; European Landscape Convention; Convention on Wetlands of International Importance, especially as Waterfowl Habitat; World Heritage Convention; Convention on the Protection of the Marine Environment of the Baltic Sea Area (the Helsinki Convention; HELCOM); and Convention on Long-Range Transboundary Air Pollution.

Nutrients

Sweden has few national regulations relating to the use of fertilisers in agriculture (GOS, 2015). The current rules are those applied across the European Union and are determined at the EU level. The rules on the spreading of organic manure are national and determined by the SBA. Sweden has a special exemption from EC Regulation No. 2003/2003 of the European Parliament and of the Council of 13 October 2003 relating to the use of fertilisers. This exemption means that Sweden is allowed to keep a national limit for cadmium in phosphorus fertilisers. However, it is mandatory to have approval as the exemption affects the free movement of goods in the European Union. The exemption applies as long as there is no harmonised limit in the European Union. Sweden has tried to lower the national limit, but the submission was rejected.

Since 1988, Sweden has implemented an Action Plan to reduce nutrient leaching from agriculture. The SBA also finances experimental work and development projects to reduce nutrient leaching. Almost all regulations on the storing and spreading of manure and fertilisers and on crop cover of autumn and winter fields are subject to cross compliance requirements of the EU CAP (Chapter 5). In nitrate sensitive areas (75% of arable land and 63% of pasture land) many of these regulations are also subject to cross compliance requirements (SBA, 2014b).

Some regulations restrict the use of new technologies, while other regulations are target oriented and give greater flexibility. In general, regulations directed towards technology or quantitative limits are dominant, thus limiting opportunities for innovations and, in some cases, incentivise cost-reducing efforts. However, improved dissemination of information and training are playing an increasingly important role in this area. Farm operators are expected to acquire the necessary knowledge to assess the environmental effects of the activities and on ways to protect the environment and human health. Operators are also obliged to carry out self-monitoring. SBA (2014b) has produced a four-step guideline for self-monitoring of fertiliser and nutrient leaching. In each step, there are several measures recommended for identifying risks related to, for example, storing and spreading manure.

Box 3.3. GMO regulations

All activities related to GMOs in Sweden are regulated and the responsibility is divided between several agencies (Swedish Work Environment Authority, Swedish Agency for Marine and Water Management, Swedish Chemical Agency, Swedish Food Agency, Medical Products Agency, Swedish Forest Agency, SBA, Swedish Gene Technology Advisory Board, Swedish Environmental Protection Agency, and Swedish Civil Contingency Agency).

The SBA has responsibility for genetically modified plants, animals and the use of GMOs in animal feed. More specifically, the SBA is the responsible authority to assess (and approve) a GMO plant from an environmental perspective, if, for example, it could have negative consequences for the environment or if it could be a troublesome weed. In the European Union, there are several genetically modified plant crop varieties approved for use in food. However, only a few GM crops are available on the market in Sweden. Currently, there are no GMO animal feed used in Sweden.

As the responsible authority, the SBA has a duty to provide information on GMOs to the public. These actions are guided by rules that are harmonized across the EU. The SBA has on several occasions received criticism, not least from environmental NGOs who contend that the SBA has been too favourable in its assessments of GMO applications.

The Swedish Food Agency is responsible for the introduction of foods that potentially contain or are produced from genetically modified organisms. The regulations are based on EU regulations. Assessments and approvals are made on a scientific basis. Use on farms is limited, due in large part to the fact that contracts with the food industry frequently exclude the use of GMO products, including animal feed.

In addition, within the Action Plan, extension services provide advice free of charge to farmers on how to reduce nutrient leaching. In most parts of the country, farmers are invited to attend courses and advisory meetings adapted to their local conditions and farms. For example, advice may be about optimal times for spreading manure, optimal doses of fertilisers, and how to adapt cattle feeding to the needs of animals. Much of the information is available online.

Regulations and measures on storing and spreading manure and fertilisers

Regulations on storing manure apply to the storage capacity for manure, the design of storage facilities, the covering and filling of containers for urine and liquid manure, and the safety around liquid manure storing. Requirements state the minimum capacities for storing manure, expressed in terms of months of manure production. Requirements differ depending on the region, type of livestock and size of herd. The facilities may vary, but must prevent any leakage to the surrounding area (SBA, 2014b).

The rules about dates and the conditions for spreading manure relate to ecological and cultural heritage values, the incorporation of manure into the soil in winter and the incorporation of urea fertilisers and sewage sludge into the soil. Any fertiliser that falls outside the field on which it is spread is prohibited and no fertiliser is permitted on traditional meadows or pastureland if nature or cultural heritage values would be damaged. Manure and other organic fertilisers that are spread during the period 1 December to 28 February must be tilled into the soil within 12 hours of application (SBA, 2014b).

In nitrate sensitive areas, there are strict additional rules on the dates, time limits and conditions. Fertilisers must not be spread during winter, or on water-saturated, flooded, snow covered or frozen land. There are also rules on the spreading of manure in autumn, the minimum distances to streams and lakes, the incorporation of manure into fallow land, and the specific technology permitted for spreading liquid manure in fields with growing crops.

Regulations and other measures on green cover in autumn and winter

The proportion of arable land that must have a green cover in autumn and winter is regulated in the southern counties, where it varies by county from 50% to 60%. The rules specify which crops are eligible as green cover, as well as the time limits for sowing and soil cultivation (tilling, etc.). Two agri-environmental payment schemes within the 2014-20 Rural Development Programme (RDP) have the objective of reducing nitrogen leaching over the winter period (Chapter 5).

Land acquisition legislation

The Swedish Land Acquisition Act governs the rights of physical persons and legal entities to acquire real estate that is classified as an agricultural unit for taxation purposes. An agricultural unit includes woodland, barren land, pasture or arable land. Physical persons mainly refer to individuals, while legal entities mainly refer to limited companies and financial associations. The basic idea of the Act is that purchase of real estate by a physical person within a municipality should be given precedence over other parties in sparsely populated areas, and that acquisitions by legal entities from physical persons should be viewed restrictively and the basic rule for acquisitions is that land with the same amount of production capacity as the purchased land must be sold to physical persons – so that the balance of ownership of agricultural properties between physical persons and legal entities should thereby be maintained.

The opportunity to give precedence to physical persons' acquisitions of real estate within a municipality has been generally accepted. However, the Act's restrictive view on legal entities' acquisitions from physical persons is currently under review. The increase in demand for agricultural properties that is expected to result from the intended change in legislation will thus probably focus more on the opportunities for increases in land values rather than the opportunities for carrying out

profitable agricultural production. The continued rise in agricultural property prices increases the need for more capital in agriculture (see also Chapter 2). However, the capitalisation of agricultural subsidies into agricultural land has also contributed to the growth in the value of agricultural land in recent years, as the income from farming would have been even lower without these subsidies (Karlsson and Nilsson, 2014; SBA 2015a). The growth in urbanisation has also influenced land prices (Nilsson and Johansson, 2013).

The case for facilitating legal entities acquisition of agricultural properties has primarily been to improve the supply of capital to agriculture, based on rising land prices and low profitability in agriculture. Improving the opportunities for legal entities to acquire agricultural land would bring an increase in the inward flow of capital and a rise in real estate prices.

Permit approval for agricultural activities

Environmentally hazardous production activities require permits or involve reporting obligations depending on their scope or type of activity. The permit stipulates where a facility can be located, which type of activity can be undertaken and the scope of the activity. Other conditions are also regulated through specific terms such as the use of chemical fertilisers and the amount of permissible emissions into the air and water. Changes in the size of production units may also involve reporting obligations or require permits. Farmers submitting applications must establish and pay for an environmental impact assessment. The requirements for such an assessment are extensive and a consultant is usually engaged to undertake the task. The cost varies and depends on factors such as the project's size, location and number of parties involved.

According to EU Directive 2011/92/EU (the Environmental Impact Assessment Directive), member states must ensure that an environmental assessment is carried out and that an environmental impact assessment is drawn up for productive activities that may be deemed to have a significant environmental impact. In Sweden, large facilities for poultry and pigs, as well as other forms of intensive animal husbandry (facilities with more than 400 livestock units) require an environmental impact assessment. It has been noted by the Animal Husbandry and the Environment Commission that environmental impact assessments are required for more agricultural production activities in Sweden than would be the case under the EU Environmental Impact Assessment Directive (SOU, 2013).

Regulations on pesticides

Plant protection to minimise the damage from pests and weeds to crops can reduce economic losses. At the same time, however, the environment needs to be protected against adverse effects, and the health of farmers and farm operators should not be endangered, while the sustainability of the production system and food quality should be maintained. Modern crops depend to a high degree on the appropriate use of chemical plant protection products, which must be weighed against the protection of lakes, rivers and food against plant protection products residues, which is an important concern in Sweden (SBA, 2015b).

The proportion of food that exceeds the required threshold for pesticides is low in Sweden (SNFA, 2014; 2016). According to a report from the European Food Safety Authority (EFSA), pesticide residues occur to a lower extent in food produced in Sweden compared to most other EU Member states (EFSA, 2016).

Ensuring the sustainability of crop protection (and stimulate integrated pest management) through the efforts of advisors has a long history in Sweden and is currently pursued under the National Action Plan on Sustainable Plant Protection for the period 2013-18 (required by the Directive on the Sustainable Use of Pesticides, Directive 2009/128/EC). The first Action Plan to reduce the use of pesticides began in Sweden in the mid-1980s and the last Action Plan, covering the period 2008-13, is the fifth Swedish Action Plan. The SBA has received a mandate in 2011 to develop a strategy to

prepare agriculture and horticulture in Sweden for a decline in the availability of chemical plant protection products in line with developments in the European Union (SBA, 2011).

Legislation on water quality, access and erosion

Provisions relating to water quality requirements are defined in legislation. Environmental quality standards also govern authorities and municipalities when they implement the laws. A national and regional water quality monitoring system gives feedback and this is registered in the Water Information System database (VISS, 2017).

The supply of water for agriculture is generally not a concern in terms of quantity and quality. However, there may be a local shortage or conflict with other demands in society, occasionally, in times of drought, especially in the southeast of Sweden during warm and dry summers. Changing the crop mix, increasing husbandry or crop area, and climate change with a longer crop season and increasing evapotranspiration may aggravate the problem locally. The Swedish Environmental Code (1998) regulates the water access for agriculture. Application and permission are required for extracting irrigation water, where each case is considered by one of the five regional land and environmental courts.

Regulations on products and processes

While legislation may hinder some innovations, it can also be used to create added value for consumers. Regulations on products and processes aim to protect human, animal and plant health and can also impact on natural resource use. Environmental and health related regulations can boost innovation by building consumer and societal trust in the safety and sustainability of new products or processes, but unnecessary or disproportionate regulations can stifle innovation and technological developments (OECD, 2014a).

The regulations on products and processes in Sweden are mainly determined at the EU level, whilst implementation is at the national level (EC, 2017a; GOS, 2016a). Most of the legislation in the food sector is fully harmonised with the EU. The SBA and the Swedish National Food Agency (SNFA) are responsible for the regulations on food and agriculture. Swedish Environmental Objectives specify the level of environmental targets in Sweden (SEPA, 2017), decided in the Swedish Parliament.

The SBA is obliged to investigate the potential consequences of any new regulations (SBA, 2015c). Such an investigation includes a description of the possible effects the proposed regulations can have on rural areas. In addition to the legislation and regulations, there are several voluntary private standards and labels used on Swedish products (Box 3.4).

Box 3.4. Private standards and labels

Från Sverige (From Sweden) is a voluntary country-of-origin label that was introduced in 2016 (Från Sverige, 2017). Från Sverige is used on a wide range of food products that meet the required criteria. Products with a Från Sverige label must be produced in Sweden. For animal products, all animals must be born, bred and slaughtered in Sweden. Vegetables and vegetable products must be grown in Sweden. For composite products, at least 75% of the raw materials and 100% of animal raw materials must be Swedish. Från Sverige is an initiative developed and run by the Swedish Food Federation, Svensk Dagligvaruhandel (Swedish Food Traders) and the Federation of Swedish Farmers.

Products labelled with *Svenskt Sigill* are guaranteed as produced in Sweden (Sigill Kvalitetssystem, 2017). Sigill Kvalitetssystem AB is an independent standard for certification of environmental responsibility, food safety and animal welfare developed by and for companies in the food and agriculture industry. The label is used on all product categories except for fish and fish products.

There are several labels for organic products in Sweden (SNFA, 2017). The basic label is the EU organic label that certifies the product meets the EU regulations on organic products. KRAV is a Swedish label for organic products with higher production requirements than the EU organic label. The major retailers also have their own organic labels for private label products.

The Swedish label *Nyckelhåle*t aims to offer healthy choices (SNFA, 2017). The label guarantees products with less sugar and salt, less and healthier fat (saturated fat not more than 33% of the total fat content) and more wholegrain and fibre than other products within the same category. The label, which is owned by the SNFA and provided to companies free of charge, is primarily used on bread, cereals, pasta, dairy products, fish and meat products.

Regulations on food, animals, plants and purchased farm inputs

Food safety

Sweden differs from many other EU Member states in several areas, notably when it comes to dealing with salmonella and the use of antibiotics in food animal production. For example, if the level of pesticide residues in fresh fruit and vegetable imports exceed Swedish limits, the National Food Agency – which controls such residues in food (SNFA, 2016b) – will decide how and if those products will be sold.

Plant health

Plant health protection products must be approved by the Swedish Chemicals Agency. Each active substance is assessed and authorised jointly with the EFSA. The Plant Protection Regulation (EC) No. 1107/2009 regulates the approval of plant protection products to ensure a high level of protection for humans, animals and the environment, as well as to safeguard agricultural competitiveness. This is in recognition that although the pressure for harmonisation across the EU has increased, member states often apply the regulations differently, resulting in differences in access to plant protection products.

The principle of mutual recognition is central to the EU's internal market (SOU, 2013b). In a European Court of Justice ruling, it was stated that a product lawfully put on the market in one member state cannot, in principle, be denied access to markets in another member state (SOU, 2011). In effect, mutual recognition means that the authorisation granted by a member state should be accepted by other Member states where conditions are comparable.[1] In accordance with the Regulation, the European Union is divided into three zones where agricultural and environmental conditions are comparable. Sweden belongs to the Northern Zone, together with Denmark, Finland, Estonia, Latvia and Lithuania.[2]

In 2014, Sweden was the subject of an audit by the EU Food and Veterinary Office (FVO) in order to evaluate the application of the requirements for the authorisation of plant protection products. The FVO noted in its final report that the system of mutual recognition is not correctly applied in Sweden, mainly because of Sweden's decision not to accept most of the assessments made by another Member state (EC, 2014).

Since the plant protection regulation entered into force between 2011 and 2013, fewer applications for plant protection were approved in Sweden than in Finland, and more companies withdrew their applications for pesticide use in Sweden than in Finland and Denmark (SOU, 2015). The fewer pesticides approved for use in Sweden suggests that the country's agriculture and horticulture are at risk of being disadvantaged in comparison to competing countries in the Northern Zone.

For most crops and pests, a limited number of plant protection products are registered in Sweden, and many of these pesticides have the same active substance (SCA, 2016). This leads to an increased risk of resistance, especially in the cultivation of apples, strawberries, oil seeds, onions and potatoes.

In 2014 when the EU audit was undertaken, countries in the Northern Zone had fewer authorised plant protection products compared to those in the Central Zone (e.g. Germany, France, and the Netherlands), and Sweden had fewer approved active substances than other countries in the Northern Zone. All countries in the Northern Zone had access to about 60% of the total number of active

substances approved in the EU (SOU, 2015). However, it is not the number but rather the active substances approved that is important for production.

The Swedish Government Commission for Competitive Agriculture has stated that in recent years it has not been possible to access approved effective plant protection products. The industry has, in the case of emergencies, applied for derogations to use certain products on apples, onions and strawberries. LRF calculates that the costs would have amounted to hundreds of millions of kronor in lost production if the derogations had not been granted (SOU, 2015). FVO has received comments regarding the Swedish approach to the emergency derogations in situations other than just exceptional cases (EC, 2014).

It was therefore considered important to facilitate the product authorisation process in Sweden as far as possible (SOU, 2015). The Commission also concluded that Sweden's handling of applications through mutual recognition leaves room for further improvement. Hence, Sweden and the Swedish Chemicals Agency need to use a simplified procedure that already exists in the European Union through mutual recognition (SOU, 2015). Specific directions were given to the Swedish Chemicals Agency with the objective of facilitating the authorisation process for plant protection products.

In order to continue developing alternative plant protection strategies to be able to maintain competitive production and satisfy consumer preferences, despite the absence of many plant protection products, increased funding in research, development and innovation is necessary to achieve effective protection covering both preventive (for example crop rotation) and direct (thermal, physical, biological or chemical) methods.

In December 2015, the Swedish Chemicals Agency received a mandate to propose solutions to improve the balance in handling cases of authorisation of plant protection products (SCA, 2016). The objective was to meet the legal timelines while maintaining a high level of protection of human, animal health and the environment, as well as to improve harmonisation across member states. The Chemical Agency has made major improvements to facilitate this process, both internally and externally, and to reduce the handling time for authorisation to put a product on the Swedish market. As a result, there has been an increase in the availability of plant protection products in Sweden. The Swedish Chemicals Agency has received additional resources from the government to further speed up the process.

Even if the availability of plant protection products has changed somewhat since the evaluation was carried out, Sweden still lacks effective products for several common pests (SOU, 2015). This is especially the case for crops grown on a small scale and for minor uses, such as onions, carrots, cabbage, greens and apples. The evaluation also states that alternatives will take several years to develop before they can be used efficiently. During the transitional period, chemical plant protection products are required to control pests and diseases. Therefore, continued efforts are needed to ensure the availability of suitable plant protection products on the Swedish market, especially for minor crops. The evaluation also stated that it is important to continue developing alternative plant protection strategies to be able to maintain competitive production despite the absence of many plant protection products. This requires increased funding for research, development and innovation if effective protection covering both preventive (for example, crop rotation) and direct (thermal, physical, biological or chemical) methods is to be achieved.

Animal health

Sweden's approach is to keep animals in a way that promotes good health and makes it possible to control and eliminate disease if an outbreak occurs. However, it is also essential to prevent infectious diseases from entering the country, and to have the expertise and resources to control and eliminate any diseases that may occur.

Sweden has a long and successful tradition of prevention and eradication of infectious diseases in food-producing animals. The main tools have been strong animal health legislation and good co-

operation with farmers' organisations. Important legislation includes the Epizootic Act that sets out strict rules for farmers to report suspicions of certain diseases, gives the authorities powers to take the necessary and effective measures and also gives the farmer fair compensation so they are willing to report and follow the rules. For less serious, but economically important diseases, good co-operation between farmers' organisations is critical.

Voluntary eradication and control programmes can be authorised and financially supported, working with both animal health legislation and in close collaboration with the stakeholder organisation in order to prevent disease in animals. The degree of support differs according to the type of disease and over time. Often, farmers have started a programme with little economic support, but receive more support at the end, as the final culling phase is more costly. The intent is to make the scheme compulsory to all herds.

There is also close co-operation with farmers' organisation to support biosecurity measures, advisory and educational activities to prevent diseases and common health problems, such as E.coli, in livestock production. This has been very important in eliminating the need for antibiotics in healthy animals. These programmes have resulted in a very good health status from an international perspective, because of the cool climate and the low animal density in some parts of the country (e.g. data from The World Organisation for Animal Health (OIE)).[3]

Animal health legislation

Currently, animal health is regulated by the Epizootic Diseases Act, Zoonotic Diseases Act, Bee Diseases Act, Act on Control of Domesticated Animals, Act on Diagnostic Testing on Animals and associated regulations and provisions issued by the SBA based on these Acts and regulations. In addition, provisions issued by the SBA based on Regulation on the importation of live animals regulate the entry of animals. While Swedish legislation implements existing EU legislation, Sweden differs from the rest of the European Union in relation to standards on salmonella and antibiotics. A unique factor in Swedish policies on infectious disease control is the concerted and rigorous policy efforts to control salmonella in the food chain.

Salmonella

Although the safety requirements on animal feed are harmonised across the European Union, Sweden differs from the rest of the European Union when it comes to dealing with salmonella (National Veterinary Institute, 2016; EC, 2017b). The control of salmonella in animal feed is an essential part of Swedish legislation on food-producing animals. The process of controlling feed for salmonella began in the 1950s through a voluntary agreement between the feed industry and the National Veterinary Institute following an outbreak of salmonella in humans from meat in 1955.

Since 1993, there has been a compulsory National Control Programme in Sweden for reducing the incidence of salmonella in feed. The programme includes mandatory monitoring of all poultry flocks, where regular testing is on-farm. For beef and pork, this includes random checks at slaughter and the autopsy testing of young animals. The combination of the control programmes and the accurate procedures now used in the feed industry have resulted in the Swedish feed industry being declared free from salmonella.

Sweden has the right to require that imported animals and animal products meet the same health status as domestic animals and animal products in relation to salmonella. Due to the requirements of the National Control Programme, the European Commission has granted a special guarantee which gives Sweden the right to set high standards – within the European Union – for imported animals and animal products (Commission Regulation EC No. 1688/2005). This guarantee currently exists only for Sweden, Finland and Norway.

This special guarantee with respect to salmonella increases production costs for Swedish producers resulting in additional demands on producers and farming practices. The special guarantee involves

additional requirements for sampling, analysing and control measures. This gives Swedish producers the opportunity to market their livestock and livestock products as salmonella-free, although this results to higher prices to Swedish consumers.

The use of antibiotics in food animal production

In Sweden, reducing the need to use antibiotics in food animal production and preventing the spread of antibiotic-resistant bacteria are high priorities (GOS, 2016b; Box 3.5). The country has the lowest use of antibiotics for food-producing animals in the European Union (Swedres-Svarm, 2015). In the 1980s, Sweden was the first country in the world to prohibit antibiotics to promote animal growth. Compared with other EU Member states, Sweden has a low incidence of resistant bacteria (Swedres-Svarm, 2015), and the lowest use of antibiotics in food-producing animals (European Medicines Agency, 2015).

Box 3.5. Strategy for maintaining a low level of antibiotic resistance

In order to maintain a low level of antibiotic resistance joint efforts are undertaken by animal keepers, animal health staff, industry organisations and government agencies. Some examples of these operational tools are:

- Restrictions on certain antibiotics (last resort antibiotics) that are especially valuable in order to protect and preserve them for humans.
- New rules to reduce the risk of transmitting infections between animals and humans (zoonosis).
- Hygiene policy and a hygiene guide provide guidance to all animal health personnel.
- Funds for agricultural sector organisations to enhance the implementation of measures at farm level to prevent or control infection and limit the spread of antibiotic-resistant bacteria (antimicrobial resistance).
- Government agencies co-operate on combatting antibiotic resistance and undertake joint activities such as seminars. They also participate in international working groups and discussions on antibiotic resistance, including the European Commission, the OIE and OECD. The impact of this strategy has resulted in Sweden having the lowest use of antibiotics in animals (mg active antibiotic substance per population correction unit), the estimated total biomass of all livestock and slaughtered animals in the country) in the European Union.

Animal welfare

The foundation of Swedish animal welfare legislation is to prevent suffering and to respect the natural behaviour of the animals (Box 3.6**)**. It is consistent with the guidelines agreed in OIE. A key factor in the legislation is preventive: it aims to prevent animals from suffering and states how animals should be kept and treated to prevent this from occurring. As a result, Sweden has a system for the pre-testing of new technology with respect to animals before it can be applied by farmers or other animal keepers. New inventions, equipment for animal shelters, or handling methods must be evaluated before use in order to make sure that they do not have a negative impact on the welfare of animals. In Sweden, animal shelters also need pre-approval from the County Administrative Board before being built to ensure that the shelter will meet the requirements of animal welfare legislation. Sweden has a long tradition of working in close collaboration with stakeholder organisations to enhance both animal health and animal welfare. The training courses stakeholder organisations provide to farmers often include both welfare and health aspects.

An important difference between Sweden and the rest of the European Union is that Swedish cows should graze outdoors during the summer (zero grazing is not allowed). Moreover, it is prohibited to tether sows in stalls and for the tail docking of pigs. In addition, more space, rules on slaughter and transportation are other aspects that are specific to the Swedish animal welfare system.

The poultry industry has a voluntary control programme initiated by the industry to improve animal welfare and animal health. Almost all of Swedish production is included in this programme. The control programme also aims to improve the competitiveness of the sector.

Sweden has traditionally used legislation in order to remove elements that are harmful for animal welfare, as well as requiring elements that are known to be good for welfare. However, legislation may be an impediment to the development of novel solutions and systems. Therefore, Sweden has started a process to make the legislation more flexible and goal-oriented, while trying to maintain the same level of animal welfare (SOU, 2011).

Box 3.6. Animal welfare legislation

The first ban on animal abuse was issued in 1857 and full animal welfare legislation came into force in 1944. The National Animal Welfare Legislation complements the animal welfare legislation of the European Union. EU legislation provides a minimum level in most cases, thus allowing Member states to have measures that are more stringent if the Member state has higher requirements for animal welfare (EC, 2017c). Sweden has such higher requirements, e.g. requiring that all animals must be stunned at slaughter without exception, a total ban on mutilations such as tail docking and beak trimming, requiring grazing pasture for cows, more space and resources for animals. The Swedish Animal Welfare Act was introduced in 1988.

Currently, animal welfare is regulated by the Animal Welfare Act, the Animal Welfare Ordinance, as well as numerous Animal Welfare Provisions issued by the SBA. The National Animal Welfare Legislation protects all animals kept by humans and contains mandatory regulations that all animal owners/handlers/keepers must meet. The Animal Welfare Provisions contains the more detailed rules on how animals shall be kept, handled, and taken care of, and may, for example, specify the amount of space an animal must have or how it should be cared for. These provisions are often species-specific, or specific to certain uses of animals.

