Chapter 7

The Estonian agricultural innovation system

This chapter describes the Estonian Agricultural Innovation System and outlines recent changes. It provides an overview of the general innovation system; describes agricultural innovation actors and their roles in the system. It then describes main trends in public and private investments in R&D, mechanisms of funding and mechanisms to foster knowledge markets and networks. It presents mechanisms to facilitate the transmission of knowledge, outlining developments in farm advisory services. The last section outlines the participation of agricultural R&D actors in regional and international co-operation.

7.1. General innovation profile

This section provides an overview of the economy-wide environment for science, technology, and innovation as it determines the underlying incentives and dis-incentives in all sectors. Moreover, agricultural innovation systems (AIS)[1] are increasingly driven, in particular by economy-wide process and organisational innovations, new developments in Information and Communications Technology (ICT), and the bio-economy. A thriving innovation profile 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 share an innovation culture (OECD, 2015).

General innovation framework

The Estonian Government is a major actor in the national innovation systems,[2] providing economic incentives to innovation through innovation policy. The current focus of public research and development (R&D) activities is placed on areas with greatest growth potential, in compliance with competitiveness objectives based on smart specialisation (Kalvet et al., 2010; OECD, 2014).

In Estonia, innovation policy is included in all policy areas, and contributes to innovation largely through achieving the agreed wider economic objectives. National and sectoral objectives, in turn, contribute to reaching the European-wide economic objectives, as depicted in Figure 7.1. This means that food and agriculture is fully integrated in the general policy and the innovation system.

Sectoral development plans are usually prepared for seven years. Sectoral strategies are in line with the country's budgeting strategy, which is drawn up for four years and updated annually. This ensures the medium-term plans are constantly adapted in response to the changes in economy, fiscal and sectoral environment (MoF, 2015). Main governance mechanisms for national and sectoral policies, including food and agriculture related policies, are presented in Annex 7.A1

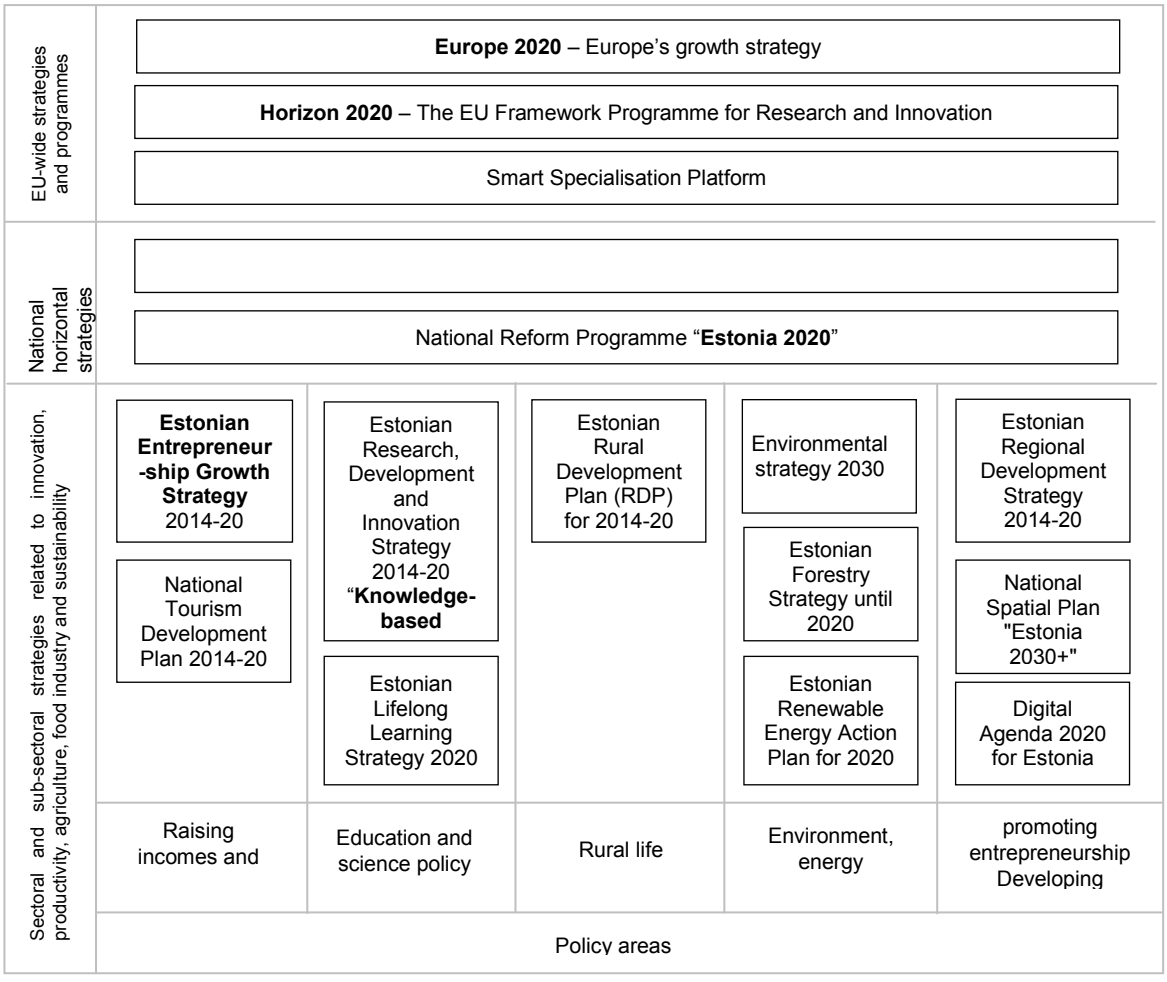
Two national horizontal strategies cover innovation, entrepreneurship and sustainable development concerns:

- **Sustainable Estonia 21** is the most general overarching guidance document, covering many areas under the responsibility of different ministries. Completed in 2005, it devises broad sustainable development objectives running to 2030. The implementation of the strategy is monitored on the basis of sustainable development indicators presented in bi-annual reports (Linnas, 2007).
- **Estonia 2020** describes the objectives and activities needed to improve competitiveness, the two central objectives being to increase productivity and employment. The development plan serves as an important basis for targeting national investments as well as the use of EU funds in Estonia (Government Office, 2014). In compliance with the EU's Smart Specialisation Platform, it focuses on growth areas and value chains with greatest growth potential. Priority growth areas are: 1) ICT, horizontally through all sectors; 2) health technologies and services, and; 3) more efficient use of resources. Key sectors are: programming, telecommunications, electronics, logistics, valorisation of wood, machine building and food industry. They were selected on the basis of their role and development potential over the period of 2014-20, in terms of value added, export volume and intensity, and number of employees in the Estonian economy, as well as on developments in Europe and in the world (EDF, 2013; Kaarna et al., 2015). Moreover, energy, sustainable development and environmental issues are increasingly important government priorities (OECD, 2017a).

At the sectoral and sub-sectoral level, the main strategy document guiding the development of Estonia's research, development and innovation (RDI) policy is **Knowledge-based Estonia**, compiled by the Ministry of Education and Research (MER), and the Ministry of Economic Affairs and Communications (MEAC). Covering 2014-20, it is the third consecutive strategic document in this area. This strategy is closely related to the **Estonian Entrepreneurship Growth Strategy for 2014-20**.[3] The underlying principle in the division of labour in RDI between the MEAC and the MER is that the MEAC is responsible for offering support to innovation, including product and service innovation and capital inflow to enterprises. The MER oversees

international cooperation in R&D, guaranteeing a high level in R&D activities and supporting universities, and public research institutions. Both ministries are accountable for supporting cooperation between enterprises and research institutions in accordance to the division above.

Figure 7.1. Framework for EU, national and sectoral innovation



Source: Compiled by authors on the basis of Christensen et al. (2012) www.hm.ee/index.php?popup=download&id=11652, and Government (2016), https://valitsus.ee/en.

In addition to its own resources, Estonia is using EU structural funds[4] to facilitate economic development, thus the investments are related to the long-term objectives of the European Union (MoF, 2014a). In the previous programming periods, the priorities and measures of Estonia's development plans were related to the renewal of infrastructure. In particular, a significant part of the EU Structural Funds has been invested into the development of R&D infrastructure, human capital and entrepreneurship (MER, 2014a). In the current period, the EU and Estonian priorities and measures are aimed at economic growth, increasing people's well-being, as well as the quality of work and life, which is closely related to innovation in products, services, processes and organisations (EUSAE, 2015). In particular, the EU focus is on the implementation of its smart specialisation platform.

The development of the 2014-20 plan reflected experience from the implementation of previous plans. For example, ministries, including the Ministry of Rural Affairs (MRA) were more proactive in providing substantive input to RDI policy pursuant to their priorities and needs. They were given greater responsibility

in developing networks supporting policy-making in their sectors. By organising sectoral debates social partners were better involved in the process of developing sectoral programmes and measures (MoF, 2014b).