Evaluation of animal welfare legislation

As noted above, the Swedish animal welfare legislation has, in many respects, higher animal welfare requirements than animal welfare legislation in many other countries inside and outside of the European Union. However, measuring animal welfare is very difficult. Although scientists have tried to establish a method to measure welfare; e.g. "Welfare Quality" (www.welfarequality.net), there is currently no standardised method that is used in a way that makes it possible to compare the level of animal welfare between countries. However, it is evident that animal welfare plays an important part in good animal health and in lowering the use of antibiotics, which are measurable.

Moreover, it is also difficult to put a financial value on animal welfare. While it is relatively easy to estimate the cost of specific resources and extra labour, it is much more difficult to estimate the benefits of improved animal welfare in terms of the animals' wellbeing, animal health and society's benefit in terms of lowering the risk of antibiotic resistance. Moreover, it is also difficult to value people's concerns or preferences on how animals are treated. To some extent, this can be measured by consumers' willingness to pay for animal source foods from production systems with high welfare and health standards.

Horgan and Gavinelli (2006) conclude that European consumers have shifted demands from production of animals simply as a means of food, to other social goals such as food safety, safeguarding environmental protection, and ensuring that animals are properly treated. They also noted that the mind-set of consumers and producers has undergone a seismic shift from merely preventing cruelty and avoidable suffering to animals, to focusing on promoting animal wellbeing and meeting their most important needs.

Regulations usually involve higher production costs and could adversely affect productivity often resulting in reducing competitiveness relative to foreign suppliers. However, stricter regulation and higher standards could also increase efficiency, promote cost-reducing innovations and create a larger demand for the firm's output in meeting consumer preferences (OECD, 2010a). So far, the empirical link between stricter regulation and higher standards, and competitiveness is inconclusive (OECD, 2010a; 2010b). Regulation and higher standards are not considered major determinants of competitiveness in agriculture.

Regulations in general, and animal welfare regulations in particular, have an influence on production costs. For egg, chicken and pig production, differences in animal welfare regulation cannot explain differences in production costs between the European Union and third countries (Andersson, 2011). The most important determinant of competitiveness in these cases is by far the cost of feed, followed by housing and labour. In the animal welfare regulations, the specific space requirement to ban traditional cages for egg production is estimated to have the largest influence on production costs, which can raise production costs by about 8%. In addition, Andersson's (2011) empirical study found no significant effect of introducing any of the animal welfare regulations on imports of eggs, chicken and pig meat in Sweden. Table 3.1 summarises the main differences between Swedish legislation on animal welfare and the common EU regulations, which have been highlighted by the Swedish Government Commission for Competitive Agriculture.

Table 3.1. Differences between Swedish legislation on animal welfare and the EU Animal Protection Directive

		EU directive	Swedish legislation
Poultry	Space requirements	Maximum 42 kg/m^2	Maximum 20 kg/m^2 or 36 kg/m^2 if linked to monitoring programme
Laying hens	Debeaking	Yes	No
Pigs	Crating	Permitted	Forbidden
	Weaning	3 weeks	4 weeks
Dairy cows	Grazing requirements	No	Yes
Lambs	Tail docking	Permitted	Forbidden
	Grazing requirements	No	Yes

Source: SOU (2015).

Originally, the higher costs associated with the higher standards of animal protection in Sweden were paid for by consumers through higher product prices, as Sweden had its own border protection. However, since joining the European Union, this option has ceased. Developments since joining the European Union have shown that it has been difficult to fully compensate for the additional costs incurred due to animal protection measures via higher domestic prices. Imports have risen significantly since joining the European Union and, according to the Swedish Government Commission for Competitive Agriculture, imports now account for 50-70% of all meat consumed in Sweden (SOU, 2015).

Swedish regulations, which are stricter than the European Union's animal protection provisions, can mean both higher and lower costs for livestock producers. For example, certain requirements can mean that animal buildings are more expensive than in other competing countries, as the number of animals per unit of area is lower. Other requirements can result in higher labour costs. At the same time, the higher Swedish requirements have led to healthier animals, resulting in lower veterinary costs for farmers (SOU, 2015).

A study of the building costs and housing for ewes, suckler cows and bull fattening in Sweden, Ireland and Germany indicated that the costs vary substantially across the species and country (SBA, 2014c). The building cost per animal depends on the housing type and the floor space per animal. The recommended floor space per animal tends to be lower in Ireland than in Germany and Sweden, thus resulting in lower building costs per animal in Ireland and Germany.

The regulation that is most important for livestock building costs in Sweden is the banning of slatted floors for cows and sheep. Swedish cubicle housing for suckler cows and bulls has a comparatively large area per animal and, consequently, the building cost per animal is higher. Slatted housing allow for a smaller area per animal and a lower cost per animal. On the other hand, bedded housing has the

lowest building cost per square metre, but the cost per animal depends on how much floor space per animal is permitted. This is illustrated by the fact that the bedded livestock housing in Sweden is the cheapest for suckler cows (measured per animal), and the most expensive for bull fattening (SBA, 2014c).

The Swedish Animal Protection Ordinance states that cattle older than six months for milk production should be kept outdoors during the summer. A study by the SBA shows that the legal requirement involves additional costs corresponding to around SEK 200-550 per cow per year for exercise pasture and around SEK 1 000-1 200 per cow per year for production pasture (SBA, 2014d). Exercise pasture constitutes the minimum legal requirement for animal production in Sweden. However, not all socioeconomic and ethical values are included in these calculations. According to the Board's study, pasture legislation can limit opportunities for herd expansion, as it can be difficult to obtain access to sufficient pasture in certain areas.

In 2011, a Commission of Inquiry submitted a proposal to the government for changes to the animal welfare legislation (SOU, 2011). Before the government submits a proposal for a new law to Parliament, it often appoints a Commission of Inquiry to examine the various alternatives available. The Inquiry proposed a new Animal Welfare Act, a new Animal Welfare Ordinance and numerous suggestions for changes to the Animal Welfare Provisions. It also carried out a thorough investigation of several problem areas, such as the animal welfare issues in breeding, competition, the definition of natural behaviour, the various permits and approval needed for using animals, as well as the level of detail needed in the legislation.

The Inquiry proposed a reduction in the level of detail in the Animal Welfare Act and the Animal Welfare Ordinance, and added more detailed regulations to the Animal Welfare Provisions in order to make it easier to update these in accordance with scientific evidence and practical experience. The Inquiry concluded that in order for the animal welfare legislation to be clear, legally secure and controllable, each regulation must be assessed individually on the basis of animal welfare risks and flexibility should be furthered improved by farmers participating in control programmes. Furthermore, a scientific council should be formed to assist the SBA with the evaluation of scientific evidence when creating new regulations.

In 2015, a proposal for changes in the Legislation of the Commission of Inquiry, submitted to the Government concerning approaches to developing a more competitive agriculture and horticulture sector, included the following proposals on animal welfare (SOU, 2015):

- The Government should push for stricter EU legislation on animal welfare. Furthermore, the Government should also promote an equivalent application of the legislation at EU level.
- That increased targeting, reduced level of detail and greater flexibility should characterise animal welfare legislation. The Inquiry suggested a review of the Swedish animal welfare legislation, based on a balance between good animal welfare and enhanced competitiveness. Special attention should be paid to regulations regarding the construction of housing and grazing requirements that could increase costs for livestock producers.
- The proposal to establish a scientific council to assess the effects of regulation on animal welfare presented by the 2011 Commission on Inquiry (SOU, 2011) should be implemented. The trade-offs between animal welfare and economic performance should be assessed following the scientific assessment.
- The SBA and the County Administrative Boards should continue their efforts to increase the co-ordination of animal welfare controls so that similar cases are assessed in the same way, so that the legal security of the controls can therefore increase. Increased targeting requires that welfare checks focus on the bigger picture of the animal environment.

- The SBA should investigate the possibilities and consequences of removing the obligation to pre-approve shelters before they are built.

The Inquiry concluded that Sweden's requirements on animal welfare should be the common regulations law in the European Union. The national rules and requirements that go beyond the common level should be well reasoned and carefully examined, including their effects on competitiveness. The Inquiry also concluded that good animal welfare can be perceived positively by consumers, which can strengthen the position of Swedish livestock products on the market. The Inquiry also noted that livestock production has declined and this indicates that the consumers' willingness to pay for good animal welfare is not sufficient to ensure the profitability of livestock producers.

Organic products

The EU regulations on organic products provide for some exceptions in individual member states. The Swedish Law and Regulations on organic production were published in 2013 and 2015. All exemptions are included in the National Regulations from 2015. These exceptions aim to promote increased organic production. For example, there are exceptions when there is a shortage of seed or organic animals to meet the market demand.

3.3. Trade and investment policy

Barriers to trade in goods and services

Sweden is an open economy, strongly integrated into global value chains, and hence particularly exposed to currency movements, international trade growth and developments in its main trading partners. Sweden joined the European Union in 1995. Sweden's export performance has remained steady since the 2008 global downturn with large current account surpluses persisting. However, since 2014 import growth tended to be stronger than export growth despite the depreciation of Swedish krona, and the share of exports to GDP has been declining.

The barriers to trade and investment in Sweden are moderate compared to other OECD countries (Figure 3.8). The Swedish score at 0.62, on the OECD's Index of Regulatory Restrictions to trade was marginally higher than the OECD average, but lower than Japan and Canada. The index is composed of four elements: tariffs, barriers to trade facilitation, barriers to foreign direct investment (FDI) and differential treatment of foreign suppliers.

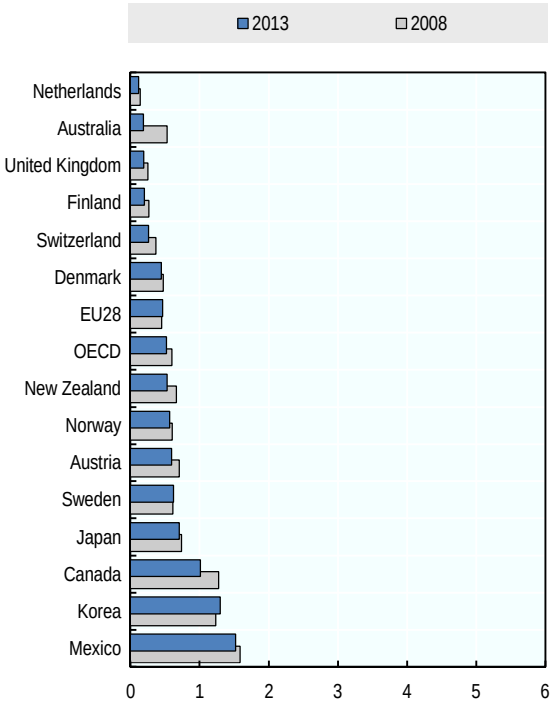
As an EU Member state and part of the customs union, all external tariffs on industrial and agricultural imports are set by the European Union. Agricultural tariffs are higher than industrial tariffs (Figure 3.9). EU tariffs for capital and intermediate goods are higher than in major OECD trade partners. Higher tariffs on intermediate goods increase the cost of specialised inputs and machinery equipment, thus discouraging competitiveness.

Barriers to trade facilitation continue to be relatively high in Sweden (Figure 3.8b). More specifically, this reflects the relatively higher use of barriers such as standards, certification procedures, and Mutual Recognition Agreements to limit trade. While there has been little progress in recent years in reducing the barriers to trade facilitation, it must be considered against the advantages of maintaining high standards to meet the preferences of domestic consumers in Sweden. Nevertheless, there is considerable scope for improving trade facilitation measures compared to the Netherlands, Finland and the OECD average. External border agency co-operation is an area where substantial improvements can be made (Figure 3.10).

Figure 3.8. Index of regulatory restrictions to trade and investment.

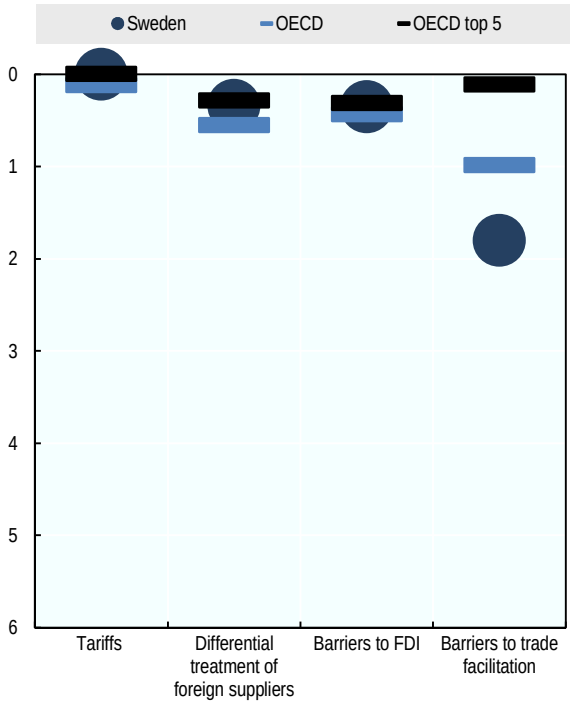
Scale from 0 (least) to 6 (most) restrictive

A. Index of regulatory restrictions to trade, selected countries, 2008 and 2013



Indices for EU28 and OECD are the simple average of member-country indices.

B. Sweden's index of regulatory restrictions to trade by principle components, 2013



OECD top 5 refers to the average of the scores for the top five performers among OECD countries (Australia, Finland, Netherlands, Switzerland and United Kingdom), with US data referring to 2008.

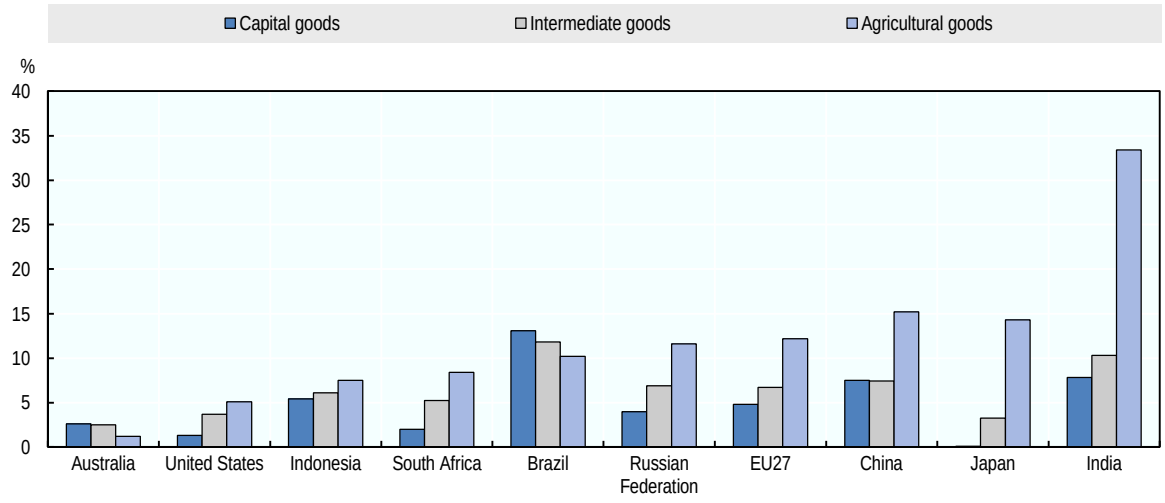
Note: Barriers to trade facilitation refer to the extent to which the country uses internationally harmonised standards and certification procedures, and Mutual Recognition Agreements with at least one other country. Tariff index is based on an average of effectively applied tariff, scaled within a range between 0 and 6 points, whereby a tariff below 3% is attributed zero points and a tariff above 19.6%, 6 points.

Source: OECD Product Market Regulation Database, 2014. www.oecd.org/economy/pmr.

StatLink http://dx.doi.org/10.1787/888933709755

Figure 3.9. Import tariffs for industrial and agricultural goods, 2015 or latest available year, selected countries

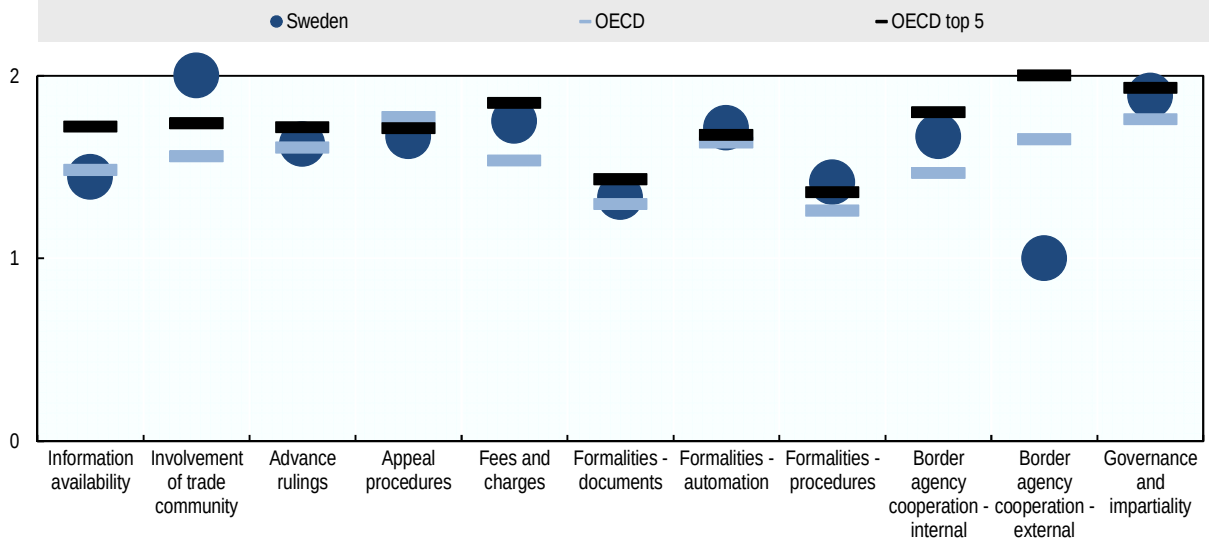
Simple average MFN applied tariff rates1



MFN: Most favoured Nation.
1. Tariff rates for agricultural products include both *ad valorem* duties and specific duties in *ad valorem* equivalent, while tariff rates for agricultural products only include *ad valorem* duties.
Source: UNCTAD Trade Analysis Information System (for non-agricultural products) and World Tariff Profiles, 2014 (for agricultural products).

StatLink http://dx.doi.org/10.1787/888933709774

Figure 3.10. Trade facilitation performance, 2015



Note: OECD top 5 refers to Australia, Netherlands, Ireland, Austria and Canada.
Source: OECD (2015), Trade Facilitation Indicators. http://www.oecd.org/trade/facilitation/indicators.htm.

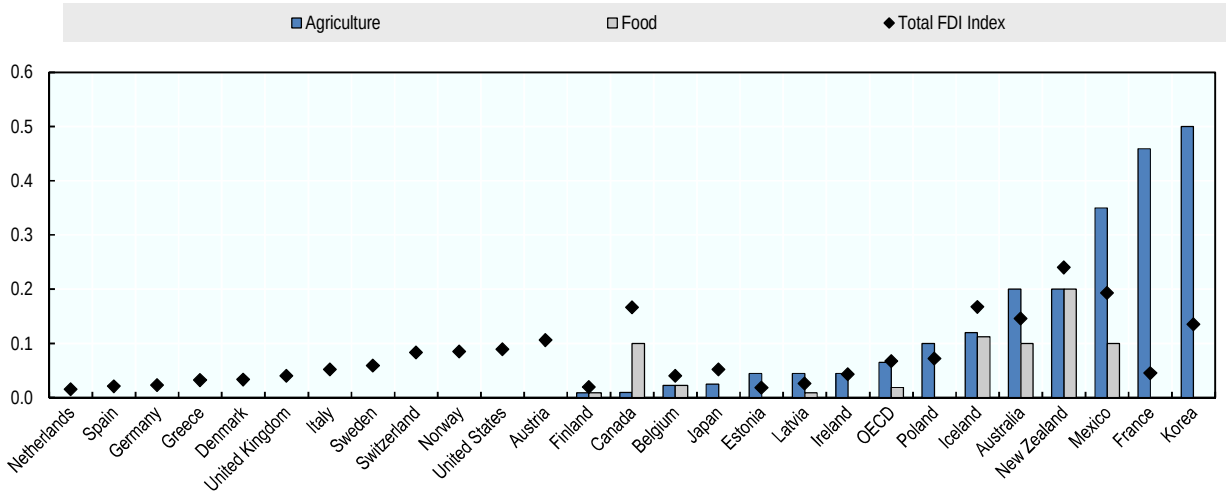
StatLink http://dx.doi.org/10.1787/888933709793

FDI regime and positions

The OECD FDI Restrictiveness Index indicates that Sweden has no restrictions in the food and agriculture sectors (Figure 3.11). As in many other countries, these sectors attract a small share of total inward FDI (Figure 3.12), which flow predominately into food processing. There are no agriculture-related provisions regarding foreign investment or foreign ownership of agricultural land. Sweden applies the same rules for foreign ownership as for Swedish citizens. There is, however, a restriction on ownership of agricultural land for legal (as opposed to persons) entities.

Figure 3.11. FDI Regulatory Restrictiveness Index in selected countries, 2016

Scale from 0 (least) to 1 (most) restrictive



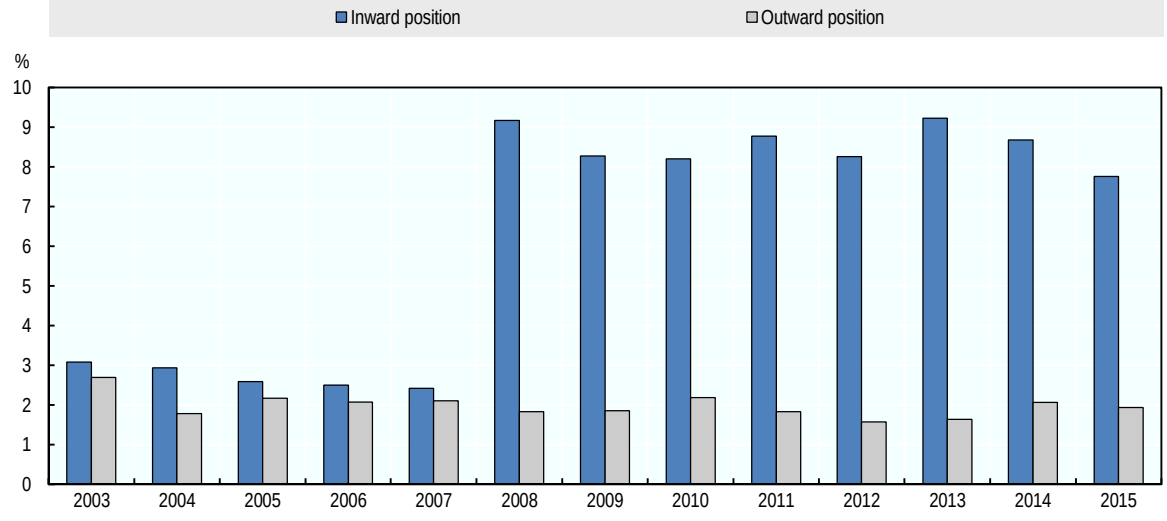
Indices for OECD are the simple average of member-country indices. Four types of measures are covered by the FDI Restrictiveness Index: 1) foreign equity restrictions, 2) screening and prior approval requirements, 3) rules for key personnel, and 4) other restrictions on the operation of foreign enterprises.

Source: OECD (2017).

StatLink http://dx.doi.org/10.1787/888933709812

Figure 3.12. Sweden's FDI in food and agriculture, 2003-15

As a percentage of total FDI



Source: OECD (2017).

StatLink http://dx.doi.org/10.1787/888933709831

3.4. Finance policy

Efficient financial markets are an essential component in enabling balanced economic development. Access to financial services can be limited or unequal across regions and firms when financial markets fail or when risks are too high. Policies that improve the functioning of financial markets can facilitate productivity enhancing investments in agriculture and farm size growth. Policies may also facilitate access to funding for sustainability enhancing investments. Low cost loans and venture capital are also important sources of funding for innovative firms with high growth sectors potential (OECD, 2014a).

Financial markets in Sweden, as in most countries, have changed dramatically over the past 20 years. During the early 1990s, the long-term interest rate in Sweden was high compared to other countries. Currently, government finances are strong and the current account balance is positive. This, in turn, has resulted in lower interest rates and lower borrowing rates.

Another difference compared with the past is that after the financial crisis (2007-08), banks were required by the government to hold more capital (as collateral) and better liquidity to withstand future financial crises. This action has led to tighter credit checks by the banks compared to earlier years.

Lower interest rates and tighter credit checks have occurred at the same time as major structural changes in the banks' branch networks. With the decline in the number of provincial offices, knowledge of the local market and relationships between branch staff and individual customers can be adversely affected.

Regarding financial market indicators, Sweden ranks well above the OECD average, indicating that the financial system is sound, well-regulated and with good access to loans (Figure 3.13a, b). In Sweden, bank loans are the main source of financing, and about 93% of lending to agriculture and forestry is through bank loans, where a mortgage can be supplemented with a second mortgage, unsecured loans and operating loans. Another form of finance for farmers is credit from suppliers, mainly used in the livestock sector. Livestock or feed credit is offered by Lantmännen (an agricultural co-operative owned by 25 000 Swedish farmers), and Scan (the largest meat producer in Sweden), amongst others.

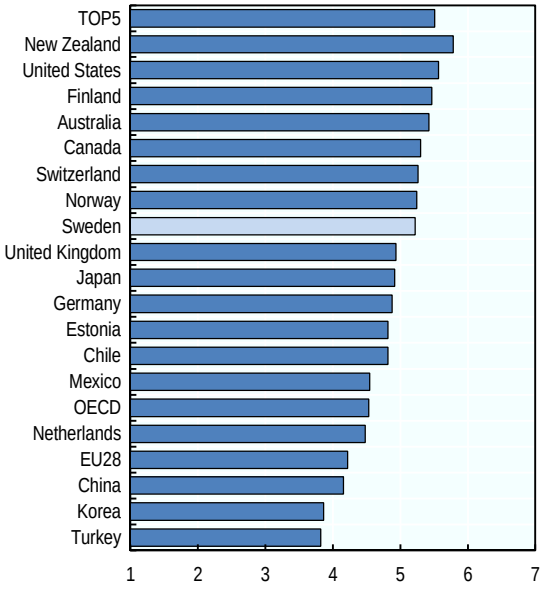
The purpose of supplier credit is to provide short-term finance for the operation of the farm. An additional security for bank financing can be a credit guarantee from a credit guarantee association. A credit guarantee reduces the need for the company and the entrepreneur to provide securities to the bank, while its financial needs can still be met. A guarantee association is a network of regional or industry-specific economic associations. They offer small- and medium-sized enterprises as security for expansion, acquisitions or new start-ups. This arrangement, which is applicable to all sectors, including agriculture, means that the guarantee association signs a guarantee to the bank for a maximum of 60% of the company's capital up to a ceiling of SEK 900 000. The fee for the guarantee is 3%-4% of the amount guaranteed.

Venture capital is used to a limited extent in agriculture (Box 3.7).[4] This is partly due to generally good financial guarantees, mainly land, which means good access to bank financing, but also to the lack of tradition and farmer experience in attracting venture capital.

Figure 3.13. Global competitiveness index: Financial market developments, 2015-16

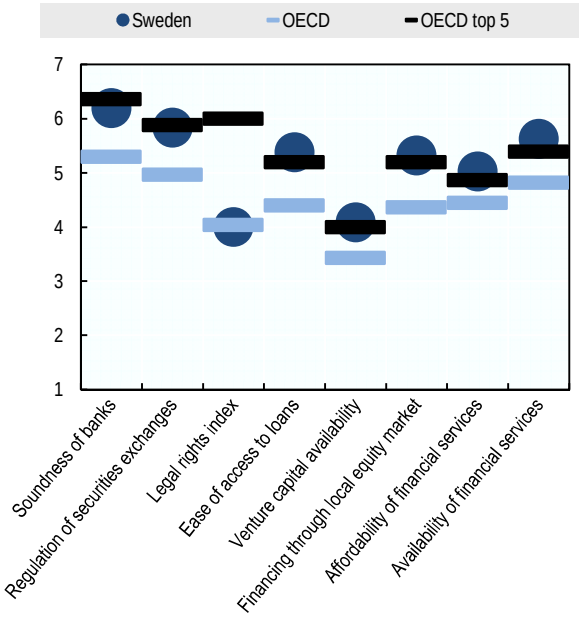
Scale 1 to 7 (best)

A. Total index of financial market development in selected countries



Indices for EU28 and OECD are the simple average of member-country indices.

B. Sweden's index of financial market developments, by component



Top 5 refers to the average of the scores for the top five performers among OECD countries (New Zealand, Canada, United States, Finland and Australia).

The Legal Rights Index is scored on a scale from 1 to 10 based on calculations by the WEF from the World Bank – International Finance Corporation's Doing Business 2016.

Source: WEF (2017), *The Global Competitiveness Report 2016-2017,* www.weforum.org/reports/the-global-competitiveness-report-2016-2017-1.

StatLink http://dx.doi.org/10.1787/888933709850

Box 3.7. Examples of venture capital sources for farmers

- Ekonord is a regional initiative focused on the green economy of the seven northernmost counties. Ekonord provides capital, expertise and networking.
- Inlandsinnovation (part of Saminvest since 1 January 2017) stated and developed businesses in northern Sweden, including the green industry (firms based on agriculture, forestry, and horticulture).
- Almi and Almi Invest provide counselling, loans and risk capital in all stages of entrepreneurship. Almi supplements the market by offering risk-takers loan when not otherwise available. Almi's role is to take on extra risk, and also offer public financing (loans).
- Business "angels" often have experience of running businesses. They also have the time, dedication and capital to invest in promising new business ideas. Business "angels" can also get a good return on their investment (but also see their money lost) and are therefore willing to facilitate the evolution of a business.

3.5. Tax policy

Tax policy[5] affects innovation, productivity and sustainability in many ways: it affects the decisions of firms and households to save or invest in physical and human capital, and thus the adoption of innovation; it raises Government revenues to finance public services, including those enabling innovation such as education and skills, R&D, and strategic infrastructure; it can also be used to provide direct incentives, for example preferential tax treatment for investments in private R&D or for young innovative companies. In addition to its economy-wide impacts, tax policy influences the conduct, structure and behaviour of farms, input suppliers and food companies. Taxes on income, property and land, and capital transfer, including land, may affect structural change, while differential tax rates on specific activities (polluting or environmentally friendly), resources, or input use may affect sustainability (Table 3.2).

Table 3.2. A summary of overall taxes in Sweden in 2014

	Amount (SEK billion)	% of total taxes	% of GDP
Taxes on labour	944	60%	24%
Taxes on capital	168	11%	4%
Taxes on consumption and input goods	456	29%	12%
Total taxes	1 568		40%
of which:			
- taxes transferred to the European Union	8	1%	
- local income tax	619	39%	
- fees for the pension system	214	14%	
- state taxes	1 024	65%	

Source: STA (2015), "Taxes in Sweden", *Tax Statistical Yearbook of Sweden 2015*.

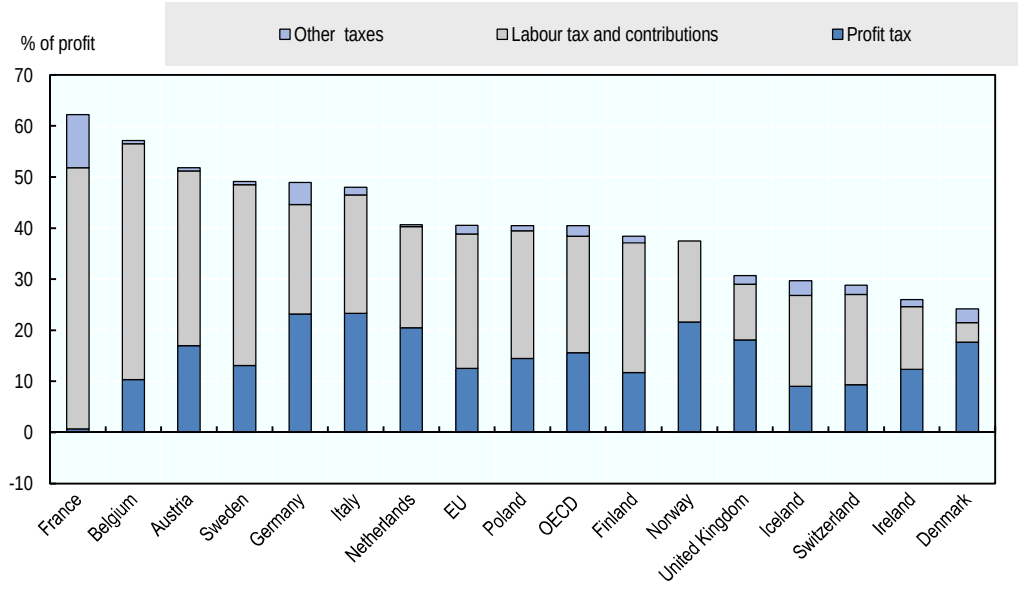
The World Bank's Global Competitiveness Report 2016-17 estimates that the total tax rate as percentage of commercial profits in Sweden is 49% (Figure 3.14). This high rate, which is similar to some other OECD countries, is mainly due to labour taxes and social contributions.

In 1990-91, the Government reformed the Swedish tax system. Tax rates were lowered, while at the same time the taxation base was broadened. Taxation of capital income was separated from taxation of labour income, and a uniform rate of taxation was applied to capital income. The principle aim of the reform was to reduce distortions and welfare losses stemming from high tax rates and a narrow tax base and, at the same time, lighten the redistributive role of the tax system by increasing child allowances and housing benefits.

Swedish farmers face, in principle, the same rules for taxation and social security as the rest of society. There are a few exemptions from the general tax legislation but no exemptions from the legislation regarding social security, or special treatment of agricultural land. Tax rules for depreciation of buildings, machinery and inventories are also the same for all business, including farming.

Figure 3.14. Total tax rate in selected countries, 2017

Percentage of commercial profits



Note: The total tax rate is the sum of taxes and contributions payable after accounting for allowable deductions and exceptions related to commercial profit of businesses before all taxes borne. The groups of taxes covered include: profit or corporate income tax; employer's social contributions and labour taxes; property taxes; turnover taxes and other (such as municipal fees and vehicle and fuel taxes).
Source: World Bank Group and PwC (2017).

StatLink http://dx.doi.org/10.1787/888933709869

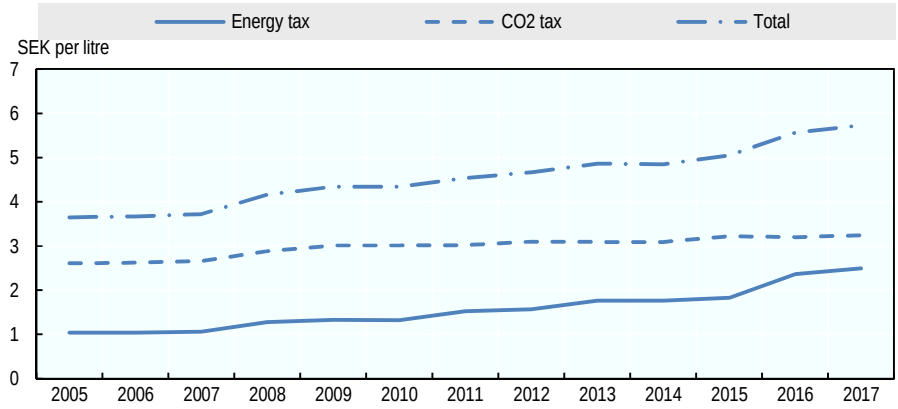
Taxes on consumption and input goods

Taxes on consumption and input goods include value added tax (VAT), as well as excise and customs duties. The standard VAT rate is 25%, but a reduced rate of 12% applies to food, restaurants, hotel accommodation and camping.

For environmental and economic reasons, there is a *tax on energy and CO_2* (Figure 3.15)[6]. The rules for energy and carbon tax on fuel changed on 1 July 2016, which mainly affected businesses in the agricultural and industrial sectors. Diesel fuel is, for example, taxed at SEK 855/m^3 from the energy tax and SEK 3 237/m^3 from the carbon dioxide tax in 2017 (STA, 2017). Electricity is taxed at SEK 0.295 per used kWh from the energy tax (STA, 2017).

These two taxes changed the requirements for reimbursement of up to 100% of the tax on fuel due to a change in EU state aid rules. The reimbursements are for those engaged in agriculture, forestry or aquaculture, industrial or heat/cogeneration, greenhouse growers, those who consume biofuels for heating, the mining industry, and importers and producers of biofuels for motor operation. Exemption from energy and carbon dioxide tax applies to biogas used for vehicles or heating, vegetable oils used for heating, and bio-fuel in motor fuel (STA, 2017).

Figure 3.15. Energy tax and CO_2 tax on diesel (MK1), 2005-17



Source: STA (2015).

StatLink http://dx.doi.org/10.1787/888933709888

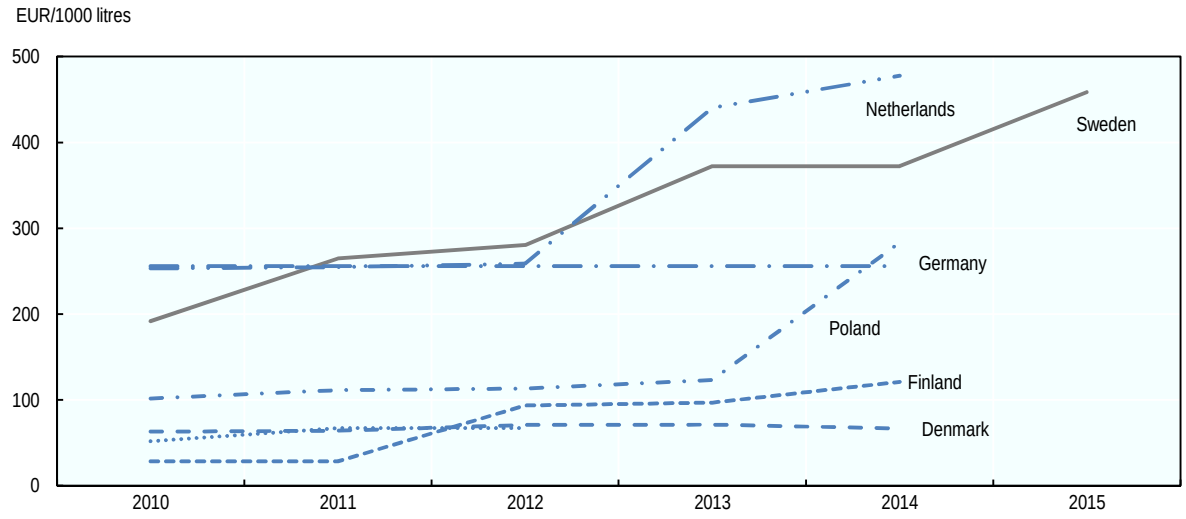
Sweden was one the first countries worldwide, that introduced taxes on pesticides, based on the volume sold, in 1984. The purpose of this tax is to reduce the use of pesticides for health and environmental reasons. The tax was increased stepwise from SEK 4 per kilo active ingredient to SEK 34 per kilo active ingredient in 2015. Manufacturers, wholesalers and importers pay the tax. Total revenue generated in 2015 was SEK 70 million (around EUR 7.5 million). Sales of active substance have fallen by more than 50% since the introduction of the tax. The Swedish pesticide risk indicator (base year 1998) shows a sharp decrease in risk to human health (now relatively constant at 20-40% as compared to 1988 levels) and to the environment (50-80% as compared to 1998 levels).[7] Though the outcome coincides with the introduction of the tax, other policy factors also contributed to these reductions such as policies aiming at an integrated pest management and stricter permissions for the registration and application of pesticides (as well as usage of low dosage pesticides) (see Chapter 2; Böcker and Finger, 2016).

International comparison of taxes on means of agricultural production

In recent years, greater prioritisation of climate change issues, in particular, has led to increased production taxes on heating fuel and diesel oil, as well as fewer opportunities to cut carbon dioxide taxes and energy taxes. It is difficult to compare the impact of production taxes on businesses across different countries due to policy changes and other developments, including innovations, streamlining or changes to the focus of production that influence the consumption of inputs and thus may also affect production taxes.

The production tax on diesel oil is one of the most burdensome taxes on the agricultural sector in Sweden (SOU, 2015). A comparison between the taxes imposed by different countries on diesel prepared by the Swedish Government Commission for Competitive Agriculture shows that the cost level varies substantially between countries (Figure 3.16). In this context it should be noted that consumption of diesel oil is higher in Sweden than in Denmark and the Netherlands due primarily to Sweden's longer distances and sparse population.

Figure 3.16. Taxation of agricultural diesel 2010-14, selected countries



Note. EUR per 1 000 litres after tax reductions.
Source: Calculations based on data from LRF; updates for 2014 from SOU (2015).
StatLink http://dx.doi.org/10.1787/888933709907

Table 3.3 shows the cost changes that would arise in replacing the Swedish tax rate with the tax rates applied in Denmark, Finland and Germany. Overall, the Swedish and Danish total costs were broadly comparable. However, the German costs were approximately 12% less than in Sweden, and in Finland the tax rates were about 60% lower, or approximately SEK 600 million. Within the European Union, tax is levied on pesticides in Sweden and Denmark. The Danish tax level is considerably higher than in Sweden, but is returned to the industry for various development measures. This comparison includes only taxes and other regulations, such as the Danish fertiliser accounting requirements, are not included in the calculations (SOU, 2015).

Table 3.3. Farmers' tax burden in Sweden and selected countries, 2014

SEK million

	Sweden	Denmark	Finland	Germany
Electricity	7	123	87	188
Fuel oil	55	28	41	38
Diesel oil	847	161	233	616
Pesticides	51	255	0	0
Commercial fertilisers	0	0	0	0
Land value tax	0	530	0	0
Total	960	1 097	361	842

Source: Calculations based on data from LRF (SOU, 2015). Calculations are based on Swedish agriculture's consumption in 2014.

Notes

1. Regulation (EC) No. 1107/2009 of the European Parliament and of the Council of 21 October 2009 concerning the placing of plant protection products on the market 1107/2009

2. The sizes of the three zones differ. According to figures from 2014, the total area of arable land in the European Union is about 113 million ha, and the Northern Zone is about 10% of the total arable area in the European Union (SOU, 2015)

3. See www.oie.int/en/animal-health-in-the-world/official-disease-status/ and www.oie.int/wahis_2/public/wahid.php/Wahidhome/Home.

4. Venture capital is the collective term for the investment of equity capital in unlisted companies. Private equity is an asset class with high risk that requires a high return. Specialised venture capital companies reduce the effects of the high risks through specific skills that increase the success potential of individual projects.

5. Most of this sub-section is based on information from the Swedish Tax Agency (2015).

6. Sweden was among the first countries to introduce a carbon tax (in 1991).

7. The risk is expressed in relation to the risk posed by pesticides in 1990. It actually indicates the potential risk for human and the environment. The health and environmental risk indicators are calculated by a point system and a set of scores. Among others, the environmental score, the application method score, the persistence score, and the operator toxicity score are used for the exact calculation.

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Chapter 4

Capacity building and public services in Sweden

Capacity building, including provision of essential public services, is one of the main channels to support innovation and sustainable development. This chapter focuses on three relevant policy areas: infrastructure and rural development policy; labour market policy; and education and skills policy.

Key points

- The overall quality of transport infrastructure in Sweden compares well with the OECD average and the quality of its electricity supply is considered as one of the best in the world.
- Sweden aims to take a leading role in digital transformation.
- New infrastructure is generally funded by the State budget.
- In the most remote areas of the country access to basic services has been decreasing, where the population is declining and provision of such services is more costly.
- Labour market efficiency in Sweden is considered to be above the OECD average. An important challenge faced by the Swedish labour market is the integration of new migrants and asylum seekers.
- The quality of Swedish higher education and training system is considered above the OECD average, although enrolment rates in tertiary education have been declining.
- Agricultural education is mainly provided through vocational and higher education programmes. However, the interest for agricultural education is low and has been declining over recent years.

4.1. Infrastructure and rural development policy

Investments in physical and knowledge infrastructure, from ICT to transportation facilities, are necessary for overall growth and development. They are vital to the delivery of and access to essential services and play a critical role in linking farmers and related businesses to markets, reducing food waste, boosting agriculture productivity, and facilitating investment in innovative techniques and products.

Broader rural development measures also affect sustainable agricultural development and structural adjustment. Off-farm income and employment opportunities mitigate farm household income risks, facilitate farm investment, and enable a wider range of farm production choices. Improved rural services, from banking to ICT, and ensure needed connectivity to suppliers and customers. Rural policy can also attract innovative upstream and downstream industries, with possible positive spillover effects locally. By reducing imbalances in economic development and access to services across regions, rural development policies improve the diffusion of innovation (OECD, 2014a).

In Sweden, where the density of population is low and the population is concentrated in main southern urban centres, the provision of infrastructure and services presents specific challenges. In remote areas with sparse population, connecting people to markets and providing information and services requires innovative solutions.

Quality of physical infrastructure

According to the World Economic Forum's Global Competitiveness Report (WEF, 2017), the quality of transport infrastructure in Sweden is similar to the OECD average (Figure 4.1.A) and ranks 25th in the world. There are, however, important differences between means of transport. The quality of port infrastructure ranks highest (13th out of 138 countries), with quality similar to the OECD top 5 averages. High port quality is essential for a nation like Sweden where over 70% of foreign trade is transported using seagoing vessels (Transport Analysis, 2016). The quality of road transport and air transport is also considered above the OECD average, even though road quality and access from the most rural airports has been decreasing. However, the quality of rail infrastructure ranks the lowest (30th), below the OECD average.

The challenges facing the railway system concern its rapidly ageing infrastructure, its need for maintenance and investment, and its growing capacity deficiencies (Transport Analysis, 2011). However, in addressing these challenges the government is currently making major investments in infrastructure, road and railway maintenance, and public transport (OECD, 2017a).

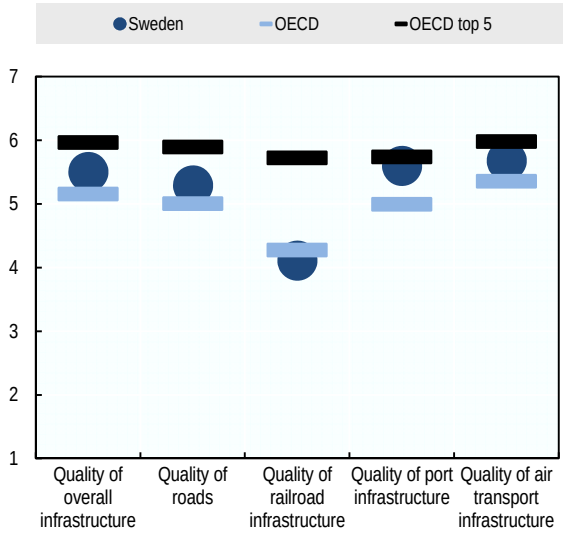
The main transport modes for agricultural products are road and rail with 64 million tonnes of products of agriculture, forestry and fishing transported by road in 2016 and 9 million tonnes by train (Transport Analysis, 2017a and 2017b). Therefore, good quality of road and railway infrastructure is essential for the development of the food and agriculture sector. But there is a need to improve the quality of transport infrastructure in rural areas and strengthen the connection with urban centres in order to maintain rural communities and increase their attractiveness (OECD, 2017a).

Regarding electricity and telephone infrastructure (Figure 4.1.B), Sweden scores significantly above the OECD average and ranks tenth out of 138 countries. This score is boosted by a very high quality of electricity supply, ranking fourth out of 138 countries and considered as one of the best among OECD countries. Regarding telephone infrastructure, the number of cellular telephone subscriptions is above the OECD average (1.3 per person in 2016) and has significantly increased since 2012 (first WEF survey). The number of fixed telephone lines is around the OECD average but has been falling, as most people have switched from fixed line to cell phones.

Figure 4.1. Global Competitiveness Index: Quality of infrastructure, 2016-17

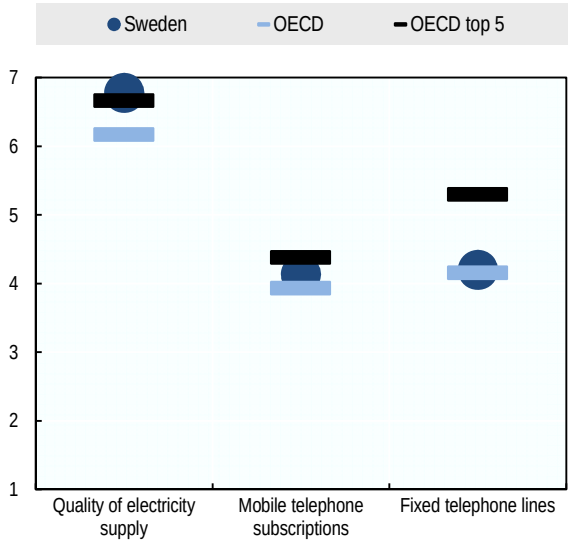
Scale 1 to 7 (best)

A. Transport infrastructure, by component



Note: OECD top 5 refers to the average of the scores for the top 5 performers among OECD countries (Netherlands, Japan, France, United States and Germany).

B. Electricity and telephony, by component



Note: OECD top 5 refers to the average of the scores for the top 5 performers among OECD countries (Switzerland, Luxembourg, Austria, United Kingdom and Japan).

Source: World Economic Forum (2017), *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/10.1787/888933709926

High-speed broadband is available in nearly every part of Sweden. Almost everyone in Sweden has access to the Internet (at least 10 Mbit/s). However, for fast broadband, accessibility varies between and within urban areas, smaller villages and sparsely populated areas. In rural areas, less than one in four households have access to 100 Mbit/s Internet, compared to almost three in four in urban areas. To improve access to high-speed broadband in remote and rural areas, the Government provides state aid for deployment of infrastructure in areas lacking commercial investments. Improving fast broadband internet services in remote areas would provide local farmers and agri-food companies with better access to information for inputs, technologies, advice, and consumers, allowing them to take better advantage of market opportunities.

Regarding agriculture-specific infrastructure, land improvement directly affects farm productivity and sustainability. According to a survey undertaken by the Swedish Board of Agriculture (SBA), nearly 80% of arable land in Sweden had satisfactory drainage system in 2016 and 47% of arable land had tile drainage. However, one fourth of arable land needed a new or refurbished drainage system (SBA, 2017).

Priorities and funding for infrastructure development

In Sweden, new infrastructure is generally funded by State grants. However, co-funding from counties, municipalities, companies, the European Union and user fees or congestion tax is also provided. Investments in broadband infrastructure is also co-founded by individuals. There is no specific provision or focus on the agricultural and food sectors. Infrastructure development plans aim to respond to identified needs such as improvement in rail and road infrastructure, high-speed broadband access for all and an entirely renewable electricity system.

State ownership is still a prominent feature for most road and railroad infrastructure in Sweden. Over 80% of electricity production in Sweden relies on hydro power and nuclear power, and there is important investment to expand renewable electricity production (hydropower, biomass-based electricity, wind power, and solar power).[1] New telecom infrastructure is mainly provided and funded by commercial actors.

Water supply and sewage disposal are a municipal responsibility. The three most important laws regulating urban water supply and sewage disposal are: the Public Water and Wastewater Plant Act (WWA), the Environmental Code and the Food Act. The WWA law articulates that water charges are not to exceed necessary costs to provide the services, and that charges can only be used within the water sector. Today, all large Swedish municipalities cover their costs for water and wastewater services solely through water charges (Lannerstad, 2002).