General innovation performance

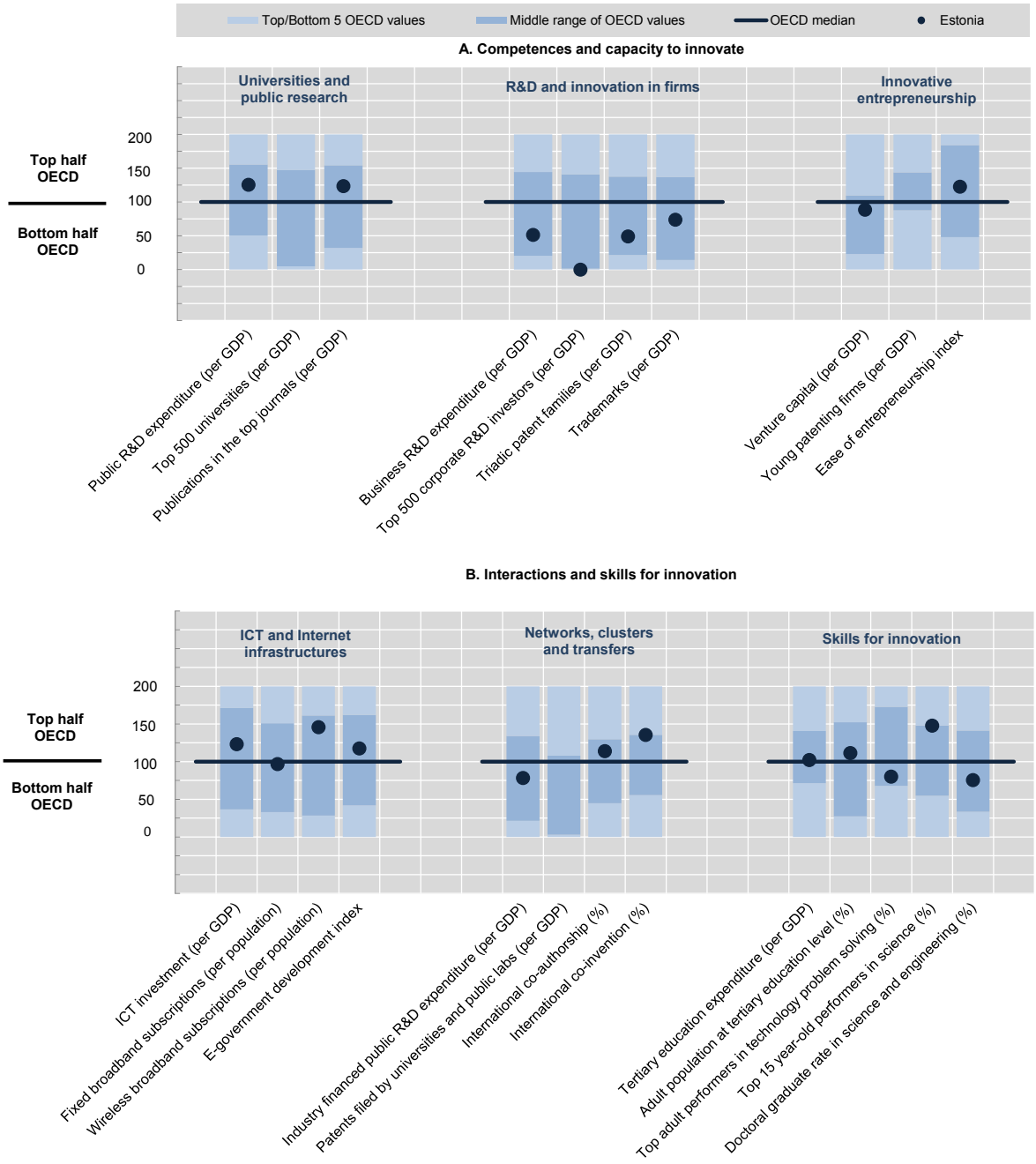
According to the *OECD Science, Technology and Innovation (STI) Outlooks* (OECD, 2014, 2017a), the strengths of the Estonian innovation system are the conducive business environment (Chapter 4), government strategy integrating innovation and economic growth objectives, and investing in smart specialisation high-growth areas, including Information and Communication Technology (ICT), the relatively strong public research system, with high level of public Research and Development (R&D) expenditure and strong performance in journal publication and international cooperation, and good skills base in the population, in particular young performers in science (Figure 7.2). Shortcomings are mainly related to low R&D and innovation in firms, which, in part is due to the relatively small size of Estonian companies.[5] In particular, industry-science linkages are not strongly developed, although programmes have been developed facilitate public-private cooperation in R&D and to connect better education and skills need to labour-market needs. Moreover, despite recent progress, Estonia still lags behind the OECD average with the doctoral graduate rate in science and engineering, and top adult performers in technology problem solving (Chapter 5). This indicates shortcomings in knowledge transfer from high level R&D groups to the education system.