For agriculture the supply of water is generally not a problem, neither concerning quantity or quality. Irrigated areas represented only 1.7% of the Swedish utilised agricultural area, 18% less than in 2010. Access to water for agriculture and land drainage is regulated by the Environmental Code. Permission is required for extracting irrigation water, where each case is considered by one of the five regional land and environmental courts. Regarding land drainage, a permit is needed and might be denied if it is considered to affect wetland conservation.

Regional policy

Sweden's approach to regional development policy has continuously evolved since the 1950s, without losing its focus on promoting equity between regions. The latest strategy, the National Strategy for Sustainable Regional Growth and Attractiveness 2015-20, establishes four national-level priorities for promoting sustainable regional growth:

- innovation and business development
- attractive environments and accessibility
- provision of skills and competence
- international co-operation.

While the priorities themselves are similar to those of the previous programming period, there has been a shift in focus within the priority areas. Overall, the concentration is now more on business development than business creation; spatial planning and housing; more fully integrating and activating its labour force, including immigrants; and furthering cross-border collaboration. There is also added emphasis on implementation and results through dialogue processes, learning and knowledge exchange (OECD, 2017b).

Sub-national government agencies also have an important role in fostering regional development with more than ten County Councils now in charge of regional development. Since 2010, Sweden also has strengthened co-ordination across levels of government for regional development policy. This has occurred mainly through two instruments: i) the new national strategy for sustainable regional growth and attractiveness 2015-20 and regional development strategies at the county level, which are intended to align with the overall national strategy; and ii) a stronger role for the government's forum on sustainable regional growth and attractiveness 2015-20. Created in 2007, this forum is used to promote dialogue and co-ordination between levels of government and type of government actor (political and civil service), bringing together representatives from ministries and regional bodies.

Rural development

Overview of rural and sparsely populated areas

The industrialisation of the economy over time has resulted in a relocation of population from rural to urban areas, and is the main cause of the stagnation of rural areas in Sweden. At present, close to 50% of the Swedish population is living in the three biggest cities of the country: Stockholm, Gothenburg and Malmö.

Rural areas in Sweden face similar challenges and dynamics to other OECD countries. Together with a faster growth of an ageing population commonly found in all OECD economies, Sweden as a relatively small economy faces more sensitivity to exogenous shocks, and the greater role of the tradable sector in economic performance. However, there is significant diversity in Sweden's rural landscape, with a densely populated south and less densely populated north where the population is concentrated in coastal areas. Those places exhibit different demographic and economic trends. In recent years, the North has generally performed better due to its natural-resource-based industries (OECD, 2017b).

Another important challenge faced by rural and sparsely populated areas in Sweden – as in many other OECD countries – is the accessibility to basic services. Declining population in some remote parts of the country has led to a decrease in the number of grocery shops, fuels stations and pharmacies.[2] Access to health, postal and payment services has also been decreasing. The government has committed to an increase in spending by SEK 36 million per year for the provision of basic services in these areas. The development of e-services could also be part of the solution, mainly for health care and grocery shops.

Swedish rural development framework

Historically, Sweden's approach to rural development has been based on providing sectoral support for agriculture, and state aid for businesses located in sparsely populated areas. With accession to the European Union in 1995, Sweden also adopted the Common Agricultural Policy (CAP), which included implementing a Rural Development Programme (RDP).

The RDP has a strong focus on agriculture and its link to the broader rural economy through improvements to environmental goods and services, and the development of a low carbon economy (Chapter 5). Only a small part of the total RDP budget (20%) is allocated to broader goals such as social inclusion, poverty reduction, economic development and access to services. This is problematic for northern counties where farming plays a far smaller role in the economy and in land use than in the south.

Sweden lacks a coherent national rural policy, and existing programmes and investment are not effectively mobilised to improve wellbeing and promote growth in rural areas (OECD, 2017b). There is no clear framework or mechanism to adapt policies delivered through sectoral ministries to the needs and circumstances of rural places. The governance and funding arrangements for the RDP also differ from regional growth policy in many regions. This separation reduces opportunities to co-ordinate investments delivered through the regional growth policy and the RDP at the regional level.

Toward a renewed rural development policy

In 2015, the government established a Parliamentary Committee to provide a blueprint for the future of rural policy in Sweden. The Committee's mandate was to identify policies to improve the conditions for growth in rural areas and highlight the current issues, and future challenges and opportunities for different types of rural areas.

In January 2017, the Committee delivered its final report: "For Sweden's rural areas – A coherent policy for work, sustainable growth and welfare" (SOU, 2017). The overall aim was to present a

coherent rural development policy for the following 30 years. The main objectives, examples of proposals and the estimated cost of the new rural policy are summarised in Box 4.1.

Box 4.1. Objectives, proposals and costs of the new rural policy

Objective 1: **Create a diversified, competitive and sustainable business community with good capacity for renewal**

- Reinforce the mandates of Almi Företagspartner AB, Saminvest AB and Vinnova to work for business development in very sparsely populated rural areas.
- Expand support for innovation groups and innovation networking within the remit of the RDP.
- Task regional export centres and Visit Sweden to carry out targeted initiatives for companies in rural areas in order to strengthen their export performance.
- Establish a new research centre in order to foster knowledge development about the conditions under which rural enterprises operate.

In addition, the Committee proposes to introduce a "*Business package*" in municipalities facing particularly tough challenges. It would concern 23 rural municipalities in local labour market regions where populations are small but cover a large geographical area. The aim of the package is to increase access to labour and free up capital for local businesses.

Objective 2: **Provide opportunities of digitalisation that benefit the whole country and infrastructure that guarantees passenger and goods transport to citizen and businesses in rural areas**

- Set a new objective for broadband expansion: access to digital infrastructure with transfer capacity of at least 100 Mbit/s for the whole country by 2025.
- Commission the SBA to shape broadband support within the 2021–27 RDP.
- Assess the consequences that a change in taxation, charges and deductions in the area of transport policy would have on the opportunities for achieving the objectives of rural development policy.
- Launch an overview of the travel deduction system with the aim of making it based on distance.

Objective 3: **Ensure that the educational system provides skills and increases access to higher education throughout the country**

- Offer higher education locally in partnership with municipalities in "education centres".
- Investigate the effects and consequences of writing off a proportion of student loans of those who live and work in the 23 municipalities facing tough challenges.

Objective 4: **Develop planning and housing policy that meets the needs of rural areas**

- Commission the National Board of Housing, Building and Planning to draw up guidance for how rural values and development opportunities can be accounted for within the framework of municipal land-use planning.
- Reduce certain restrictions that apply to building and development in rural areas.
- Investigate whether building can be facilitated by introducing special rural loans for self-builders, rentals, owned apartments, cooperative tenancies and tenant-ownership.

Objective 5: **Improve access to services, welfare and the arts in rural areas**

- Safeguard access to post office and payment services.
- Adapt the system that ensures equal financial conditions in municipalities to demographic changes and other circumstances and make earmarked government grants more general.

Objective 6: **Increase the presence of the State in rural areas jobs, government agency services and police force**

- Stop planned cuts in the Swedish employment service's local office network until the consequences of the cuts and the introduction of alternative digital channels for job seekers have been evaluated.
- Set up a service organisation tasked with responsibility for local services that are currently performed by the Swedish social security agency Försäkringskassan, the Swedish Tax Agency and the Swedish Pensions Agency.
- Relocate 10 000 posts at government agencies in Stockholm's Functional Analysis (FA) region to FA regions in need of public sector employment for a five-year period.

Objective 7: **Clearer steering and co-ordination of rural development policy**

- Assess and outline the consequences of Committee reports and Government decisions for rural areas.
- Set up a strategic and operative coordination function in each county, known as "rural delegation".

Objective 8: **Encourage better conditions for civil society to contribute towards rural development**

- Expand the *Liaison entre actions de développement de l'économie rurale* (Leader) method nationwide and expand the State's agreement with civil society at national level by also focusing on developing working methods for rural development.
- Strengthen targeted support for non-formal adult education, in particular, the opportunities and capacity of young people and people with an immigrant background to participate in rural development.

Regarding costs, education centres in FA regions incur an estimated annual cost of SEK 70 million. The cost of the Committee's proposal for broadband expansion is estimated at approximately SEK 2 billion. The Committee's proposal to carry out locally-led development using the Leader method nationwide is estimated to cost a further SEK 150 million over a seven-year period. Finally, SEK 500 million is needed for growth enhancing measures in the package targeting the 23 municipalities facing particularly tough challenges.

Source: SOU (2017), För Sveriges landsbygder – en sammanhållen politik för arbete, hållbar tillväxt och välfärd.

4.2. Labour market policy

Labour market policy influences employment composition and labour mobility, in particular by facilitating (or discouraging) labour to adapt to new circumstances. It can play an important role in facilitating structural adjustment, including farm consolidation, by assisting excess labour in farming to exploit more remunerative non-farm income and employment opportunities. Policies to improve skills and the international mobility of human resources can also help to better match labour supply with demand, and can affect innovation and knowledge transfer through exchange of skills and skilled labour. Structural adjustment allowing younger and better-educated farmers to enter the sector, and skills improvement policies are expected to improve the adoption of sustainable practices (OECD, 2014a).

Labour market legislation

Swedish and Nordic labour laws are largely based on collective agreements. Sweden has no minimum wage, but instead has a well-established structure of collective agreements that set a "reasonable" minimum wage. These labour laws are mainly the result of initiatives from the Swedish Trade Union Confederation in the early 1970s and a number of laws were put in place, such as the Employment Act, the Act on Employment Protection and the Representatives Act. These laws are applied to all sectors, and agriculture is generally not considered as a specific case. Collective agreements are not compulsory by law, but the coverage rate is very high. In 2015, about 85% of all employees in the private sector were covered by collective agreements while the corresponding figure for the public sector is 100% (Kjellberg, 2017).

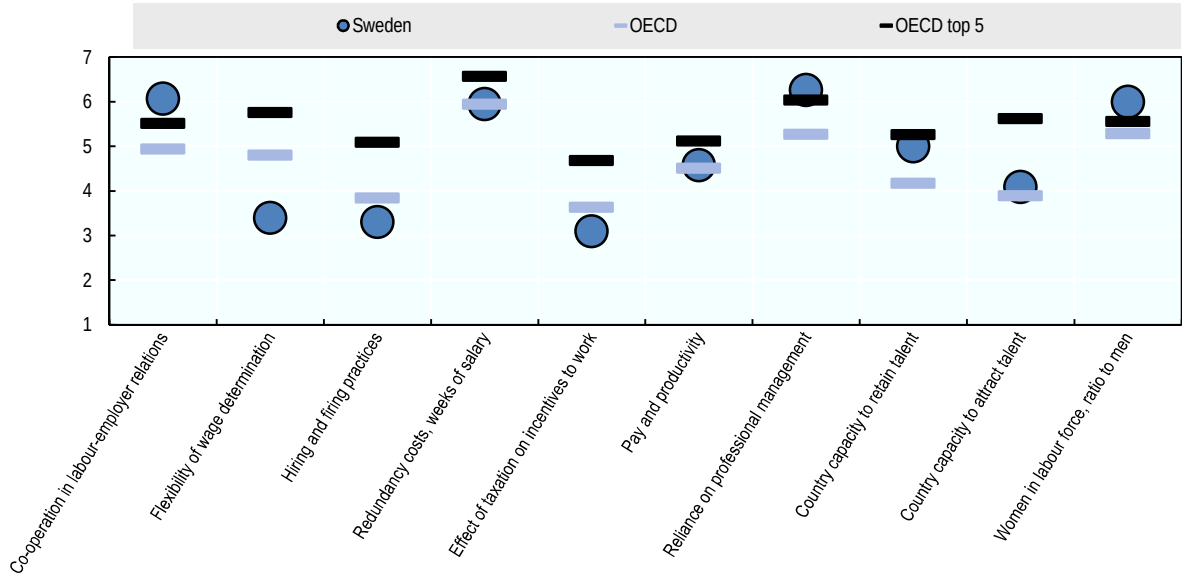
According to the WEF Global Competitiveness Index, which is based on an executive opinion survey, labour efficiency in Sweden is above the OECD average and ranks 18th out of 138 countries. However, this overall evaluation hides differences in performance by components of labour market efficiency (Figure 4.2). Regarding labour flexibility, Sweden scores below the OECD average for most of the indicators; namely: flexibility of wage determination, hiring and firing process and the effect of taxation on incentives to work. However, the protection of temporary forms of employment is significantly lower than the OECD average and is one of the most flexible among OECD countries. Flexible regulation on temporary forms of employment facilitates the use of seasonal labour, which is much needed in agriculture. In Sweden, about 45% of annual working units in agriculture are seasonal employees (SBA, 2016a).

Restrictive labour regulation is perceived as the second most problematic factor for doing business (Chapter 3). Only the co-operation in labour-employer relation is considered very high. Sweden is doing much better in terms of "Efficient use of talent" with a score above the OECD top 5 average for

reliance on professional management and female participation in the labour force. Pay and productivity and the country capacity to attract talent are in line with the OECD average.

Figure 4.2. Global Competitiveness Index: Labour market efficiency, 2016-17

Scale 1 to 7 (best)



Note: OECD top 5 refers to the average of the scores for the top 5 performers among OECD countries (Switzerland, United States, United Kingdom, New Zealand and Canada).
Source: World Economic Forum (2017), *The Global Competitiveness Report 2016-2017: Full data Edition*, Geneva 2016. https://www.weforum.org/reports/the-global-competitiveness-report-2016-2017-1.

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Initiatives to create new jobs and assist labour adjustment

An important challenge faced by the Swedish labour market – which is important for rural areas and activities – is the integration of new migrants and asylum seekers. In 2015, Sweden had the highest per capita influx of asylum seekers ever recorded in an OECD country, and the share of foreign born persons in Sweden more than doubled from 7.5% in 1980 to 16% in 2015 (OECD, 2016a). The problem is that most of the early migrants have a low level of education and literacy proficiency. The unemployment rate of foreign born persons has thus been much higher than for native Swedes and has been increasing, mainly reflecting a gap between native and migrant skills. However, the government has already taken some steps in order to tackle this issue.

The Swedish policy response to increase the employability of low-skilled migrants has so far mainly been a mix of two broad policy tools: upskilling and enhancing transparency on migrants' skills on the one hand, and temporarily lowering the cost of hiring through wage subsidies on the other. Swedish tuition for immigrants has recently been made more flexible and more resources have been allocated to improve the recognition of foreign qualifications. Furthermore, the government intends to broaden newly arrived migrants' access to training and vocational introduction employment[3] (OECD, 2016a).

In the Budget Bill for 2017, the Government will invest in an active labour market policy for increased employment, strengthen the supply of skills, and improve unemployment insurance for part-time unemployed people. The Government is also intensifying efforts to better enable new arrivals to quickly become established in working and community life. More investments will be made for asylum seekers and increased resources for the introduction programme.[4] The Government also

intends to introduce a new compensation system for the reception of un-accompanied minors and young people (GOS, 2017).

Labour supply in rural areas

Relative to urban and intermediate regions, rural areas generally have a smaller working age population compared to a growing share of the population aged over 65 and less than 15. Despite recent growth in population there is a long-term trend of ageing and a shrinking workforce which has result in shortages of workers in many rural places. In addition, young people (and especially skilled ones) tend to leave and go to cities where most higher education is provided and where employment in services is increasing, and only a few of them return. This reduces the number of skilled workers available for local businesses and makes it difficult to attract knowledge intensive businesses to rural areas.

There is an on-going discussion on whether the agricultural sector and rural areas can be part of the integration of immigrants in Sweden. This would at the same time reduce labour shortages in the agricultural industry, enable low-skilled new comers to be integrated into the labour market, and modify the age structure of rural areas. The proportion of immigrants in the agricultural sector has already increased for all sub-sectors in the industry since 2007. The growing of perennial crops is the industry with the highest proportion of immigrants (25%), while the lowest proportions are found in animal production, mixed farming and the agricultural support industry.

Currently, there are few initiatives for the integration of migrants into the agricultural sector. Existing initiatives are mostly operated in the private sector, and partly publicly financed. These projects attempt to combine the challenges relating to integration, rural competence provision and generation change. One such project is *Grön Integration* (Green Integration), initiated by the Rural Economy and Agricultural Societies.

The government has provided incentives to promote employment in the green industries for newly arrived individuals (The Swedish Forest Agency, 2017). In 2016, it commissioned The Swedish Forest Agency, The Swedish University of Agricultural Sciences, and Sweden's Public Employment Agency to identify potential solutions in order to increase attractiveness and accessibility to the green industry. SOU (2015) and the Food Strategy (GOS, 2015) emphasise that the adjustment speed and adjustment opportunities are insufficient, within both agriculture and the food sector. Increasing entry into the sector and more flexible labour market from both demand and supply perspective should be encouraged. The Food Strategy also points out the importance of these new ways of adjustments at a time of high migration and need for integration.

4.3. Education and skills policy

Education policy affects innovation in at least three ways: a high level of general and scientific education facilitates acceptance of technological innovation by society; well-educated researchers, teachers, extension officers, and producers are needed to develop relevant innovations; and farmers and business operators with higher education and skills are better able to adopt technological innovations. Continuous skills development (training, re-training) is thus essential to improve the matching of skills demand in evolving food and agriculture sectors, which need to adopt productivity and environmentally enhancing technologies and practices (OECD, 2014a).

The general education system

Governance and funding

The Swedish educational system includes primary school education (compulsory school), upper secondary education, university/college education and higher vocational education studies. Municipal

adult education, preparatory courses and folk high schools provide opportunities for adults with upper secondary education to complement their studies with theoretical or practical classes, and be able to enter university or higher vocational education programmes.

The education system is a municipal and state responsibility. Compulsory school and upper secondary level, including adult studies at upper secondary level, are a municipal responsibility. Overall guidance such as course contents, regulations and grades are decided by the state, but the implementation and financing lie with the municipalities.

Sweden's decentralised educational system, where municipalities and Swedish National Agency for Higher Vocational Education decide what vocational education programmes are offered, gives schools a high level of autonomy. In contrast to the majority of OECD countries, the authority to determine teachers' base salaries and award additional payments rests at the local level with the School Board or the Head Principal of schools. Although the total working time per year is statutory, school leaders decide on the number of working hours per week and on the use of teachers with regard to teaching and non-teaching activities (OECD, 2015).

In Sweden, teachers' salary scales are compressed and lag for those starting in their careers, both compared to the OECD and EU-22 averages of teacher salaries, as well as workers with the same level of educational attainment within the country. Despite a flat salary scale, Sweden has among the highest statutory working hours per school year (OECD, 2016a). This has led to a shortage of qualified teachers across the country, reflecting the low attractiveness of the teaching profession in Sweden.

At university level, the responsibility lies entirely with the State. Most major educational institutions are controlled and financed by the Ministry of Education and Research. The Swedish University of Agricultural Sciences is an exception, and comes under the Ministry of Enterprise and Innovation in charge of agriculture-related matters. Universities have a great deal of freedom, and can largely decide for themselves – within the framework of their assignment – what studies to provide. The education system is generally free for students. Two exceptions are higher vocational education studies and, for non-EU students, higher education for which fees are levied.

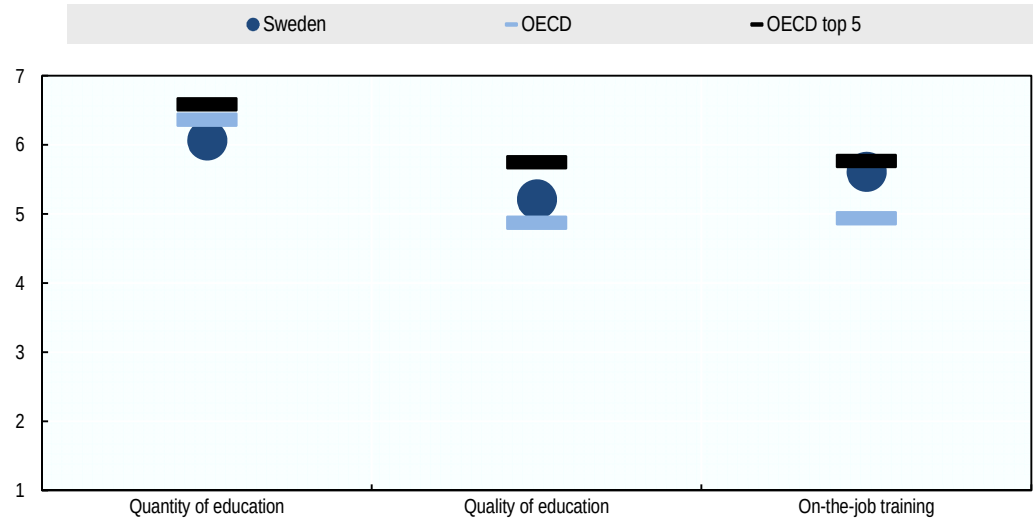
Overall performance

Business leaders rank Sweden above the OECD average in terms of the *quality* of higher education and on-the-job training (WEF, 2017) (Figure 4.3). The quality of higher education, reflecting business executives' assessment of how well the educational system meets the needs of a competitive economy, is considered above OECD average, despite a relatively low quality of maths and science education. Regarding on the job training, Sweden compares with the OECD top 5 average and ranks 7th in the world. Provision of on-the-job training, is measured by the availability of high-quality, specialised training services and the extent to which companies invest in training and employee development.

However, the *quantity* of higher education, as measured by an index of secondary and tertiary enrolment rates, scores below the OECD average and ranks 43th in the world. This score is affected by a low and decreasing gross enrolment rate in tertiary education compared to the OECD average. If current patterns of entry continue, it is estimated that 62% of young adults in Sweden will enter tertiary education at least once during their lifetime, compared to the OECD average of 68%. However, the share of the population that have attained tertiary education is above the OECD average (40% against 36%) (OECD, 2016a). Incentives to pursue higher education might be lower in Sweden due to homogeneous employment rates among educational attainment levels and the low earnings advantage of tertiary education. The earnings advantage of a tertiary education in Sweden is the smallest among OECD countries.

Figure 4.3. Global Competitiveness Index: Higher education and training, 2016-17

Scale 1 to 7 (best)



OECD top 5 refers to the average of the scores for the top 5 performers among OECD countries (Finland, Netherlands, Switzerland, Belgium and Denmark).

The quantity of education index is based on secondary and tertiary education enrolment rates from UNESCO Institute for Statistics. The quality of education index is based on responses from a WEF Executive Opinion Survey on "How well does the educational system meet the needs of a competitive economy; Executives' assessment of the quality of math and science education in schools and the quality of business schools; and on how widespread is Internet access in schools. The on-the-job-training index is based on survey responses on the availability of high-quality, specialised training services and the extent to which companies invest in training and employee development.

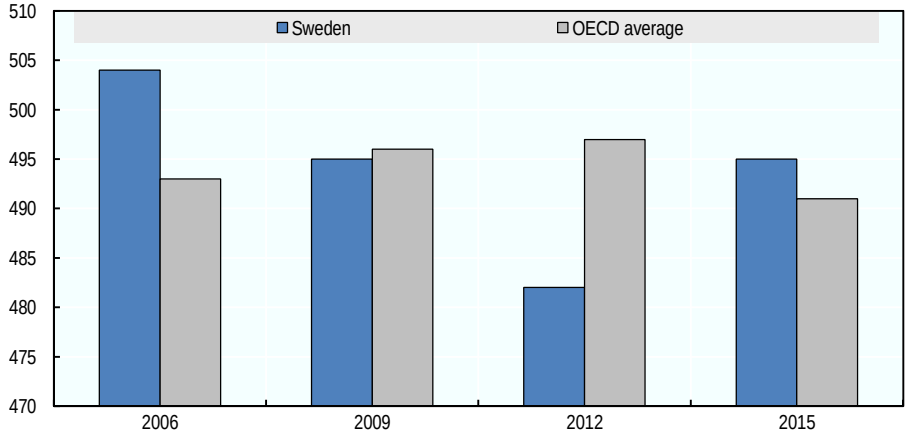
Source: World Economic Forum (2017), *The Global Competitiveness Report 2016-2017: Full data Edition*, Geneva 2016. https://www.weforum.org/reports/the-global-competitiveness-report-2016-2017-1.

StatLink http://dx.doi.org/10.1787/888933709964

According to the OECD Programme for International Student Assessment (PISA), the earlier trend of declining learning outcomes in Sweden for the past decade has been reversed since 2012 (Figure 4.4). In 2015, the score of Swedish 15 years-old students in sciences was similar to the OECD average and the scores in mathematics and reading were above the OECD average[5] (OECD, 2016b). However, the impact of socio-economic status on students' performance has increased. Variation between schools seems to be driven mainly by residential segregation and to a limited extent by the introduction of school choice and independent schools in the 1990s (OECD, 2017a). Finally, Sweden (as is the case in many other OECD countries) is still struggling to close the performance gap between native and immigrants students.

According to the OECD Programme for the International Assessment of Adult Competencies (PIAAC) survey, Swedish adults (16-65 years) performed significantly above the OECD average in literacy and numeracy, and in terms of problem solving in technology-rich environments[6] (OECD, 2016c). In particular, about three-quarters of the adult population in Sweden display moderate to good skills and readiness to use ICT for problem solving, together with New Zealand the highest proportion among surveyed countries. For all three categories, young adults (16-32 years) scored better than their older counterparts (55-65 years).

Figure 4.4. Mean PISA score (maths, science, reading) Sweden and OECD average (2006-20015



Source: OECD PISA.

StatLink http://dx.doi.org/10.1787/888933709983

Trends in education expenditures

While students and adult skills are well-above the OECD average, expenditure on education as a percentage of GDP (5.4%) is close to the OECD average (5.2%). Its level of expenditure per student (for core services, ancillary services and research and development) is among the highest across OECD countries at USD 13 072 per student per year for primary to tertiary education, above the OECD average of USD 10 493. Sweden is also one of the two OECD countries (with Norway) which funds 100% of primary, secondary and post-secondary non-tertiary institutions from public sources, compared with the OECD average of 91.3% (OECD, 2016a).