Regarding the overall effectiveness of the innovation policy so far, R&D activities in Estonia have perked up over the past decade, which has boosted productivity growth. Overall, enterprises in Estonia can be regarded as innovative, as reflected in their willingness to experiment with new products, services and solutions, and introduce innovative products (see for example Box 7.1 on innovation in food and drink processing companies). The innovative character of Estonian organisations is close to the EU average, both in product and process innovation, as well as in organisational and marketing innovation (Statistics Estonia, 2015a).

As to agriculture, in 2009-13 most of the applications for innovation (investment) support asked financing for the purchase of modern equipment, whereas in food production and forest enterprises support was predominantly requested for new product development (EMÜ, 2015a). However, the results of the survey "Innovation in Estonian enterprises and innovation support schemes" conducted under the aegis of the MEAC showed that the added value created by the low-tech enterprise sector has so far been higher than that of the high-tech enterprises. For example, based on the data of the first three quarters of 2015, beverage production ranked among the first in producing the highest added value per employee. The added value per employee in the timber industry was almost one and a half times higher than the corresponding figure for the furniture industry. Some very complex products are produced in Estonia, but units responsible for their technological solutions, marketing and sales are located elsewhere. The timber industry, on the other hand, is dominated by a number of companies based on national capital that control the entire value chain and, therefore, the added value remaining in Estonia is higher. There are a number of very successful and innovative enterprises in Estonia (for example, Estonia is the biggest exporter of wooden houses, and Europe's largest wood pellet producer is located in Estonia), but their impact on the Estonian economy as a whole has so far been modest (Kaarna et al., 2015).

According to MER (2014a), the aspect calling for development in the innovation system is the cooperation in R&D between enterprises and universities, especially in the light of demand-driven innovation policy development. It is also necessary to develop communication between the public sector (as to long-term strategic plans) and the private sector (as to innovation capacity). Estonian enterprises need a new qualitative leap in the highly competitive and global production and innovation networks. This requires enterprises to have greater capacity and skills to make progress in value chains.

Figure 7.2. Science and innovation in Estonia, 2016
Comparative performance of national science and innovation systems



Source: OECD (2017a), *"Estonia", in OECD Science, Technology and Innovation Outlook 2016,* http://dx.doi.org/10.1787/sti_in_outlook-2016-58-en.

StatLink http://dx.doi.org/10.1787/888933654788

Investigating the feasibility of implementing demand-side innovation policy instruments in Estonia, Romanainen et al. (2014a) also call for improvements in co-operation between various parties, including the meaningful involvement of stakeholders. Although stakeholder involvement in the design and implementation of innovation policy in Estonia has gained momentum, their involvement is mostly restricted to participation in discussions with sectoral umbrella organisations and universities. Among activities that call for further

development, they also include the implementation of horizontal innovation policy in the country as a whole, and the management of risks relating to the implementation or purchase of innovation. They find that Estonian innovation policy is characterised by an abundance of policy documents, strategies, action plans, programmes and projects, which inter-connectedness is difficult to identify. According to some experts, this may be considered a problem.

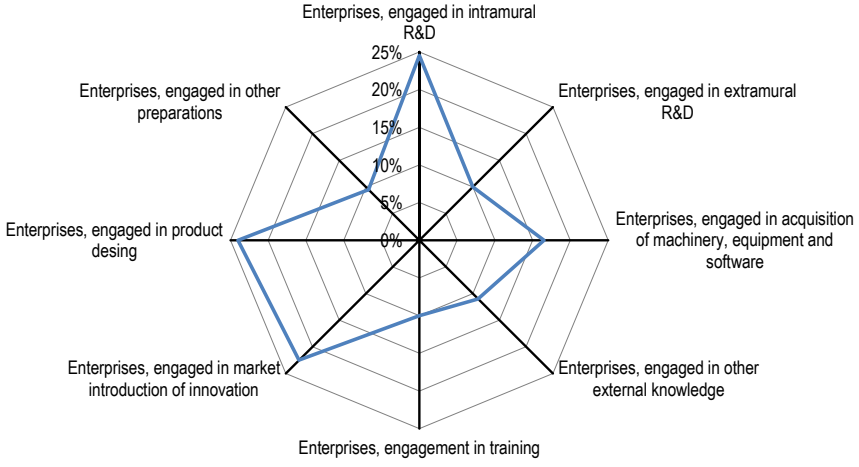
Romananien et al. (2014a) acknowledge that Estonian innovation policy is objective-based, with clear prioritisation, selectivity mechanisms and effective cooperation between the stakeholders in policy development. However, it is characterised by resource-based management, which primarily focuses on how to use the existing and new purchased resources to achieve a lasting competitive advantage. Demand side innovation[6] has attracted more attention in Estonia in recent years for two main reasons. First, it has been understood that only supply-based measures fail to guarantee the expected results in the promotion of innovation and economic growth in general. Second, the country must find new and more effective ways to continue to elaborate on the existing innovation policy measures in the limited budgetary conditions. Public procurement has so far been the most frequently used demand-side tool with the highest impact.