Current policy efforts

The Government has already taken some steps in order to face the different challenges encountered by the Swedish educational system. Education received an additional SEK 8.3 billion (about 0.2% of GDP) in 2016 to enhance the attractiveness of the teaching profession, notably through salary increases, and to promote early intervention and equity. Special resources have been channelled to schools with low learning outcomes. Measures are also being taken to enable teachers to devote a larger proportion of their working hours to teaching (OECD, 2017a).

Agricultural education

Agriculture-related education programmes

Agricultural education is available in Sweden both through higher education and vocational education programmes. The main vocational programmes that are adapted for working within the food chain are the natural resources use programme and the food programme. In 2010, the food programme was merged with restaurant education and has become the "restaurant management and food'' programme. There are four elements in the national natural resources use programme: animals (pets), agriculture, forestry, and gardens; and three in the restaurant management and food programme: kitchen and serving, baking and patisserie, fresh foods, delicatessen, and catering.

There are several higher vocational programmes within agriculture, horticultural production and food processing. The Swedish National Agency for Higher Vocational Education authorises various education providers to offer specific programmes following an application process. Those who apply to offer a particular programme must demonstrate that there is market demand for the programme's

qualifications, and that students can expect to find a job after completing their studies. Higher vocational education courses usually correspond to at least one year and maximum three years of full-time studies-often including a work placement- and end up with a qualification.

The Swedish University of Agricultural Sciences (SLU)[7] is the institution responsible for agricultural higher education and research. The university is composed of four faculties: Landscape Planning, Horticulture and Crop Production Science; Natural Resources and Agricultural Sciences; Veterinary Medicine and Animal Science; and Forest Sciences. In particular, SLU offers Bachelor's and professionals programmes in agronomy, food, and horticultural management and Master's programmes in agricultural economics and management; agricultural, food and environmental policy; agroecology and plant biology. Students from SLU contribute to agriculture in Sweden in the form of officials, advisors, and trainers but they have fewer opportunities to work directly within agricultural businesses, which increasingly demand high-skilled workers with practical knowledge.

Food programmes specialising in industry are offered by Lund University's Faculty of Engineering in the form of its Food Technology programme, and they are in high demand thanks to their attractive combination of theoretical and practical skills. Admission for 30 places takes place every year. Lund University's Faculty of Engineering and Chalmers University of Technology also have a number of students who specialise in food technology towards the end of their engineering programmes, but they are few in number, according to the Swedish Food Federation. There are other food-related programmes at several Swedish universities, such as programmes in nutrition and dietary economics. However, few students from these programmes end up working in the industry, although they are often find jobs in education.

The career path of graduates from any agriculture and food related higher education institution has evolved over time. The share of graduates in any agriculture-related higher education ending up working in education and public administration increased between 2003 and 2013 and education is now the second largest sector employing higher-education agricultural graduates. They have also tended to spread out in more sectors, some of them being unrelated to the food industry (transport, chemistry, and computer science for instance) (SBA, 2016a). This has been possible as these programmes offer skills that can be easily transferred to other sectors.

There are few options available for agricultural or horticultural entrepreneurs or food producers who want to continue building on their skills. Continuation courses are sometimes arranged by farmers' own organisations such as the Rural Economy and Agricultural Societies or the Federation of Swedish Farmers. They are financed by the participants themselves, often with support from the County Administrative Board or the SBA. Employers can also pay for their employees' further education via commissioned education. SLU offers some courses within food and agriculture/horticulture such as online learning within the framework of MENY, a system for web-based commissioned courses.

Vocational training programmes are arranged by the Swedish Public Employment service in certain occupations with a shortage of workers. There are currently a number of programmes that benefit the food industry, such as training of slaughterers and butchers, and there are plans for a training programme for dairymen. There are also some training programmes in agriculture and horticulture. These courses are usually aimed at the long-term unemployed and new arrivals, normally at first-cycle level.

Agriculture enrolment trends

Upper secondary school programmes were reformed in 2011, distinguishing more clearly between vocational programmes and university entrance programmes. In two years, between 2010 and 2012, the number of students starting the natural resources use programme decreased by over 30% (Figure 4.5). During the same period, all vocational programmes together lost over 28% of their applicants, who instead applied to study more theoretical programmes. Since then, the number of students starting the natural resource use programme has slightly decreased, reaching 3000 in 2016.

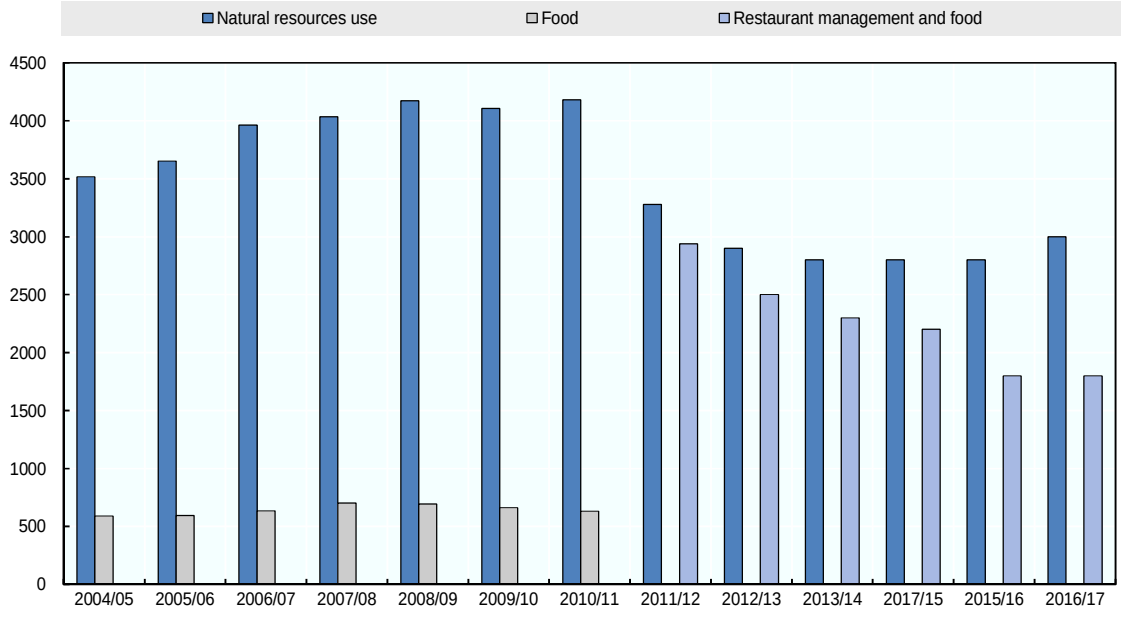
As the food programme merged with restaurant education, it is difficult to see and compare how the number of pupils with a food specialisation has evolved over time. Vocational programmes are not very popular among parents as there are few opportunities to go to university afterwards.

Regarding the number of students in the different branches of the natural resources use programme, animals (pets) is the largest – but is also the one that is the least related to the agricultural sector. Agriculture and Forestry are smaller but the number of students has been stable during recent years, representing around 500 new students per year for agriculture. The programme on "Gardens" is the smallest one and the number of students is on a declining trend (Figure 4.6).

In March 2017, the Government presented a bill that aims to increase vocational education in the country. The Government notes that interest in vocational education has decreased and that there might be up to 100 000 fewer vocational students by 2025. The goal is to establish closer ties between agri-food industries and the municipal schools. Currently, there is no control within upper secondary education over the number of places within the various programmes based on the needs of the labour market.

The total number of students enrolled at SLU decreased by 5% between 2013 and 2016. The biggest decrease is at the doctorate level (-16%). The number of newly registered students in programmes related to agriculture and food has been quite constant for the period 2013-15 with an average of 522 students, but it decreased to 422 in 2016.[8] According to SLU, the decline in the number of full-time equivalent (FTE) students over the last five years is mainly due to a reduction in government grants for the period 2012-15. The Government has set a three-year FTE target for SLU (2016-18). In order to reach this target, SLU will have to increase the number of FTE students by 10% in the next two years.

Figure 4.5. Number of pupils (1st grade) in upper secondary school in the natural resources use programme and the restaurant management and food programme



Source: Swedish National Agency for Education.

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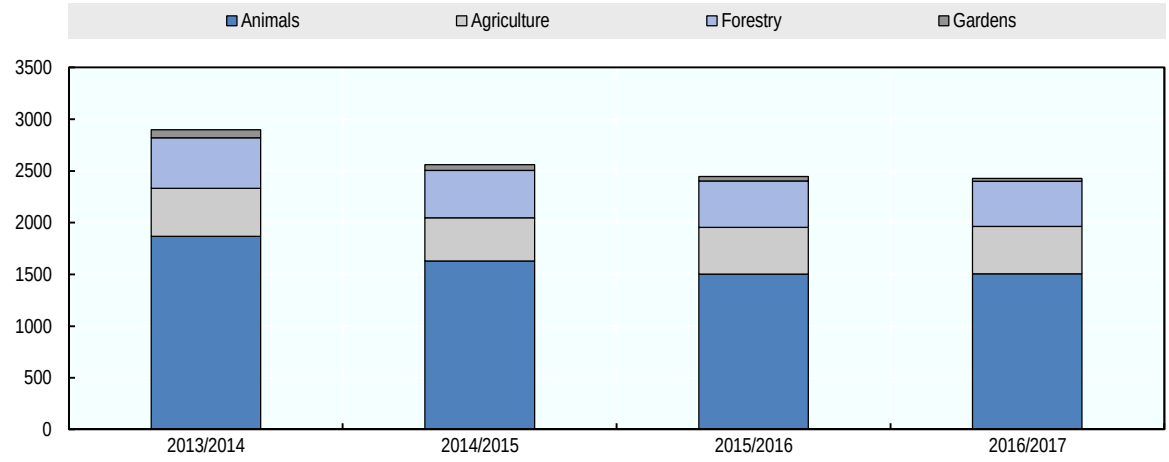
Figure 4.6. Number of students in the natural resources use programme by orientation, grade 3

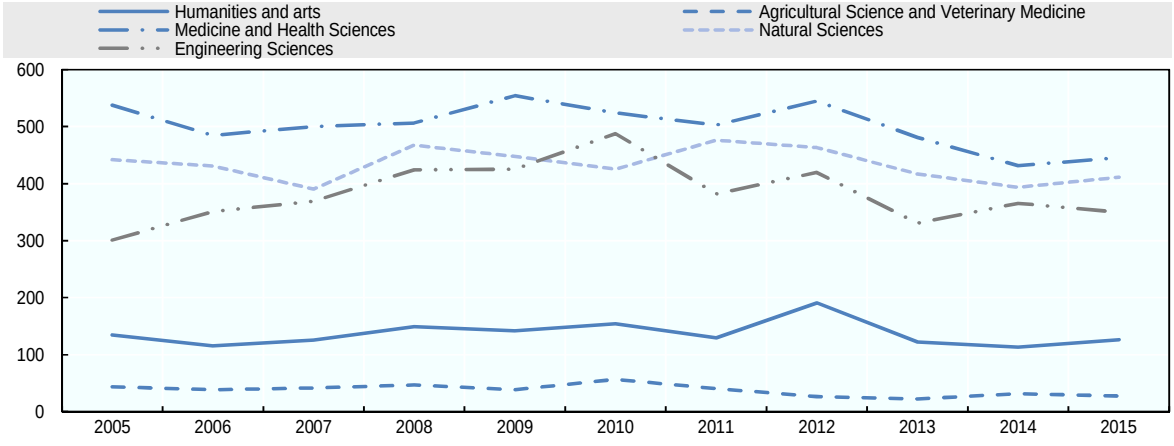


Source: Swedish National Agency for Education.

StatLink http://dx.doi.org/10.1787/888933710021

Regarding post-graduate studies, agricultural sciences and veterinary medicine is the research area with the lower number of new students in Sweden, although it has been quite constant since 2005 (Figure 4.7). Another issue lies in the fact that half of the agricultural PhD students are foreign students, so the future of the agricultural innovation system will depend on them staying in Sweden. The food industry is also experiencing a serious shortage of research according to the Swedish Food Federation. Researchers in food are few, partly since there are few graduate students. Applied research is no longer the priority, which might result in the poorer long-term development of the industry (SBA, 2016b).

Figure 4.7. New post-graduate students by research area



Source: Swedish National Agency for Education.

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Meeting labour market needs in the food and agriculture sector

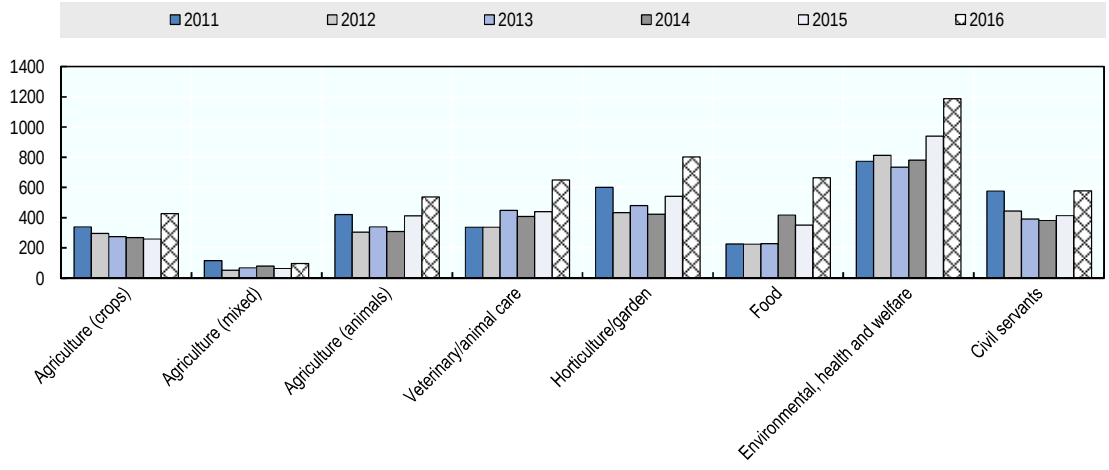
Vocational schools and higher education institutions have difficulties attracting enough students to meet labour market expectations. The Federation of Swedish Forestry and Agricultural Employers describes major problems for its members in finding skilled workers at all levels. The greatest needs are for animal handlers, tractor drivers and management. Within the horticultural sector, there are shortages in all areas. Additionally, monitoring shortages in the supply of workers has proven to be difficult, leaving little room for the authorities to take action (Box 4.2). This suggests that there are market failures, related to lack of information and/or poor remuneration and conditions in the food and agriculture sector.

Box 4.2. Difficulties in assessing the demand for agri-food workers

Shortages of workers in the agricultural sector have not been well monitored by the authorities. This is due to the fact that the agricultural industry – which consists of many small businesses – has taken different approaches to look for staff, so the Swedish Public Employment Service has not always registered the need for workers. The authorities have interpreted this as meaning that there is no shortage, and very few educational and training programmes have been arranged as a consequence.

The industry is now trying to provide information about its needs on a regular basis, and the Federation of Swedish Farmers has its own website for "green jobs", which currently includes 654 adverts for 1 266 job vacancies, many of them within horticulture (Figure 4.8). The authorities have become more sensitive to these needs in recent years, but there is still a shortage of programmes and workers within several areas.

Figure 4.8. Number of job vacancies advertised on gronajobb.se (2011-16)



Source: The Federation of Swedish Farmers.

StatLink http://dx.doi.org/10.1787/888933710059

A significant shortage for larger agricultural businesses is for management and supervisory positions that require both theoretical and practical skills. Many of these positions are currently filled by foreign workers. The larger units are also looking for specialised workers with new skills within fields such as biotechnology. Larger businesses need to focus more on customer demands in the market place, which has increased the need for entrepreneurial skills in both horticulture and farming.

Similar labour market experiences can be found in the post-farm gate stage of the agri-food chain. According to the Swedish Food Federation, the educational system is not meeting the labour needs of the food industry.[9] Few young people apply for jobs in food production, and this is true for both industrial and artisan work. There is a particularly significant shortage of labour in the meat and cured

meats sectors. Industrial developments are heading towards greater automation and a higher level of technology, which also places new and higher demands on staff.

Both the advisory industry and the education sector within the food chain lack qualified staff with both practical and theoretical knowledge. Advisors need to be trained to assist more competent business owners both with farming and breeding and with processing as a whole. Within the education system, young people should be given a sound education in both practical and theoretical elements by qualified teachers. *Naturbruksskolornas Förening*, which organises most of the natural resources sector schools in the country, has noted an increasing problem for many schools in finding qualified and competent teachers.

One possible explanation for the low interest in agricultural studies and the shortage of workers along the food chain are low wages in the food and agriculture sector. In 2016, berry pickers and planters, mixed crop and animal breeders and livestock and dairy producers were part of the 20 occupations with the lowest average monthly wage in Sweden (Statistics Sweden, 2017). Wages in food processing are also low, and currently below the average monthly wage across all occupations.[10] Additionally, agriculture is facing competition from other sectors, in particular forestry and mining, which offer better wages and working condition. Students with vocational education on agriculture easily find jobs in the sector, but they tend to quit for easier and better paid opportunities. Lack of focus on productivity and economic performance could also play a role in the sector's low wages.

Another possible explanation lies in the fact that agricultural jobs might not be very attractive for young people as many of the employers are located in rural areas. Sweden shows a high degree of "urbanisation of knowledge" (i.e. highly educated people tend to live in urban areas) and this pattern also holds for knowledge in agriculture. Graduates with food and agricultural education tend to locate within or close to more urban, denser places. This might be problematic since agricultural knowledge is somewhat related to an industry which is tied to rural areas as a result of locational-specific natural resources (SBA, 2016a).

Science and environment awareness in education and society

Science

Only 0.9% of Swedish students are not required to attend formal science courses, against the OECD average of 6.4%. The quality of science education, reflected by PISA scores, has improved since 2012 and compares with the OECD average, after some years of declining learning outcomes (OECD, 2016b). An improvement in science scores has also be recorded for 8th grade students between 2011 and 2015, according to the TIMSS measurement (IEA, 2015).

Scientific education plays a major role in higher education and research. In Sweden, around 30% of graduates obtained their master's degree in science or engineering, manufacturing and construction, and more than half of doctoral graduates acquired their degree in sciences and engineering (OECD, 2016a). Medicine, natural sciences and engineering are also the research areas that attract the more postgraduate students.

Environment

Sweden has a long-standing tradition of environmental education, which is considered a key element of progress towards sustainable development. Teaching of basic environmental issues begins at the pre-school level and expands in primary school. The secondary school curriculum, which was updated in 2011, covers sustainable development aspects in several subjects. The new guidance documents mark a shift from the concept of environmental education towards the concept of education for sustainable development, including ecological, social and economic sustainability (OECD, 2014b).

According to the OECD PISA survey, Swedish schools play a bigger role in teaching children about most environmental issues, on average, than schools in other OECD countries. For example, 65% of

children in Sweden learn about water shortages and 72% learn about nuclear waste issues at school, against fewer than 59% on both counts for OECD countries on average (OECD, 2014b).

The "School for Sustainable Development" project run by the National Agency of Education provides annual awards to schools with achievements in sustainable development; to date, 400 schools have received such an award. In addition, over 2 500 Swedish schools have been awarded a Green Flag – an international distinction under the Eco-Schools Programme that is co-ordinated nationally by the Keep Sweden Tidy Foundation.

According to the Swedish Higher Education Act (1992), higher education institutions should promote sustainable development. Since 2011, all public universities and colleges must report annually to the government on their environmental work. Several have been certified to the ISO 14001 EMS standard. In addition, the use of natural resources, environmental protection and climate-change related disciplines are taught at Bachelor, Master and Doctoral levels.

The Swedish Environmental Protection Agency and the Ministry of Environment and Energy are responsible for raising the population's environmental awareness and providing information about current challenges and the state of the environment. They are also setting environmental objectives and targets at the national level, with the overall objective of ensuring a good quality of life for future generations.

Notes

1. Electricity production sources (2014): hydro power (42%), nuclear power (41%), wind power (8%), solar power (0.06%), and other thermal energy (9%) (IVA, 2016). The production of electricity makes the second largest contribution to the share of renewable energy with hydroelectric power as the main source, followed by biomass-based electricity and wind power. Bioenergy is used primarily for process heat in industry and for residential heating.
2. In these places, one in four village shops disappeared during the period 2004-14 (SBA, 2016a).
3. Vocational introduction employment concerns people who lack relevant experience in the occupation, and are mentored or trained during part of their working hours.
4. The introduction programme is a two-year programme which provides language classes and a wide range of targeted activities aimed at preparing new humanitarian migrants and their families to enter the labour market.
5. In 2015, Swedish 15-year old students scored 493 in science, 494 in maths and 500 in reading, on average. Corresponding figures for OECD average are 493, 490 and 493.
6. In 2015, Swedish adults scored 279 in literacy, 279 in numeracy and 44 in problem solving in technology-rich environments. Corresponding figures for OECD average are 268, 263 and 31.
7. SLU is mainly located at Uppsala, Alnarp, Umea and Skara. Research activities and environmental monitoring and assessment are carried out throughout the country.
8. Number of newly registered students on programmes related to agriculture or food at SLU: 525 in 2013, 511 in 2014, 529 in 2015, and 422 in 2016.
9. For instance, the Swedish Food Federation estimated an annual labour need of 100 new food process operators while only 50 operators are trained each year at upper secondary school, and they will have to meet the needs of the food industry and all other processing industries (pharmaceuticals, chemistry, plastics, and paper).
10. Average monthly salary in SEK (2016): 32 800 across all occupations and 24 800 for food processors.

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Chapter 5

Agricultural policy in Sweden

This chapter provides an overview of the agricultural policy framework and instruments, focusing on European Union (EU) Common Agricultural Policy (CAP) and national (non-EU) measures, and their implementation in Sweden. Particular attention is paid to measures related to knowledge generation, knowledge transfer and innovation. Finally, there is a discussion of the likely policy impact of agricultural policies on innovation, productivity growth and sustainability performance.

Key points

- Sustainable production methods, food safety, animal welfare and a competitive agri-food chain are key objectives of policy reforms in Sweden.
- Around 9% of the total Rural Development Programme (RDP) budget is allocated to the *knowledge package* for 2014-20, with its main focus on ecosystem management related to agriculture and forestry.
- Sweden is well-advanced in terms of agri-environmental programmes, as compared to other European Union member states and has a higher share of payments for improving sustainability through better ecosystem management than other EU Member states.
- Environmental measures and measures for areas under natural constraints, both of which are related to the ecosystem management, each account for almost a quarter of the total 2014-20 RDP funding.
- Research suggests that the impact of EU decoupled support on productivity in Swedish agriculture is mixed and inconclusive even though a negative (inverse) relationship between CAP payments and productivity tends to prevail.
- Due to the wide variation in Sweden's agro-ecology and geography, and the broad nature of the greening measures, these measures are unlikely to improve environmental conditions.
- Cross-compliance requirements have existed within Swedish legislation for a long time, so the environmental improvements following their introduction are expected to be small.
- The Swedish Board of Agriculture (SBA) is running a pilot project to test performance-based payments for landscape elements in 2016-19.

5.1 Agricultural policy framework

Sweden is a long-standing advocate of a market-oriented agricultural sector (Box 5.1). Since its EU membership in 1995, Sweden's main agricultural policy framework is the EU CAP. The CAP typically covers a seven-year period, currently 2014-20. It is composed of two pillars: Pillar 1 (*market measures* under the Common Market Organisation – CMO – and direct payments); and Pillar 2 (*rural development* payments, which includes agri-environmental elements). Pillar 1 measures are fully funded by the European Agricultural Guarantee Fund. Pillar 2 measures, which are implemented according to the national RDP, are co-financed by the European Agricultural Fund for Rural Development and EU Member states.

The 2014-20 CAP offers some discretion for member states in implementing both pillars. It also contains important elements of redistribution of Pillar 1 direct payments, both within and between member states (OECD, 2017). Member states have the flexibility to transfer 15% of their direct payment envelope from Pillar 1 to Pillar 2 as well as in the opposite direction (so-called "modulation"). In the case of the transfer from Pillar 2 to Pillar 1, 12 Member states are permitted to transfer an additional 10%, bringing the maximum permitted transfer up to 25%.[1] Sweden has chosen not to carry out this modulation (Henke et al., 2015).

Box 5.1 Sweden's stance on agricultural policy reform: Deregulated and market-oriented

The Swedish position on long-term changes in agricultural policies is to favour a market-oriented food and agriculture sector, emphasising phasing out direct farm payments and rewarding the provision of public goods. Spending targeted at competitiveness, on research and development, strategic investment in cross-border transport and energy infrastructure and education are areas that are considered to provide added value at the European Union level and so all EU Members benefit and justify common financing. On harmful environmental effects associated with agricultural production, the basic principle advocated is that the polluter pays principle should apply. As a small open economy, Sweden is strongly dependent on trade and has traditionally been free trade oriented.

Sweden has a long tradition of attaching importance to considerations other than narrow farm interests. A unique feature of the Swedish system in the past was the participation in agricultural policy matters of the Consumer Delegation, a government appointed body representing consumers' interests. A radical reform of agricultural policy took place in 1967 aimed at accelerating structural change. In 1990, the Swedish government decided to radically reform agricultural policy. The reform aimed at removing internal market regulations and export subsidies. The idea that high market price support could be justified on the grounds of so called non-market objectives was rejected. Rather, the provision of public goods was to be encouraged through direct payments, which were intended to be temporary. However, the reform was never fully implemented due to the accession of Sweden to the European Union in 1995. Nevertheless, the political legacy of the reform is still present and has influenced the Swedish attitude towards the reform of the CAP ever since.

As a result of the accession negotiations prior to Sweden joining the European Union in 1995, Sweden was granted permission to pay a fully nationally financed support measure, Nordic Aid, to agriculture north of the 62nd parallel. The negotiations also resulted in a relative generous allocation of funds to rural development and, in particular, agri-environment measures.

The health and protection of the environment is a fundamental driving force in domestic agricultural policy and in the overall economy. The preservation of biodiversity and an open landscape are considered to be especially important objectives. Because agricultural land constitutes such a small share of total land use, land abandonment, especially of grazing land, would be deemed detrimental to the achievement of these objectives. On the other hand, because farms of different sizes have approximately similar household incomes, indicating that farmers are able to secure adequate earnings in agriculture and from other sources, farm income is not such a big issue in the political debate. As reform of the CAP continues, Sweden advocates the following two principles: i) agricultural and food enterprise production should be driven by consumer demand; and ii) production should be ecologically and economically sustainable.

Source: Based on Rabinowicz and Hammarlund (2008), CAP Reform Profile – Sweden, http://cap2020.ieep.eu/2008/10/16/cap-2020-reform-profile-sweden#background.

Pillar 1 payments account for half of total EU and national CAP funding in Sweden, compared to 61% on average for the EU28 (Figure 5.1). Within Pillar 2 funding, national payments account for a high share – around 30% – of total CAP and national co-financing, compared to 14% on average for the EU28. When the sum of EU and national funding for Direct Payment and RDP measures over 2014-20 is divided by the number of years (seven) and by the Utilised Agricultural Area (UAA) in 2016, the average annual payment rate in Sweden is higher than the EU28 average (Figure 5.2). Likewise, when annual CAP and national support is related to the value of agricultural output, Sweden has a higher share (25%) than the EU28 average of 16%, but lower than in Finland (close to 50%), as farmers receive additional regional payments in Finland (Figure 5.3).

Broad-based measures – Pillar 1: Direct payments

Direct payments, are mostly per hectare payments that do not require production. Recipients need to be active farmers, but except for a small share of payments for specific commodities, production is not required to receive payments. Payments are, however, conditional on the respect of regulations and the adoption of specific farm practices, in particular maintaining agricultural land in good agricultural and environmental condition. In Sweden, the national ceiling of Direct Payments is EUR 700 million per year for the 2014-20 period (Henke et al., 2015).

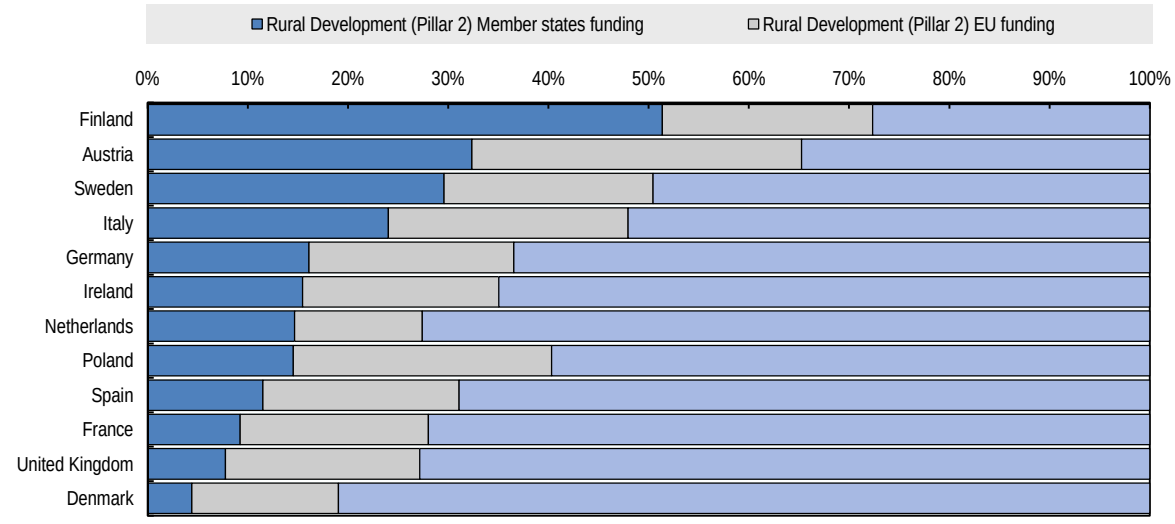
Direct Payments entail three mandatory elements: the Basic Payment Scheme (BPS); payments for agricultural practices beneficial for the climate and the environment (the so-called 'greening'); and the young farmer scheme. Member states can also choose to introduce some optional measures – e.g. production-coupled support and payments to farmers in areas where there are natural constraint.

Within the BPS, there are several rules and optional elements.[2] The BPS is implemented in Sweden as a flat rate per hectare payment and makes up the main part (55%) of the Pillar 1 Direct Payment budget. The *greening payments* account for 30% of the Direct Payment entitlement, contingent on certain farming practices deemed to be beneficial for the climate and environment. These farming practices go beyond cross-compliance and include crop diversification, maintenance of permanent grassland and the establishment of ecological focus areas. Sweden also applies the regulation on the "green payment" that exempts member states with more than 50% of the land covered by forests from the obligation to apply the provision on Ecological Focus Areas (EFAs). In Sweden, the basic payment will be levelled out to 1 170 SEK/ha/year in 2020 and the greening payment to SEK 640 per ha per year.

Voluntary coupled support, which can be granted to specific sectors or regions, accounted for 13% of the direct support in Pillar 1 in 2015-19. Sweden has chosen targeted support only for the beef sector. The Young Farmers' Scheme, which is a top-up payment for young farmers, accounts for 2%.

Greening payments are applied at the holding level. Sweden has chosen five of the CAP greening options. Among the Swedish greening measures are crop diversification, which states that the share of a farm's area that must consist of a minimum of three crops; the permanent grassland measure, which states that such areas must not decrease by more than 5% from a reference area set at national level; a measure that states that farms must have a minimum of 5% of their eligible cultivated land as EFAs; and keeping land lying fallow and non-cultivated field margins on arable land, which are examples of land use eligible as EFAs.

Figure 5.1. CAP budget by funding source for 2014-20 and share in EU28, selected EU Members



Note: Budgets represented are after transfers between pillars and may be subject to revisions as from budget year 2018. Member states funding of rural development include statutory co-financing and national top-ups and exclude domestic policy.
Source: CAP 2014-20 Budget and OECD calculations based on national 2014-20 RDP budget as published in: http://ec.europa.eu/agriculture/rural-development-2014-2020/country-files/index_en.htm, 2016.

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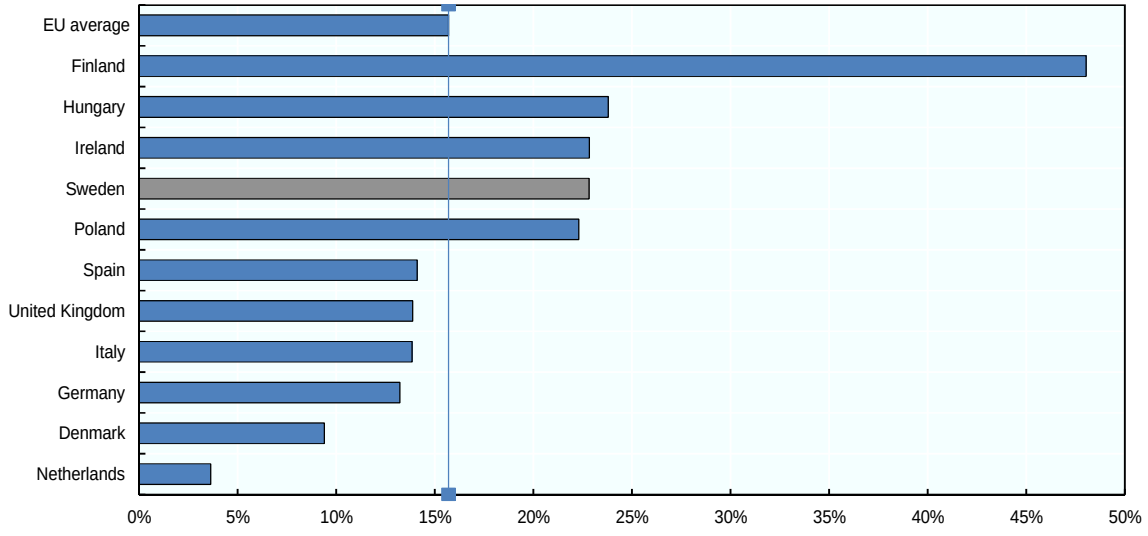
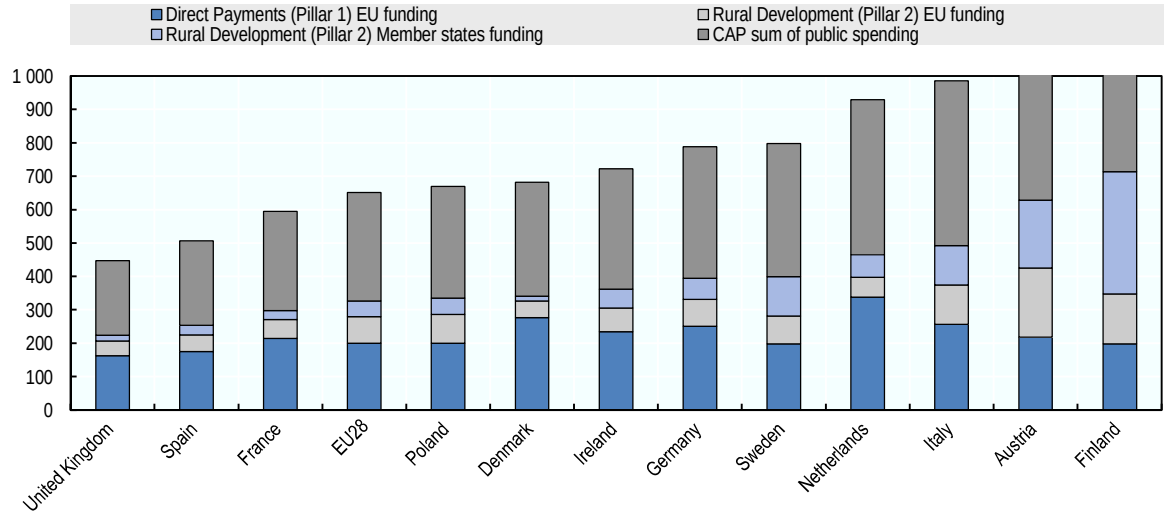
Figure 5.2. Ratio of public spending to the value of agricultural output, selected EU Member states



Note: The ratio has been calculated by dividing the average annual public spending by the average value of agricultural commodity output in 2014-16. Public spending includes member states statutory co-financing of rural development and national top-ups, and excludes domestic policy. Budgets represented are after transfers between pillars and may be subject to revisions as from budget year 2018.
Source: CAP 2014-20 Budget and OECD calculations based on national 2014-20 RDP budget as published in: http://ec.europa.eu/agriculture/rural-development-2014-2020/country-files/index_en.htm, 2016. Value of agricultural goods output: Eurostat, Economic Accounts for Agriculture database, agricultural goods output, production value at producer prices, February 2017.

StatLink http://dx.doi.org/10.1787/888933710097

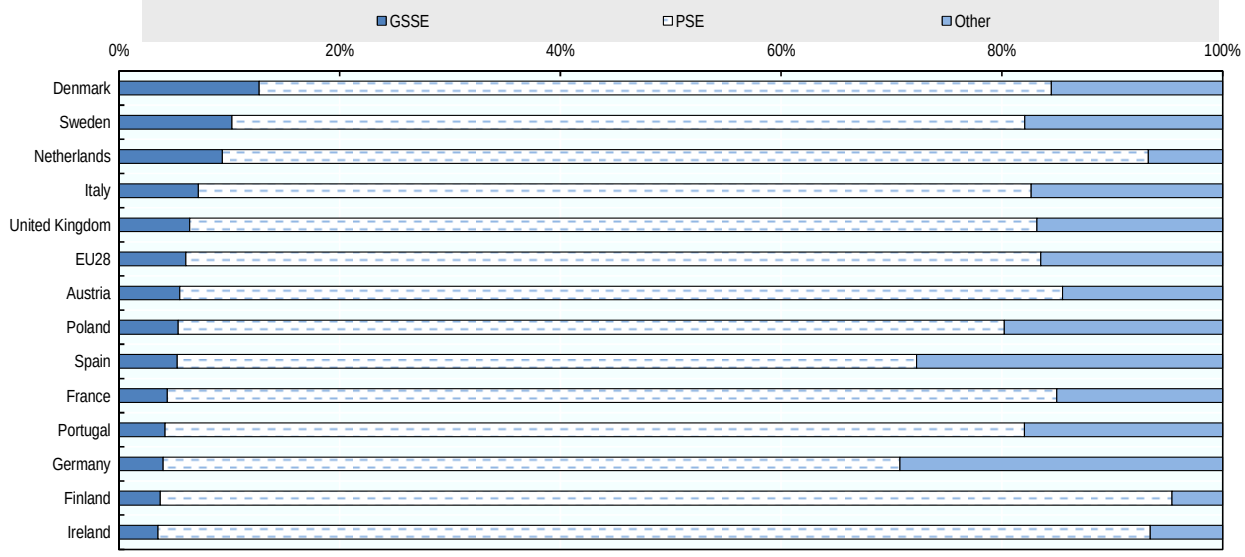
Figure 5.3. Average annual payment rate per hectare over 2015-20, selected EU Member states



Source: Budget data from OECD (2017), Utilised agricultural land from Eurostat.

StatLink http://dx.doi.org/10.1787/888933710116

Figure 5.4. CAP rural development budget: OECD indicators of support, selected EU Member states



Countries are ranked according to the share of the General Service Support Estimate in the rural development budget.
Source: OECD calculations based on national 2014-20 RDP budget as published in: http://ec.europa.eu/agriculture/rural-development-2014-2020/country-files/index_en.htm, 2016.

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Sweden's 2014-20 Rural Development Programme: Domestic measures targeting specific issues

EU rural development policy aims at improving the competitiveness of agriculture and forestry, providing public goods such as environmental improvement and enhancing the conditions for creating attractive rural areas. Pillar 2 has been re-organised from four thematic axes in the CAP 2007-13 to six priority areas for the period 2014-20:

- Fostering knowledge transfer and innovation (*Priority 1*)
- Enhancing competitiveness of all types of agriculture and the sustainable management of forests (*Priority 2*)
- Promoting food chain organisation, including processing and marketing, and risk management (*Priority 3*)
- Restoring, preserving and enhancing ecosystems (*Priority 4*)
- Promoting resource efficiency and the transition to a low-carbon economy (*Priority 5*), and
- Promoting social inclusion, poverty reduction and economic development in rural areas (*Priority 6*).[3]

Two conditions apply: a minimum 30% of rural development funding from the EU budget is spent on measures related to the environment and climate change adaptation, including forestry and investments in physical assets; and another 5% is spent on the LEADER approach.[4] Member states can choose from a menu of 20 measures, which are defined at the EU level, to serve the six priorities they have identified in their RDPs.

Member state choices as to which measures they implement determine how close to the producer and to the farm the programmes are delivered. These can support on-farm investment, services and insurance; they can also be paid based on area or animals, or be offered as support to the sector and sometimes to the wider rural area.

Sweden has allocated 70% of RDP funds to provide support to producers, compared with around 10% to services to the sector as a whole, primarily for agricultural knowledge and innovation systems (Figure 5.4). This is similar to broader trends in the European Union – all Member states have chosen to target at least 65% of their RDP funds to producers, with some as high as 90% and more. On average, 77% of Pillar 2 funds result in a direct transfer to producers, while 6% goes to the agricultural sector and the remaining 17% to forestry or rural areas at large (OECD, 2017).

The RDP for Sweden – EUR 4 300 million for the 2014-20 period – was allocated to the above six priorities through the implementation of 13 measures. Moreover, in order to better co-ordinate actions and maximise synergies with the other European Structural and Investment Funds (ESIF), a Partnership Agreement has been agreed between Sweden and the European Commission highlighting a broad strategy for EU-funded structural investment.

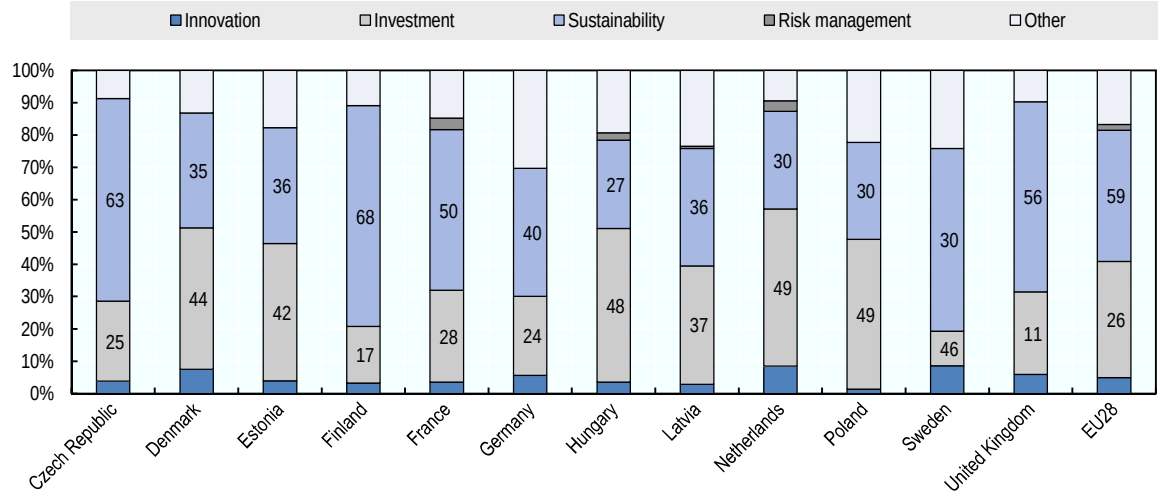
Restoring, preserving and enhancing ecosystems related to agriculture and forestry (*Priority 4*), accounts for 61% of the total RDP budget. This strong focus on environmental measures is a continuation of the former programming periods. *Priority 6* is the second largest at 21% and involves strengthening the focus on better services for the rural population, including investment in broadband. Environmental measures and measures for areas where there are natural constraints, both of which are related to ecosystem management, each account for almost a quarter of the total.

In order to strengthen competitiveness, nearly 5% of farms are targeted for support under *Priority* 2 (Competitiveness of the agricultural sector and sustainable forestry). Measures under this priority are aimed at supporting new farmers and simplifying the process of taking over existing farms. An expected 550 young farmers will benefit from this start-up support.

On social inclusion and local development in rural areas, the RDP will invest in local development, with more than 50% of the rural population helped by local development strategies which will be carried out by 48 Local Action Groups across the country. Around EUR 387 million will be devoted to broadband and 43% of the rural population can expect better access to services and infrastructure. Sweden also expects the RDP to support the creation of 3 400 rural jobs outside the agricultural sector. It is estimated that 43% of its rural population will benefit from improved services or better infrastructure through local development actions, and another 7% under ICT measures.

Compared to the EU28 average, Sweden's RDP includes a higher share for improving sustainability (Measures 10 to 13) through better ecosystem management (Figure 5.5). The payments for the environment also include specific payments for areas facing natural constraints, which are very high.

Figure 5.5. RDP 2015-20 priorities by selected EU Member states



Note Innovation includes Measures 01, 02 and 16; Investment is the sum of Measures 04, 05, 06 and 08; sustainability is the sum of Measures 10, 11, 12, 13 and 15; and risk management is Measure 17.
Source: OECD calculations based on European Commission (2015), http://ec.europa.eu/agriculture/rural-development-2014-2020/country-files/ee/factsheet_en.pdf.

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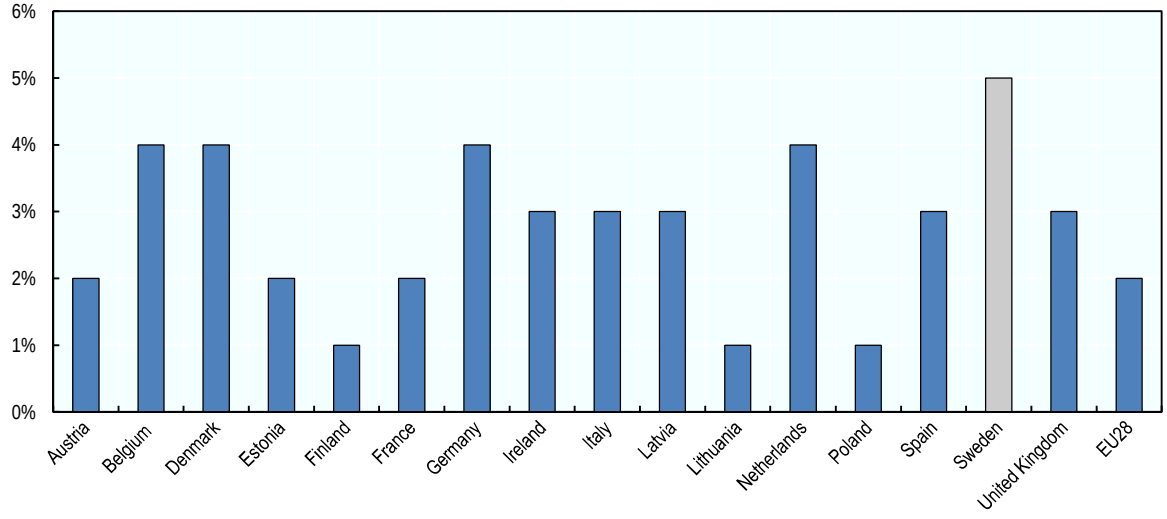
Knowledge transfer, advisory services, innovation and co-operation

Successful innovation systems are crucial in assisting farmers to develop profitable business strategies. Sweden offers financial support to stimulate the transfer of knowledge in order to strengthen competitiveness and to tackle environmental challenges. This will help the agricultural sector and rural businesses to incorporate the results of research and innovation into their production systems.

In order to reinforce farmers' capacity to improve farm management techniques and to assist farmers to develop profitable business strategies, Sweden has devoted 5% of RDP budget for agricultural knowledge transfer and knowledge generation (advisory services) to support all Pillar 2 priorities, as compared to 2% for the average EU28 (Figure 5.6). It should be noted that this EU percentage only covers expenditure on agricultural knowledge transfers from the RD budgets, and member states may use other education and advisory related budgets to cover related expenditure.

Figure 5.6. Knowledge transfer and generation in selected EU Member states, 2014-20 (%)

Share in RDP expenditures



Note: Data do not include funding for the European Innovation Partnership (EIP) and co-operation.
Source: OECD calculations based on national 2014-20 RDP budget as published in: http://ec.europa.eu/agriculture/rural-development-2014-2020/country-files/index_en.htm.

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The measures for knowledge transfer, advisory services and innovation are fairly large parts of the Swedish 2014-20 RDP, at EUR 370 million or almost 9% of the total budget (Table 5.1). These measures also include support for farmers' co-operation, and can be used to implement the European Innovation Partnership for Agricultural productivity and Sustainability (EIP-agri) launched by the European Commission in 2012. Sweden is also targeting the creation of 710 co-operation operations and to have around 170 000 participants in training courses over the 2014-20 period.

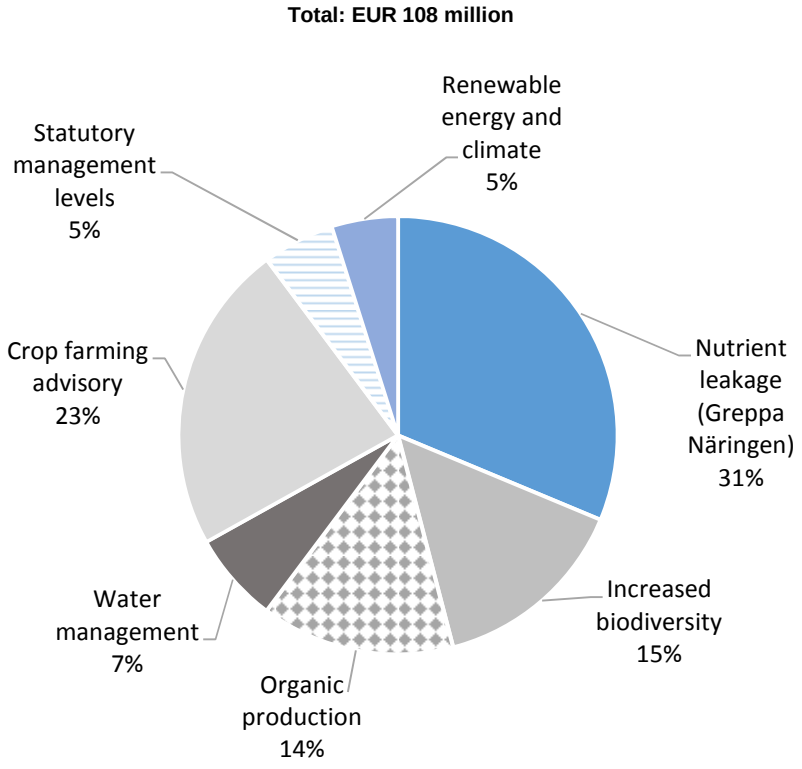
The measure aims to create better links between research and new technologies in agriculture, horticulture and reindeer herding to develop products, methods, processes and application of technologies. This can take the form of co-operation between researchers, advisors and entrepreneurs. The projects can be implemented as a completely new co-operative or by co-ordinating on-going projects to achieve synergies. Projects can also be carried out by transnational partnerships. The projects should be based on previously completed research and can also lead to proposals for new research projects in areas such as Horizon 2020. The projects should also include the dissemination of the results, and the measure can therefore be considered to lead to increased knowledge in the areas where the projects are carried out.

Knowledge and advisory operations also constitute an important component of the ecosystems management (*Priority 4*) (Figure 5.7). Most funding will be on reducing nutrient leakage, followed by advisory services to improve biodiversity. One large project that has been running for some time is Focus on Nutrients (*Greppa Näringen*), which mainly addresses nutrient leakage. The project is being implemented in association with the Federation of Swedish Farmers.