According to recent analyses of Estonian innovation policy (Karo et al., 2014a; 2014b), there are comparatively asymmetric and fragmented RDI networks in Estonia that do not facilitate cooperation between the various parties, and the holistic management of innovation ecosystem. So far, the implementation of RDI policy at the measures, regulations, indicators level has been based on the linear understanding that innovation begins with basic research, which is followed by applied research and by the implementation of the new practical solutions in industry and the economy. The persistence of this linear approach in Estonia can be explained by the relatively limited understanding of the role of the government in science and innovation, which finds expression in low-intervention and high-tech centred RDI policy affecting mainly the framework conditions for the economic environment, and where the main feedback mechanisms of innovation policies are general statistics on the developments in the research systems and corporate financial indicators, such as the number of publications and added value per employee.

Box 7.1. Innovation in Estonian food and drink processing companies

According to the Eurostat Community Innovation Survey,[1] about a quarter of Estonian food and drink processing companies were engaged in innovation activities in 2012-14 (Figure 7.3). Most of innovative companies were engaged in product design, and the introduction of innovation on the market and two-thirds in upgrading equipment.

Figure 7.3. Share of food and drink processing companies engaged in innovation activities, by type of activity, 2012-14



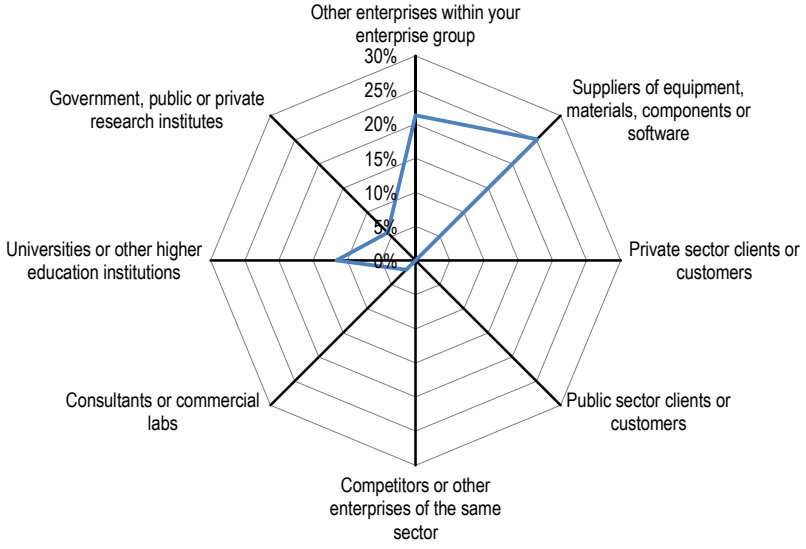
Source: Statistics Estonia (2015a), Table RDI1227: Technologically innovative enterprises by type of innovation activity engaged during 2012-2014 and economic activity, 2014, www.stat.ee; Calculations Estonian University of Life Sciences.

StatLink http://dx.doi.org/10.1787/888933654807

Box 7.1. Innovation in Estonian food and drink processing companies (cont.)

Collaboration of food and drink processing companies[2] is mainly with equipment, materials, components, and software vendors (about a quarter of the cooperating companies), and with other enterprises within the enterprise group (21%) but significantly less with universities and other institutions of higher education (12%) (Figure 7.4).

Figure 7.4. Share of food and drink processing companies that collaborate in product and process innovation with other companies or organisations, by origin, 2012-14



Source: Statistics Estonia (2015a), Table RDI1247: Technologically innovative enterprises finding partner most valuable during 2012-2014 by type of partner and economic activity, 2014, www.stat.ee; Calculations Estonian University of Life Sciences.

StatLink http://dx.doi.org/10.1787/888933654826

1. The statistical survey "Innovation Survey of Enterprises" is the implementation of the European Community Innovation Survey (CIS) in Estonia. The survey is carried out every two years in all European Union member and candidate states simultaneously. The frame of the survey covered all enterprises with at least ten employees in industry and selected economic activities in services. To evaluate an enterprise's innovativeness, it was asked about its activities in 2012–14. If an enterprise did not introduce during this period any innovations or did not engage in any innovative activities, it was considered non-innovative (Statistics Estonia, 2015a).

2. An enterprise that, during the years under consideration, introduced a product innovation to the market or implemented a process innovation or was involved in some other innovation activity (in connection with abandoned or ongoing innovation projects; also, research and development can be the main or secondary activity of the enterprise).

Government's communication with citizens on science

Estonian society is favourable to science and technology. The Eurobarometer 2015 survey shows that, compared to the EU average, Estonians consider innovation as a positive phenomenon that provides a number of benefits, including the overall increase in the quality of life, environmental sustainability (such as the introduction of electric cars), medical technology and the positive impact of pharmaceutical industry developments on medical services and drug efficacy, easier and faster access to the necessary information, e-services, including time-saving by means of digital signing and e-commerce, positive change in planning of working time and form (work from home, virtual meetings). However, such developments also pose threats, including a decline in social skills, data security, privacy loss, and manpower being replaced with machinery (Eurobarometer Qualitative Study, 2015).

During the period 2007-12, various activities for the popularisation of science were tested and developed, but the government did not offer a clear strategic approach (Kirss et al., 2013). A Research and Technology Pact was signed in 2015 between the government, municipalities, business, education and the tertiary sector, to provide joint support in the fields of science, technology and engineering for the

implementation of the innovation strategies for 2020. One of the aims of the Pact is to popularise science, technology and engineering in the society. Activities include research competitions for schoolchildren and students under the leadership of the Estonian Research Council (ERC), and ERC annual research conferences, which primarily target students in general education (ERC, 2015a). Since 2006, Estonia acknowledges remarkable individuals and bodies with the national science communication award to value science communication.

TeaMe+ is an ERDF financed programme for popularising science, technology, engineering and math (STEM) education fields introduced in 2009. Introducing scientific topics in the mass media, developing science journalism and promoting an open dialogue between scientists and society are among its objectives. The programme has supported the public broadcast of two science programmes. "At the Top of the Pyramid" (Püramiidi tipus) aimed at the public, and adventurous science gameshow "Rocket 69" (Rakett 69) for the young. The latter was selected by the European Broadcasting Union as the best educational programme of 2012 (ERC, 2015b).

Initiated by Enterprise Estonia (EE), the largest competition of business ideas called *Ajujaht* (Brain Hunt) has been organised since 2007. Several times, the winners of the event have come from the primary sector related ideas (including a sensor-backed fish farming system, an automatic irrigation system for household plants, a web environment that allows people not having a household plot to purchase horticultural produce, a sensing device that makes it possible to measure the number and diameter of logs accurately and quickly, etc.). The competition is mainly targeted at professionals who want a career change, and students who want to create start-ups (Ajujaht, 2016).

The universities also support the popularisation of science. For example, the Estonian University of Life Sciences (EMÜ) organises applied science prize competitions designed to encourage scientists and working groups to find effective ways of cooperation with the end-users of research results, to introduce innovative ideas into practice, and contribute to an increase in the applied research capacity and volume of external financing at the University (EMÜ, 2013a). The University of Tartu (TU) is engaged in popularising science among the people of different ages interested in the research. The activities of TU Sciences School are targeted at young people in particular, and in cooperation with the Estonian Physical Society, the University launched science bus, where schoolchildren with a deeper interest in science have the opportunity to broaden and extend their knowledge. To introduce science to a wider public the TU cooperates with the Science Centre AHHAA[7] and administers the science news portal "Novaator" (TU, 2015).

The EU Framework Programme for Research and Innovation, Horizon 2020, pays more attention to social problems that affect people's lives, such as improving health services, environment-friendly transport, and food and energy security. It includes a separate activity "Science with and for society", which focuses on the integration of scientific and technological achievements into the society. In addition, Horizon 2020 introduces the endeavours in research and technology among young people.[8]

7.2. Actors, institutions and governance of agricultural innovation systems

Agricultural innovation systems (AIS) involve a wide range of actors who enable, guide, fund, perform, implement, inform and facilitate innovation. The key players include policy-makers, researchers, teachers, advisors, farmers, private companies and consumers. A well-functioning innovation system can help ensure good use of public funds, improved collaboration between public and private participants, including across national borders, and a more demand driven system that is responsive to the needs of "innovation consumers" (OECD, 2015).

In Estonia, the **Government** plays a central role in the governance of the AIS, by setting the policy, monitoring the implementation of programmes and evaluating policies and institutions (Figure 7.1). The MRA is responsible for planning, coordination and implementation of R&D activities related to agriculture (for more information on AIS governance, see Annex 7.A1). To this end, the MRA has drawn applied research programmes since 2004 (MRA, 2016a). The MRA is responsible for extension services and R&D institutions, except the universities, and finances applied research, knowledge transfer and innovation in agriculture, food

and fisheries sector through national programmes. The European Union plays a growing role in the orientation and financing of Estonian national programmes and research collaboration between EU member states, including in the agri-food area.