Table 5.1. Knowledge transfer, advisory services, innovation and co-operation, indicative budget 2014-20

Measure	Competitiveness (Priority 2)	Food chain & animal welfare (Priority 3)	Ecosystem management (Priority 4)	Resource efficiency and climate change (Priority 5)	Social inclusion and local development (Priority 6)	Total
			EUR million			
1. Knowledge	18	15.1	78.9	0	22.8	134.8
2. Advisory services	11.9	8.9	40.7	0	18.2	79.8
16.1 Innovation (EIP)	23.8	15.7	7.3	5.8	0	52.5
16.2-16.9 Co-operation	12.8	14.1	3.3	3.3	69.6	103.1
Total	66.6	53.7	130.2	9.2	110.6	370.2

Figure 5.7. Knowledge and advisory operations in ecosystems management, 2014-20



Source. SBA.

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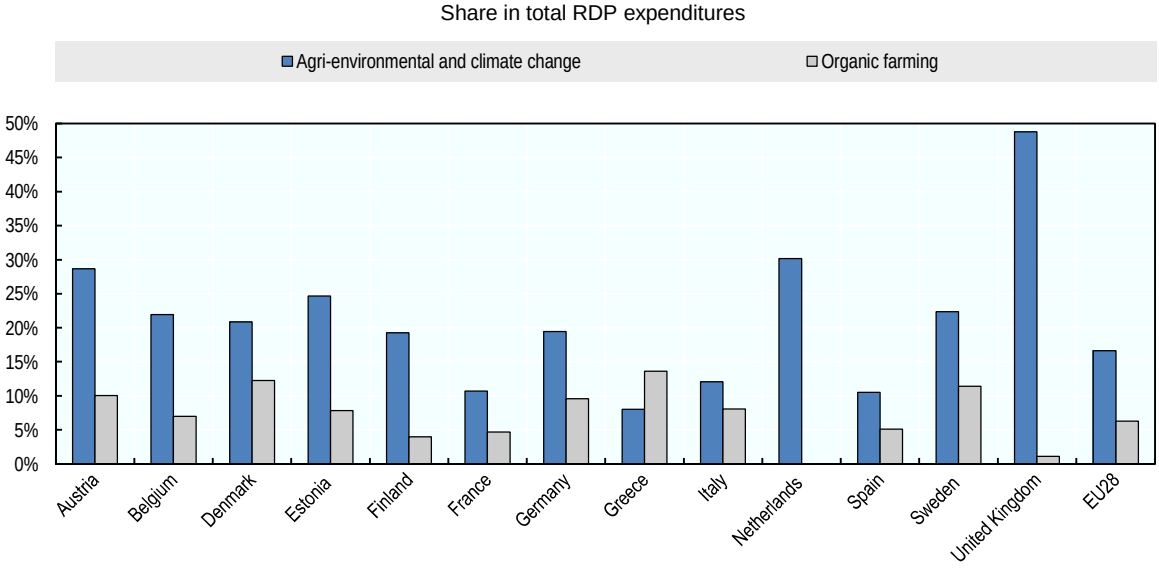
Support can also be granted to projects to evaluate and develop renewable energy in rural areas (*Priority 5*). These may involve technology, methods, processes and logistics in the whole fuel chain, from raw material to heat or other forms of energy. Support may be granted for projects to develop knowledge and technologies and to test and evaluate methods and processes for more efficient energy use. Support is also available to projects to increase access to and use of renewable energy, including energy from residues, bi-products and waste. It can apply to both bioenergy and other forms of renewable energy such as energy from wind, sun, soil, rocks or water. Support may be granted for projects to evaluate and develop the production, as well as for projects that can contribute to reducing emissions of greenhouse gases and ammonia from agriculture.

Measures affecting use of natural resources: Sweden prioritises agri-environmental sustainability

Sweden is a strong supporter of environmental issues with a well-informed civil society (Engström, Nilsson and Finnveden, 2008), one reason being its past experiences with environmental problems that were the result of human actions. For example, Sweden has experienced the effects of acid rains, resulting from air pollution from the surrounding states at a national and international level (Molin, 2000).

Sweden has a long history of prioritising environmental objectives. It established ambitious environmental objectives and an institutional system to develop, implement and monitor environmental policies and measures (OECD, 2014). Sweden is well advanced in terms of implementing environmental programmes in agriculture in comparison to other EU Member states. In the 2007-13 period, Sweden allocated 64% of total RDP funding (European Union and national) for environmental purposes. For the 2014-20 period, 22% of RDP funds in Sweden are allocated to agri-environment and climate change, which is higher than the EU28 average, but lower than Austria, Estonia, the Netherlands and the United Kingdom (Figure 5.8). In addition, Sweden is one the first countries to have introduced taxes on agricultural pesticides. There are also taxes on fertilisers, energy, and carbon dioxide (Chapter 3).

Figure 5.8 Agri-environment, climate change and organic farming expenditures



Source: OECD calculations based on national 2014-20 RDP budget as published in: http://ec.europa.eu/agriculture/rural-development-2014-2020/country-files/index_en.htm, 2016.

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In the 1960s, land use and biodiversity were increasingly affected by Sweden's increased dependency on fossil fuels and the industrialisation of agriculture. A range of agri-environmental measures was implemented in the 1970s, beginning with the banning of DDT pesticide.

Further importance was given to environmental problems in agriculture in the1980s. In 1988, an Act was passed requiring that all the sectors should investigate their influence on the environment and establish activities to improve the ecological sustainability of their respective sectors. Sectoral responsibility for the environment had become a major principle of environmental discussions (Engström, Wadeskog and Finnvedena, 2007). Such administrative reforms and actions have set an example for environmental policy integration at a domestic level (Molin, 2000).

Sweden has established its environmental objectives with a focus on restoring ecosystems, conserving natural and cultural landscapes, protecting biodiversity, ensuring efficient material cycles and energy use, the sustainable use of natural resources and good human health. With respect to agriculture and the environment, biodiversity loss, toxicity, eutrophication and climate change are the most commonly prioritised issues among Swedish policy makers (Engström, Nilsson and Finnveden, 2008).

Sweden's system of environmental quality objectives underpins its environmental policies in all areas and involves all government agencies and administrative levels. Sixteen national environmental quality objectives, consisting of twenty-four milestone targets, make up these targeted environmental objectives to be achieved by 2020. Two of the 16 environmental quality objectives are directly linked to agriculture: zero eutrophication and "a varied landscape", which focus on the need to address issues related to biodiversity of farmlands and forests in Sweden (SEPA, 2016).

The state of the environment, as well as the existing measures and policy instruments, are assessed annually to ascertain whether they are sufficient to achieve the environmental status defined by the Environmental Quality Objectives. These assessments are carried out at both the National and Regional levels. Supplementary or revised instruments and measures can be implemented should the outcomes not be achieved. Every two-three years, a more in-depth evaluation of the environmental actions and the prospects of reaching these objectives is carried out.

The latest assessment, however, shows that "a varied agricultural landscape", "a rich diversity of plant and animal life", and "a non-toxic environment" are amongst the objectives that have the least prospect of reaching their targets, while the prospects for "good-quality groundwater" are more positive (SEPA, 2016). For "a varied agricultural landscape", the most serious problems relate to the decline of the area and the quality of the cultivated landscape, thus implying that many of its inhabitants and species do not have a favourable conservation status. Nevertheless, the status, for example, of the productivity of arable soils, the domesticated genetic diversity and recreation, are broadly assessed to be acceptable.

The SBA is running a pilot project to test *performance-based payments* for landscape elements (conserve biologically rich small biotopes and habitats) in 2016-19. This is an alternative approach to financing the generation of positive environmental effects. Instead of management-oriented payments, conditioning the payment with a number of management measures of what the farmer must or must not do, the payment is related to the environmental outcomes, such as the condition of the pasture or the landscape element as measured by indicators (Hasund and Johansson, 2016). With performance-based payments, farmers are not constrained to a specific technology that may be more expensive and are instead freer to adopt the methods of production in relation to their own particular conditions.

Nutrients and nutrient leaching

Sweden's RDP includes a number of schemes with the objective of reducing nutrient leaching. Two agri-environmental payment schemes have the objective of reducing nitrogen leaching in wintertime. Catch crops and spring cultivation are subsidised at a rate of SEK 900 ha/year and SEK 500 ha/year respectively for areas in southern Sweden with high nitrogen leaching (GOS, 2017). Detailed specifications define requirements for the respective schemes.

There is also an agri-environmental payment scheme for the construction of wetlands and ponds, and another one for their maintenance. Besides reducing the nutrient load to the sea by retention and denitrification, wetlands and ponds enhance biodiversity and may contribute to landscape amenities. Those who want to construct wetlands or ponds are free to do so where and however they want (subject to not violating any laws), but the county boards will prioritise grant applications based on criteria relating to the project's expected environmental effectiveness and costs.

Biodiversity and landscape amenities

The Swedish RDP supports biodiversity, cultural heritage and social values from a number of perspectives: agri-environmental payments; traditional meadows and pastureland; extensively cultivated grassland on arable fields; management of wetlands; support to areas with natural constraints; investment grants; restoration of pastureland; construction of wetlands; and information, education and advisory services.

Several environmental quality objectives are aimed at promoting biodiversity. The programme "*A Varied Agricultural Landscape"*, which is one of the 16 national environmental objectives, aims to encourage agricultural practices, to consider and conserve the natural and cultural elements of farm landscapes, protect local Swedish livestock and crop plants and yet be efficient and competitive in production (Box 5.2).

Within the 2014-20 RDP, more than 28% of agricultural land will come under contract for biodiversity, around 33% under contract for better water management and 35% under contract for soil management (Priority 4). A number of co-operative projects and environmental investments will give a boost to the environmental and climate impacts of agriculture. Some EUR 10.5 million of government aid will support such co-operative actions. Actions to improve water and soil management include support for organic production and reducing nitrogen leaching, buffer zones and ley farming, as well as for environmental investments in the form of wetlands. More than 11% of the total budget will be used for organic farming activities, covering 420 000 hectares, which accounts for more than 17% of the arable area.

Box 5.2. A Varied Agricultural Landscape: A key environmental objective

The objective "A Varied Agricultural Landscape" establishes that the value of agricultural land for biological and food production must be protected, while biodiversity and cultural heritage values are preserved and enhanced. Attaining the objective will involve using the agricultural landscape in a way that minimises adverse environmental impacts and promotes biodiversity. The agricultural landscape must be open and varied, with significant elements of small—scale biotopes and aquatic habitats. Biological and cultural heritage assets in the agricultural landscape which arose through centuries of traditional management must be conserved or improved, while endangered species, biotopes and cultural heritage environments, and genetic variation in domestic animals and plant must also be protected and conserved. Finally, alien species and genetically modified organisms that may threaten biodiversity must not be introduced.

Energy and climate

Agriculture accounts for 12% of total GHG emissions, mostly of nitrous oxide and methane. Emissions from this sector have decreased by 16% since 1990 due to a decline in livestock numbers and reduced use of fertilisers and manure in agriculture. Policies in place to reduce emissions from the sector focus on moving away from fossil fuels and towards renewable energy, and through greater energy efficiency in agricultural buildings. These policies include targeted agri-environment payments under the RDP; energy and carbon dioxide taxes and support for biogas.

Measures within the RDP include: investment grants for agriculture, horticulture and reindeer production; investment grants for employment and climate; capacity building; advisory services; co-operation and innovation; and payments to manure gas production.

Investment grants

Investment grants for energy crops and increasing energy efficiency cover part of the costs for materials, equipment, software, consulting, and land preparation for energy crops, labour costs for fencing, and energy plants (GOS, 2017). Investment grants are available for increased manure storing capacity, equipment for spreading manure, or other equipment to reduce emissions of greenhouse gases (and ammonia), as well as for consulting in connection with such investments.

Capacity building and advisory services

The aim of competence building and advisory measures is to stimulate the use of new technology and methods based on emerging knowledge from research and testing. Increasing knowledge of efficiency improvement measures and renewable energy underpin climate and energy-efficient technologies and methods.

The farming activities that are entitled to receive support include courses and information about manure storage or spreading, which may reduce emissions of methane, nitrous oxide and ammonia, and also about how to increase the production of renewable energy or achieve more efficient use of energy (GOS, 2017).

Co-operation and innovation

RDP includes a co-operative measure, which contains several support activities. One of these is the investment support for setting up innovation groups and to finance innovation projects within the EIP-Agri. The main objective is to strengthen the competitiveness in the agriculture, reindeer herding and horticultural sectors. The measure is divided into two types of support. One is to form an innovation group (group support) and the other is to implement the innovation idea (project support). Support can be given until the product, service or process is ready to be commercialised. The decision of accepting group support is handled by the SBA and the selection criteria are relatively generous. The successful applicants can be granted between SEK 50 000 and SEK 80 000 (GOS, 2017). The project support has no upper limit and the applications are handled by the SBA but with a rigorous selection process with an external expert advisory committee.

Payments to manure gas production

Payments are made to projects running from 2014 to 2023. Participation in the project is a prerequisite for the grant. The conditions for getting the grant include not mixing sewage sludge with manure, and that there is equipment for burning the gas in the event of excess production or stoppage in the production process. The size of the grant depends on the production measured by kWh of biogas and on how much of the gas production comes from manure. If electricity is also produced at the plant, the KWh of electricity is converted into kWh of gas.

Organic farming

Support for organic farming covers both transitional aid to those producers who switch from conventional production to organic, but also to maintain organic farming production. The CAP rules for organic production state the conditions for the payments to organic animal husbandry and to organic crop production in Sweden. The rules prescribe, for example, certification, harvesting or adherence to cross-compliance rules, regulation of the use of non-farm produced feeding stuffs, and not using mineral fertilisers, pesticides, or GMO crops. The share of payment to organic farming in total RDP spending in Sweden is almost twice as high as the average for the EU28 (Figure 5.8).

Both agri-environment-climate payments (previously agri-environmental payments) and payments for organic farming are granted to farmers within programmes adopted by farmers on a voluntary basis (in contrast to compulsory environmental cross-compliance, compulsory greening, and payments for nature reserves).

5.2. Are agricultural policies supportive of sustainable productivity growth?

As an EU Member state, the CAP is Sweden's main agricultural policy framework. Successive policy reforms of the CAP initiated since 1992 have considerably reduced the level of support and altered the way it is delivered to farmers. Direct intervention on domestic markets has been gradually reduced and payments that do not require production have become more significant so that price distortions have been markedly reduced. Border protection and market access for agricultural products have improved through bilateral agreements and the reduction of applied tariffs. However, import and export licensing, Tariff Rate Quotas (TRQs) and special safeguards continue to apply to a number of products. Moreover, non-tariff measures, such as product standards and rules of origin have thus become relatively more important.

In general, agricultural support policies affect productivity and sustainability through a variety of channels. They may either increase or decrease productivity. Theoretical studies also suggest that agricultural support may have a positive impact on farm production, while at the same time a negative impact on farm productivity. Still, these studies are inconclusive in predicting the exact relationship between agricultural support and productivity, while there are mixed effects in the empirical literature (World Bank, 2017).

Support may negatively affect farm productivity because it distorts the production structure of recipient farms, leading to inefficiency in the allocation of resources. Recipient farms may modify their behaviour and start investing in support-seeking activities that are relatively less productive. Allocative inefficiency may also be a result of distortions in input use (e.g. over-investment in subsidised inputs). More generally, support helps to keep existing resources in the sector and slow down the rate at which resources are reallocated to more productive uses in response to new technologies or market conditions. It is also well established empirically that agricultural subsidies tend to get capitalised into land values, deterring new entrants to the sector.

Allocative inefficiency is particularly the case for market price support (MPS) measures, such as border protection and support based on commodity output (coupled), which are potentially the most distorting and environmentally most harmful forms of support. These distorting measures can encourage more production on marginal or fragile land and adoption of farm management practices that do not always take adequate consideration of longer-term environmental sustainability. As such, they hinder structural adjustment and discourage producers to innovate to become more competitive. In the European Union in general, including in Sweden, notwithstanding the decrease in the level and composition of support, some commodities continue to receive significant MPS (OECD, 2017). In the Swedish case, this concerns mainly the beef sector, which is granted voluntary coupled support. Other less market and resource distorting means should be considered to support farm holdings' efforts to achieve long-term competitiveness and productivity gains (OECD, 2017).

The positive production/productivity impact of specific agricultural support measures may stem from investment-induced productivity gains caused by the interaction of credit and farmers' risk behaviour with some support (subsidy-induced credit access, lower cost of borrowing, reduction in risk aversion and thus an increase in productive investment). For example, if farms are credit rationed and there is market failure in credit availability and provision and/or informational deficiencies, then support may provide an additional source of financing, either directly by increasing farms' financial resources or indirectly through improved access to formal credit. Support can also positively affect farm behaviour under uncertainty through a wealth effect. Farmers may be more willing to expand production through certain types of activities that would otherwise be viewed as too risky in the absence of the guaranteed income from agricultural support.

Decoupled income support from commodity production means that farm business decisions are more responsive to market signals through two main mechanisms. First, decoupled payments could reduce the risk preferences of farmers leading them to make more productive investment decisions. Second, decoupled income support could increase access to borrowed capital for credit-constrained farmers by

increasing available collateral, impacting on investment and output. The extent to which the decoupling of payments will impact on agricultural production, however, is an empirical question and will depend on other distortions in agricultural markets and market signals.

Decoupled support would have a higher positive (investment-induced productivity gain) or a smaller negative (allocative efficiency loss) impact on productivity than coupled support. First, the efficiency loss is smaller for decoupled payments because farm eligibility for decoupled payments is not directly linked to farm factor and production decisions, which thus lead to lower allocative inefficiency.

Some empirical studies suggest that decoupled payments in the European Union enhance productivity by correcting for inefficiencies in the agricultural sector related to credit access (i.e. when there is a market failure in the credit market) and risk attitudes (Box 5.3). However, in Sweden it was found that the effect of subsidies after decoupling was negative suggesting that market imperfections (e.g. credit problems) in the agricultural sector are not significant. For example, if farm credit problems are insignificant, there is minor or no gain from subsidies through the credit channel.

Box 5.3. Does decoupled support increase productivity in Sweden? What does the empirical evidence show?

Zhu and Lansink (2010) found negative efficiency effects of coupled subsidies for crop farms in Germany, the Netherlands and Sweden. Similarly, Zhu et al. (2012) found that both output-related and input-related CAP subsidies had a negative impact on dairy farm efficiency in Germany and the Netherlands between 1995 and 2004, but no significant impact in Sweden. Their results also imply that a higher degree of coupling in farm support negatively affects farm efficiency.

Decoupled income support in Sweden has been found to have a positive influence on the efficiency of dairy farms (Manevska-Tasevska et al., 2013) and crop farms (Zhu and Lansink, 2010), whereas a negative impact has been found for beef farms (Manevska-Tasevska et al., 2013).

Rizov, Pokrivcak and Ciaian (2013) empirically studied the impact of CAP direct payments on total factor productivity using samples from the Farm Accountancy Data Network for EU15 member states over the period 1990-2008 (for Austria, Finland and Sweden, the period of analysis is 1996-2008). Their main findings are that subsidies clearly impacted negatively on farm productivity in the period before the decoupling reform was implemented. However, after decoupling the effect of subsidies on productivity is more nuanced (either have no effect or a small positive effect on productivity in the majority of EU15 countries). The negative effect of subsidies after decoupling observed in Sweden is attributable to insignificant market imperfections (credit problems) in the agricultural sector. For example, if farm credit problems are insignificant, there is minor or no gain from subsidies through the credit channel.

These findings are consistent with the study by Kazukauskas, Newman and Sauer (2014) of Danish, Dutch and Irish farms using a similar methodology, but assuming a uniform production function for each of the EU Member states. They also found that decoupling had a positive and significant effect on productivity, and behavioural changes related to farm specialisation.

Minviel and Latruffe (2017) analysed, in a meta-analysis, 195 results about the effect of subsidies, extracted from a set of 68 studies carried out from 1972 to 2014. The authors conclude that aggregating all subsidies received by farmers increases the probability of a negative effect of subsidies on farms' technical efficiency, but investment subsidies alone are positively related to farms' technical efficiency.

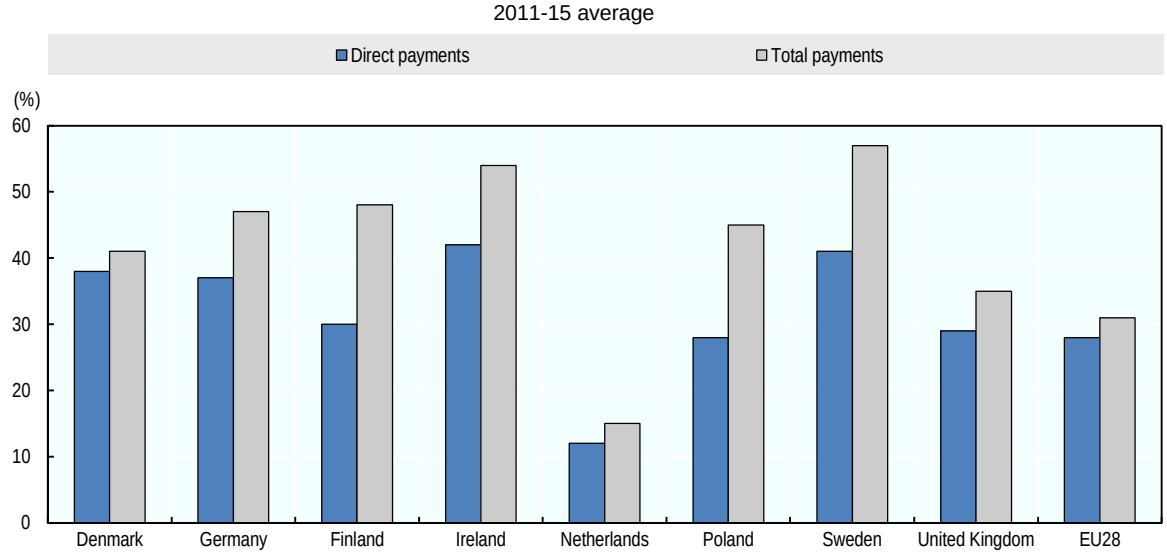
The World Bank (2017) study found that CAP's decoupled payments are associated with increases in agricultural productivity per worker, in particular in the new member states and have a small positive impact on agricultural employment.

Manevska-Tasevska et al. (2013) report that investment subsidies do not have any significant influence on the efficiency of Swedish farms. This result was interpreted both as poor targeting of investment support and as an effect of investment subsidies only being apparent in the long run. However, agri-environmental payments are in general beneficial for the technical efficiency of Swedish agriculture.

On balance, the existing empirical evidence suggests that the allocative and technical inefficiency losses associated with commodity production decisions are reduced, and/or the positive investment effects are increased. Nevertheless, in all cases, the economic importance of the effects identified is very small, although the land allocative distortions of decoupled income support should not be overlooked.

However, if most of the income is derived from the entitlement to decoupled support, it is likely that there would be less incentive to innovate and the productivity effect would be small relative to a situation where most of income is derived from the market. This is the case of Sweden where producers are highly dependent on government support, with direct payments accounted as much as 40% of agricultural factor income (28% for the EU28) and total support almost 60% (32% for the EU28) (Figure 5.9).

Figure 5.9. Share of EU support (direct payments and total) in total agricultural income



Source: https://ec.europa.eu/agriculture/sites/agriculture/files/cap-post-2013/graphs/graph5_en.pdf.

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As payments are conditional on the adoption of environmentally friendly practices (*cross-compliance)*, they may prevent abandonment of land and losses of public goods associated with agriculture.[5] Although the effects of the single farm payment on the agricultural landscape and its provision of public goods are considered to be positive, the report by SBA (2014b) shows that an alternative allocation of these financial means could give significantly better biodiversity and landscape effects, and have higher social efficiency. Moreover, as most of the cross-compliance requirements have existed within Swedish legislation for a long time, the additional environmental improvements following the introduction of the EU cross-compliance requirements have been small (SBA, 2011).

Through the *greening payment*, additional environmental conditions have been imposed on payments that would have otherwise been only conditional on less stringent cross compliance. While it is too early for an *ex post* evaluation of the greening measures, the nature of their impacts will depend on the specific method of implementation, particularly on the type, location and management at farm level.

However, due to the varying and diverse geographic context and the broad nature of the greening measures, these measures are unlikely to improve environmental conditions in Sweden. SBA (2016) study on the implementation of greening in Sweden found that there is no net environmental effect as the expected environmental benefits induced by changes in farming practices are nullified by the

expected increase in transaction costs. Small effects of greening at the aggregate EU28 level (less than 1%) are also reported by the OECD (2017) study.[6] Similar findings are reported by SBA (2016), which concludes that the requirements for the diversification of crops and for permanent grasslands have minimal environmental benefits. Ecological Focus Areas may give considerable environmental benefits, but some of the individual measures and terms should be redesigned in order to increase their effectiveness.

The three mandatory greening measures (crop diversification, maintenance of permanent grasslands and ecological focus areas) are broad brush measures designed to make all member states responsible for their agricultural practices and environment. However, these general measures do not seem to fit well with the diverse environmental conditions in Sweden (Chaganty, 2016). Environmental and natural landscape is quite different than in other EU Members' agriculture. Northern Sweden, for example, has vast grasslands and large forested areas, which do not provide diversity; whereas the homogenous agricultural fields of South also lack biodiversity.

Crop rotation, which is followed in the south of Sweden, might be preferred over crop diversification as diversification would not give agronomic benefits such as improved soil quality, would be difficult to manage and would not give the best business (production) solution. Replacing it with diversification would only lead to complex implementation, planning of crop production (Hart, 2014) and difficulty in identifying its ecological benefits.[7]

Agricultural measures that support or facilitate innovation are likely to create stronger incentives and capacity for innovation among agricultural producers, although some evaluations of the 2007-13 RDP pointed out that the programme has failed on triggering innovation (Box 5.4). In Sweden, investments in agricultural knowledge and innovation are the main components of *general services* to the sector. Moreover, Sweden attributes 9% of its RDP funds to knowledge transfer and knowledge generation, and co-operation, which is one of the highest in the EU28.

Concerning *risk management*, Sweden does not use RDP measures to encourage farmer take-up of risk management and risks related to businesses are the responsibility of the farmer (OECD, 2017). In Sweden, agricultural insurance is no longer subsidised in any way and the main role of government is to inform about risks and other preventative measures related to natural risks. As the previous, heavily subsidised system was abolished in the late 1980s, the government has offered farmers little financial relief in case of major, nearly catastrophic, crop failures and Sweden is not in favour of including risk instruments new instruments. However, the Swedish government believes that current instruments in Pillar 2 could be changed in order to make them more effective, easy to implement and to enhance their uptake.

Box 5.4. Evaluation of the 2007-13 Rural Development Programme

An evaluation of the previous RDP in Sweden (SBA, 2017) points out that the programme was complex, containing several goals and a number of trade-offs between different parts. The evaluation pointed to the need to shift the focus from production and traditional business models to more emphasis on development directed towards innovations, alternative models, and openness for both new ideas and new actors in rural policy.

As the focus of the implementation of the programme has been on developing processes rather than added value (by taking larger risks and enhancing diversity), rural policy has not been well integrated with regional development policy. This has led to reduced opportunities to interact with the most important parts of regional development such as infrastructure, public transport, culture, and innovation support and competence provision.

More specifically on innovation, it underlined that the RDP has not succeeded. This is true for all types of innovations such as products, services, processes and systems. This is somewhat surprising given that innovation has been a policy priority over a long period.

The mid-term evaluation of the 2007-13 RDP also finds positive effects on investment, although there are also indications of crowding-out. In addition, the effects on employment are small but positive, whilst the effect on value added is small but negative and that the effect on total factor productivity is insignificant (Andersson, Höjgår and Rabinowicz, 2017).

Box 5.5. OECD approach to risk management

OECD work has demonstrated that effective risk management requires an integrated approach that addresses all risk exposure and incentives, distinguishes between normal, marketable and catastrophic risk layers and articulates the respective roles of public authorities and economic actors, involving them in the development of risk management strategies based on sound economic analysis of the three risk layers. A holistic approach to risk management instruments extends beyond the traditional boundaries of agricultural policy, emphasising policy coherence.

For more information, see www.oecd.org/tad/agricultural-policies/risk-management-agriculture.htm

Almost all Swedish farmers are covered by normal insurance schemes. The basic scheme usually covers property damage, production disruptions, third-party liability, and legal expenses. The property cover includes damage to buildings, equipment, animals, machinery and products. Insurance schemes cover only fire damage in relation to crops. Benefits are paid for production disruptions only when the loss of income was caused by property damage. There is no full coverage *harvest loss insurance* available on the Swedish insurance market, but private *hail damage and reseeding insurance* is available. About 60% of Swedish crops are covered by insurance schemes of this kind.

Overall, within the CAP framework that allows EU Member states some flexibility in implementing payments, Sweden has made choices based on two principles: agro-food production should be driven by consumer demand; and ii) production should be ecologically and economically sustainable. Sweden uses a combination of market- and non-market-based policy instruments to support explicitly the adoption of more sustainable technologies or practices (agri-environmental measures) or measures to adapt and mitigate climate change. Swedish farmers and food industries have to comply with environmental, food safety and animal welfare regulations, which are often higher than the EU standards.

Notes

1. These countries are Bulgaria, Estonia, Spain, Latvia, Lithuania, Poland, Portugal, Romania, Slovakia, Finland, Sweden, and the United Kingdom.
2. For example, member states not operating the Single Area Payment Scheme must shift Direct Payments to farmers away from being calculated on an historic basis towards a uniform per hectare rate across the country (or region – which can be defined according to a number of criteria). Further, fine tuning of the BPS includes a reduction of amounts paid per recipient above a certain threshold (EUR 150 000), the option to grant higher payments to the first hectares per recipient, a compulsory top up of payments to young farmers, and simplified procedures for small farmers who receive only small amounts of direct support.
3. This last priority is also identified as LEADER (from the French *Liaison Entre Actions de Développement de l'Économie Rurale*).
4. Previously 25% of the budget was to be allocated to environmental measures in Axis 2 and it was required that each Axis receives at least 10% of the EU budget.
5. Model calculations indicate that, *ceteris paribus*, the area of arable land would have been 30% smaller in 2010 if the single farm payment had not existed, (SBA, 2014a). With dynamic effects – including structural changes of farm sizes – is has been estimated that the area of arable land would decrease by 50% in a ten-year period after 2010 if there was no single farm payment. Land abandonment would mainly take place in the north and in the forest or mixed regions. The area of permanent pastureland would have been 35% smaller if there had not been any single farm payment in 2010, including 5 200 ha with specifically high environmental values. With dynamic effects, the pastureland area is estimated to be 180 000 ha lower, including 13 000 ha with specifically high environmental values.

6. The CAPRI model was used to estimate, *ex ante*, the impacts of new measures on production, prices, trade, welfare and the environment. Modelling results show that the voluntary coupled support generally increases nutrient surplus per hectare, where the introduction of greening generally seems to reduce nutrient surpluses.

7. Diversification might also lead to growing of same crop on the same field every year if the crop mix is right; or an input intensive crop would end up being grown because of the mandatory crop diversification conditions (SBA, 2012).

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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).

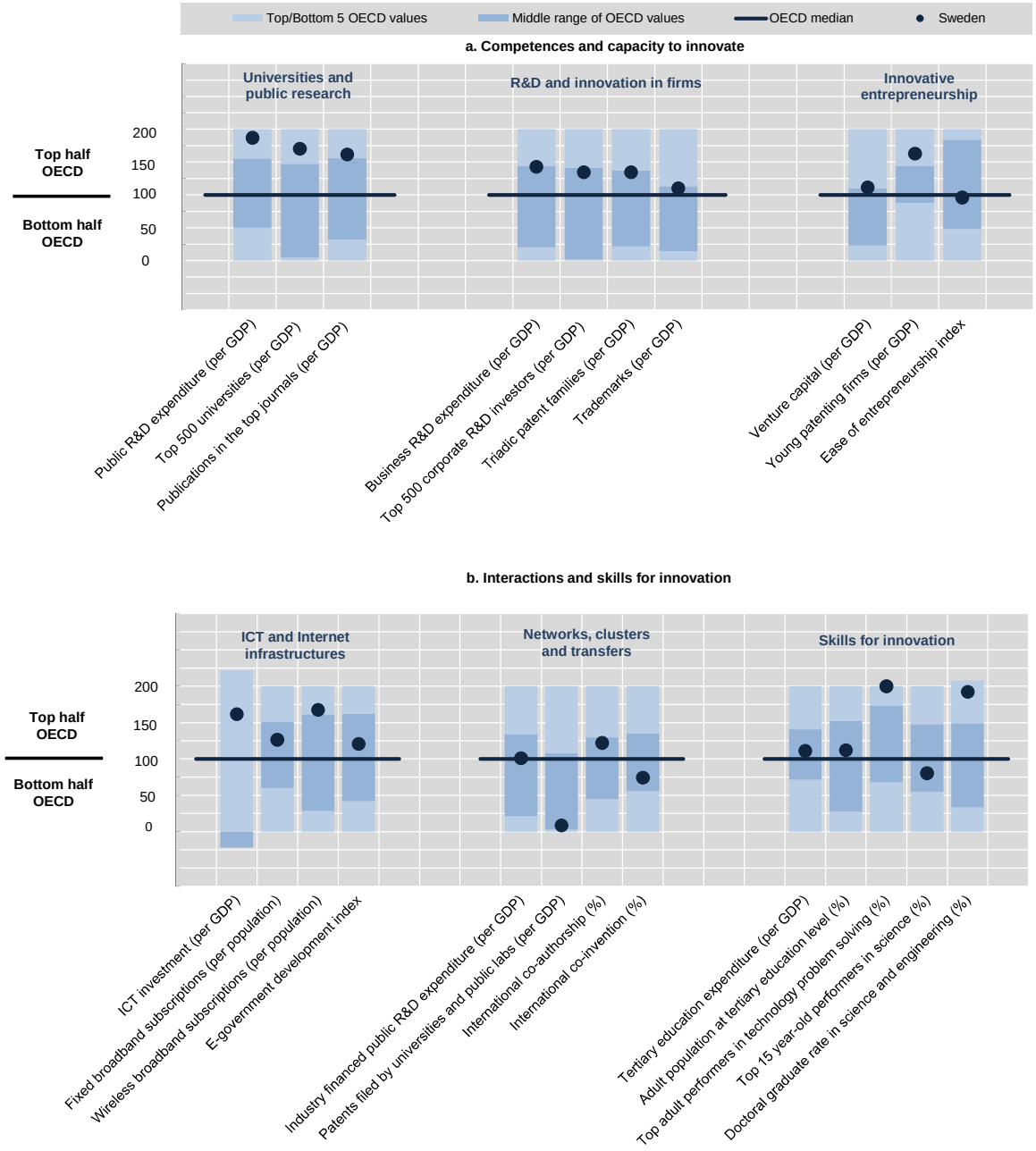
There have been changes in public funding mechanisms in the last decade. In particular, funds delivered through institutional block grants have increased (OECD, 2016a). Currently, institutional block grants account for about 45% of public funding for research in Swedish universities, with the remainder 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.

StatLink http://dx.doi.org/10.1787/888933710249

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	
BioInnovation	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 *(Start at the beginning of 2017* 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 competiveness 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 (*Livsmedelsacceleratorn*) 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 and2016. 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 *Skolmatsakademin*.

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 sub-divisions: 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 competiveness, 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 is 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.

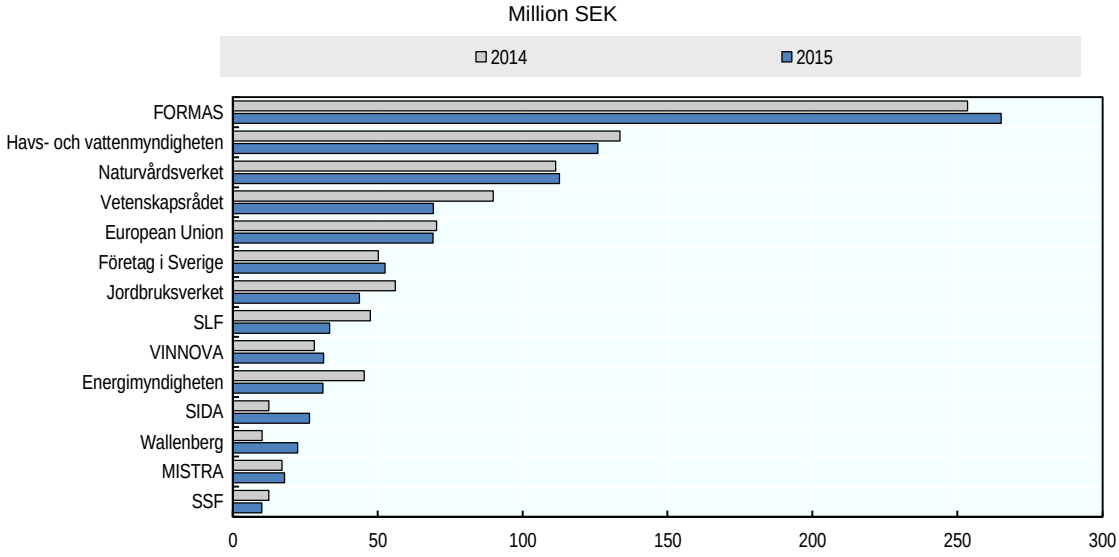
The Swedish Foundation for Strategic Environmental Research (MISTRA) focuses on issues that interact with the challenges of bringing about sustainable social development. MISTRA invests about SEK 200 million annually in various research initiatives with a focus on building inter-sectoral bridges. It 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 (*Hushållningssällskapet*)	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.
Länsstyrelserna (County Boards)	Environmental issues related to agriculture	21 (all) counties	Counselling.	Publicly financed
Farm and Animal Health (*Gård och djurhälsan*)	Health issues, efficiency in animal production	50 employees	Veterinary and production counselling, education	Owned by the industries: Svenska Köttföretagen AB, Sveriges Grisföretagare, Sveriges Nötköttsproducenter 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.

*DeLava*l (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

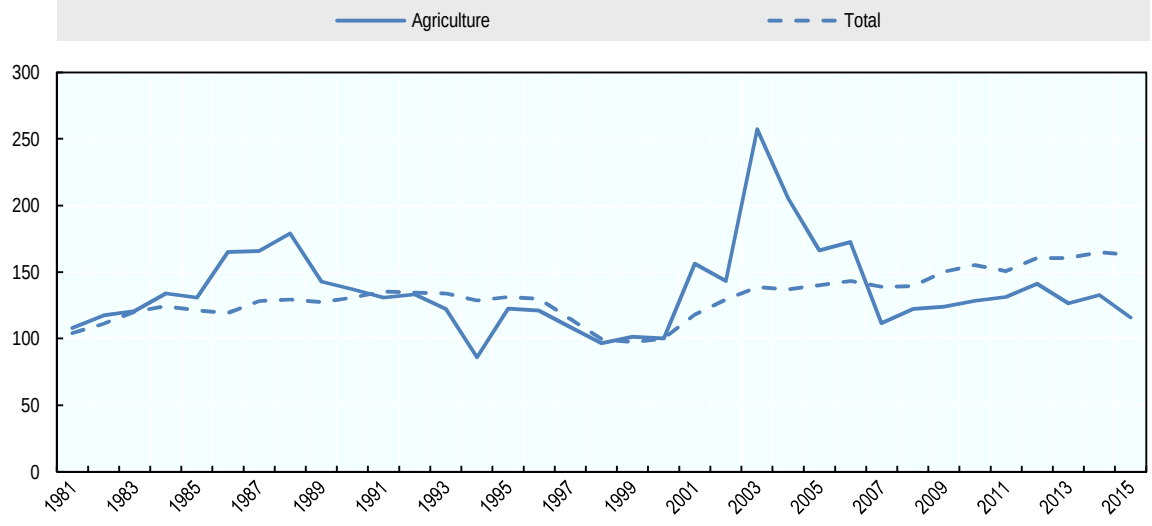
The public sector continues to be the main source of funding for agriculture R&D, whether performed in public or private organisations. There are no specific provisions for funding agriculture research in Sweden, although one funding organisation specialises in agriculture-related areas. Business investment 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

Government budget appropriations or outlays for R&D (GBAORD)
Index 2000 = 100, based on 2010 USD – Constant prices and PPPs



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

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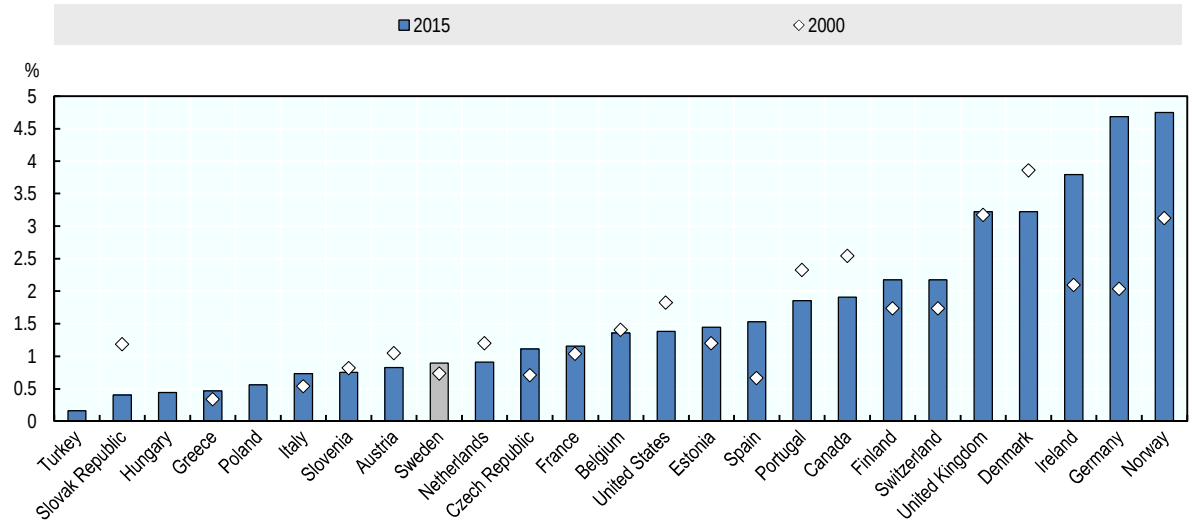
Figure 6.4. Agricultural R&D intensity in selected countries, 2000, 2015

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).

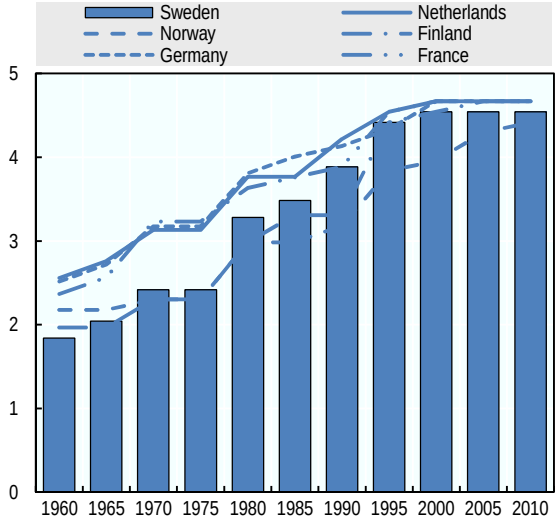
Table 6.4. Intellectual property rights

	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)

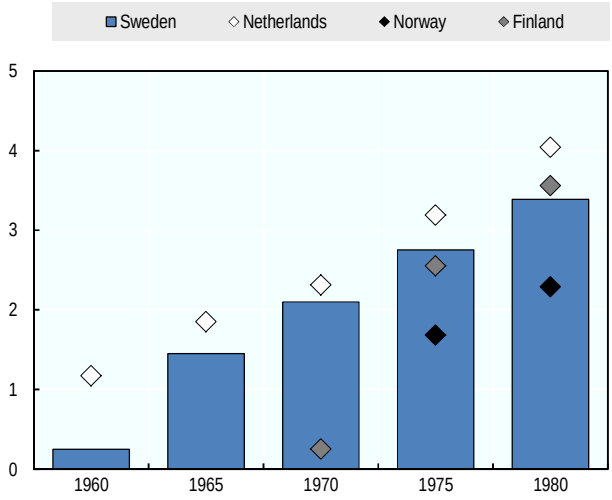


Sum of indices for duration, enforcement, loss of rights, membership and coverage.

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

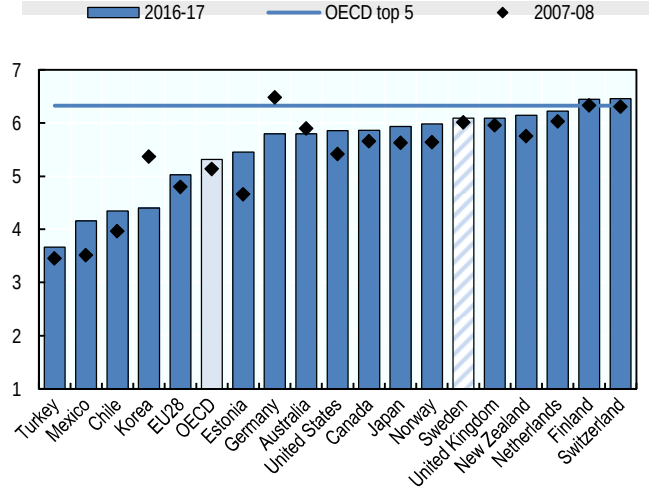
B. Plant Variety Protection Index

Score 1-5 (best)



Source: Campi and Nuvolari (2013): Intellectual property protection in plan 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 (Trippl, 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 Producation (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
Publica-tions	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 Mjölk 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.

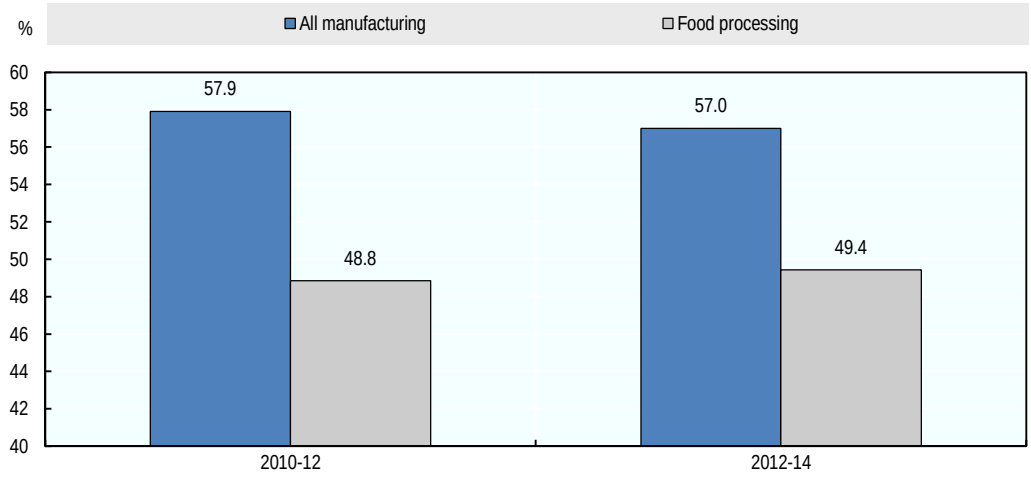
Innovation in food and agricultural firms

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.

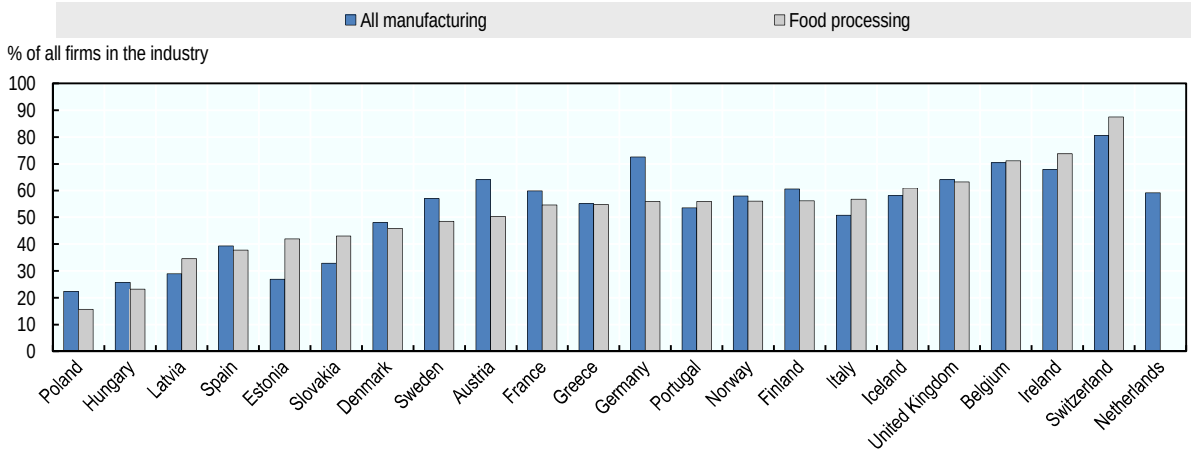
Figure 6.6. Share of innovative firms in Sweden



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).

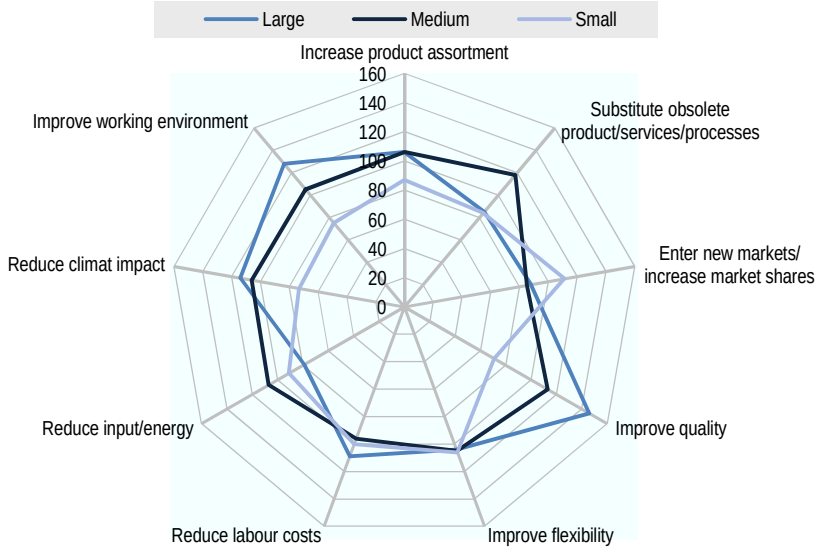
StatLink http://dx.doi.org/10.1787/888933710363

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).

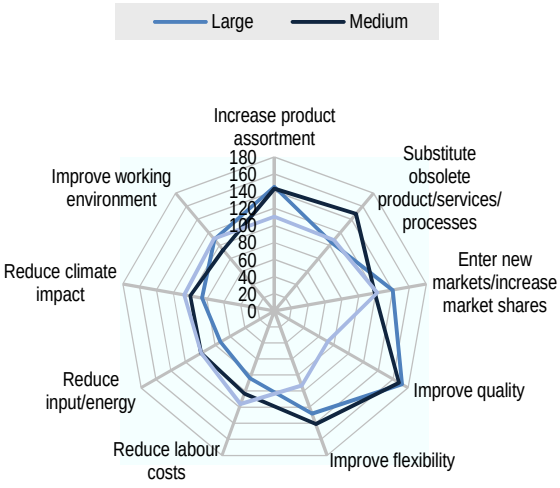
Figure 6.8. Reasons for innovation: Agriculture



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 positivity 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 collabo-ration partners	Lack of innovation support	Uncertain demand for the innovation ideas	Too much compe-tition 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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