Some organisations support the MRA in implementing policies. The Estonian Agricultural Registers and Information Board (ARIB) is a paying agency administrating agricultural policy measures. The Council of Agricultural Sciences advises the MRA on RDI issues under their authority, observes the implementation of RDI measures funded by the MRA and, on this basis, proposes improvements.

Regarding **R&D organisations**, the EMÜ carries out the largest part of agriculture-related research in Estonia, covering animal husbandry, veterinary, agricultural economics, rural sociology, environment, plant sciences, and food sciences. The TU carries out research in environmental sciences, and the Tallinn University of Technology (TUT) in biotechnology and food sciences. A research organisation specialised in crop research, the Estonian Crop Research Institute (ECRI), is under MRA umbrella (Figure 7.5). Previous research institutes have been integrated in universities (Box 7.2).

The Agricultural Research Centre (ARC) is mainly carrying field tests and experiments, laboratory analyses, preparing liming and fertilising maps, good agricultural practices and agro-chemistry research, evaluation of agri-environmental measures, and horticultural testing activities.

Higher **education** in agriculture-related fields is mainly in the EMÜ. At the vocational level, there are nine vocational schools in different regions. Three are specialised in Rural Economics and Service, Forestry, and Horticulture, respectively.[9]

Box 7.2. Merger of Estonian agriculture research organisations in the 1990s

Up to 1994, agriculture research institutes were under the jurisdiction of the Ministry of Agriculture (MoA). In 1993, they started being integrated into the universities. By 2001, five research institutes had been merged with the EMÜ. In 2003-06, faculties were restructured into institutes. By 2016, there was only one R&D institute under the umbrella of the MRA: the Estonian Crop Research Institute (Table 7.1)

Table 7.1. Merger of agriculture research institutes over 1993-2013

Research institutes	Year	Merger and other restructuration
Institute for Rural Development	1993	Merged with the Estonian Agricultural University
Estonian Research Institute of Animal Breeding and Veterinary Science (ELVI)	1994	
Estonian Forest Research Institute	1996	
Institute of Zoology and Botany, Institute of Experimental Biology, Estonian Plant Biotechnical Research Centre EVIKA	1997	
Estonian Agrobiocentre	2001	
Estonian Institute of Agrarian Economics	2001	Merged with Jäneda Training and Advisory Centre
Estonian Institute of Agricultural Engineering	2002	Merged with Estonian Research Institute of Agriculture
Jäneda Training and Advisory Centre	2006	renamed Rural Economy Research Centre
Jõgeva Plant Breeding Institute and Estonian Research Institute of Agriculture	2013	Merged into the Estonian Crop Research Institute, which remains under the Ministry of Rural Affairs

Source: compiled by the authors, based on EMÜ (2016a) and (MRA, 2005).

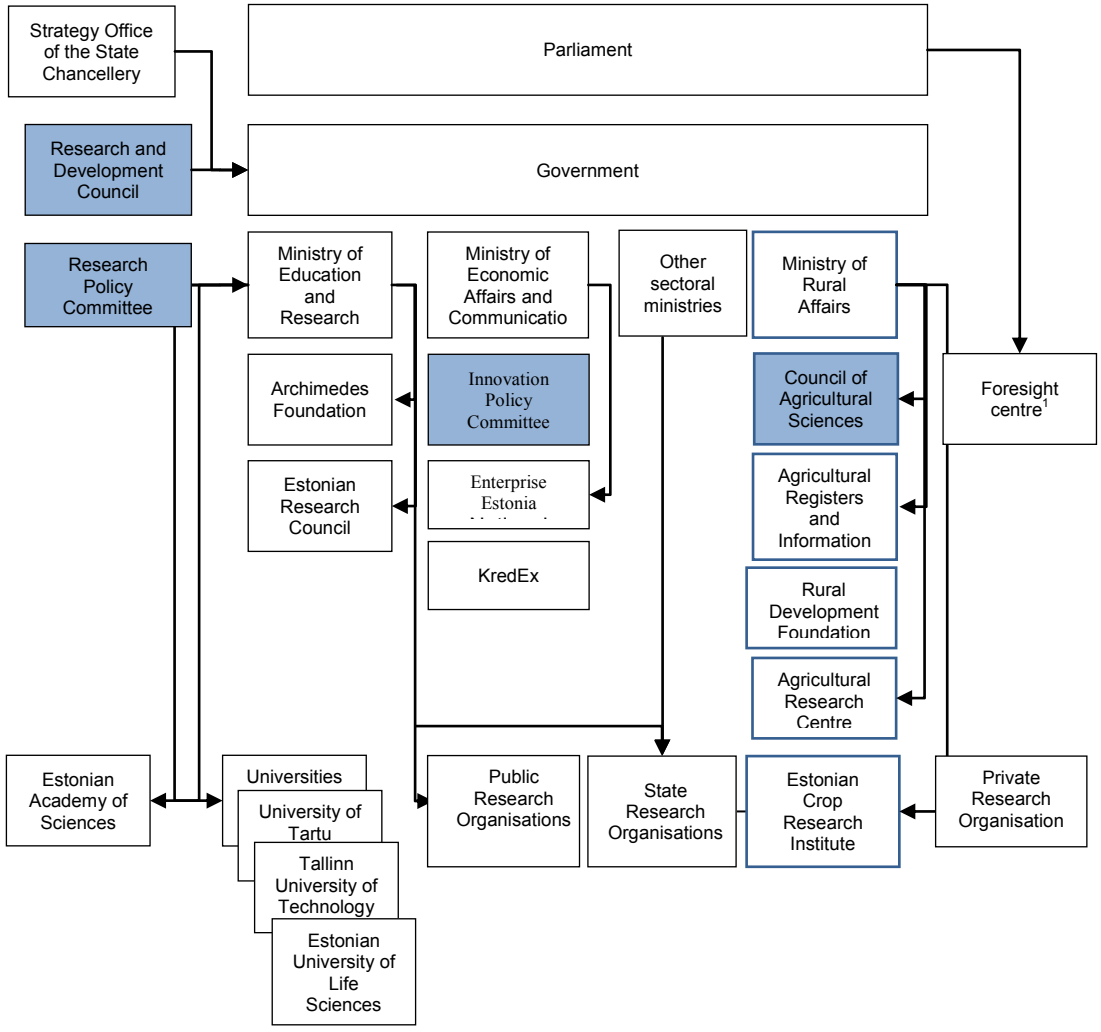
The research carried out in the research institutes under the jurisdiction of the Ministry of Agriculture was mainly applied research by nature. It concerned for example the development of new varieties, biological medicinal products, and technologies (MRA, 1999).

The Rural Development Foundation (RDF) is responsible for the elaboration of the **advisory system** for Estonian agricultural and rural enterprises and guaranteeing them access to high-quality consulting services. The Rural Economy and Agricultural Advisory Service is a registered trademark belonging to the RDF, which offers advisory services in agriculture and rural economy and brings together advisers who pass on advice to

farmers and rural entrepreneurs. Farmers can also seek advice from Estonian and foreign input suppliers, cooperatives, and web-based providers.

The **private sector** is an important partner in the Estonian AIS, mainly as a user of innovation. Estonian enterprises are mostly small and they often lack resources for research-intensive activities. Therefore, competence centres, funded by Enterprise Estonia, were created to develop innovative solutions, in cooperation with enterprises in a specific field, universities and research institutes. Over 2014-20, six state-supported competence centres will operate in Estonia, two of them in the field of food technology and one in biomedicine (EE, 2016a).

Figure 7.5. Overview of the Estonia's research system's governance structure



1. In April 2016, the Estonian Development Fund (EDF) was abolished. An independent unit (the Foresight Centre) with its own budget and competence for decisions was set up under the Estonian Parliament to carry out EDF monitoring activities (www.riigikogu.ee/en/foresight/), whereas the responsibility for EDF investment activities were transferred to KredEx.

Source: Christensen et al. (2012), www.hm.ee/index.php?popup=download&id=11652, elaborated in EMÜ (2017).

7.3. Public and private investments in agricultural R&D

In most countries, the public sector is the main source of funding for agriculture R&D, whether performed in public or private organisations. A wide variety of funding mechanisms are used from direct spending on research projects. Business investment in R&D is normally driven by market demand, but governments also provide different kinds of incentives. Knowledge infrastructure is a public good that can enable innovation; it includes ICT infrastructure and general purpose technologies as well as specific knowledge infrastructure such as databases and institutions (OECD, 2015).

Priorities for agriculture research, development and knowledge transfer

In Estonia, the general priorities for public research in agriculture stem from the EU level, national horizontal and sectoral strategies (Figure 7.6). The overall priorities and measures for Estonian R&D policy are defined in Knowledge-based Estonia (MER, 2013).

The specific aims for agricultural research in Estonia are: 1) Competent scientific support for designing and implementing the Common Agricultural Policy (CAP) and the fisheries policy; 2) Competent scientific support for the agriculture, food and fisheries sector; 3) Sustainability of scientific community; 4) State-of-the-art facilities and infrastructure; 5) Estonian researchers participation in international research cooperation; 6) Plant and animal breeding; plant genetic resources *ex situ* conservation and collection; and 7) Effective knowledge transfer, including between R&D organisations and agricultural producers (MRA, 2016b).

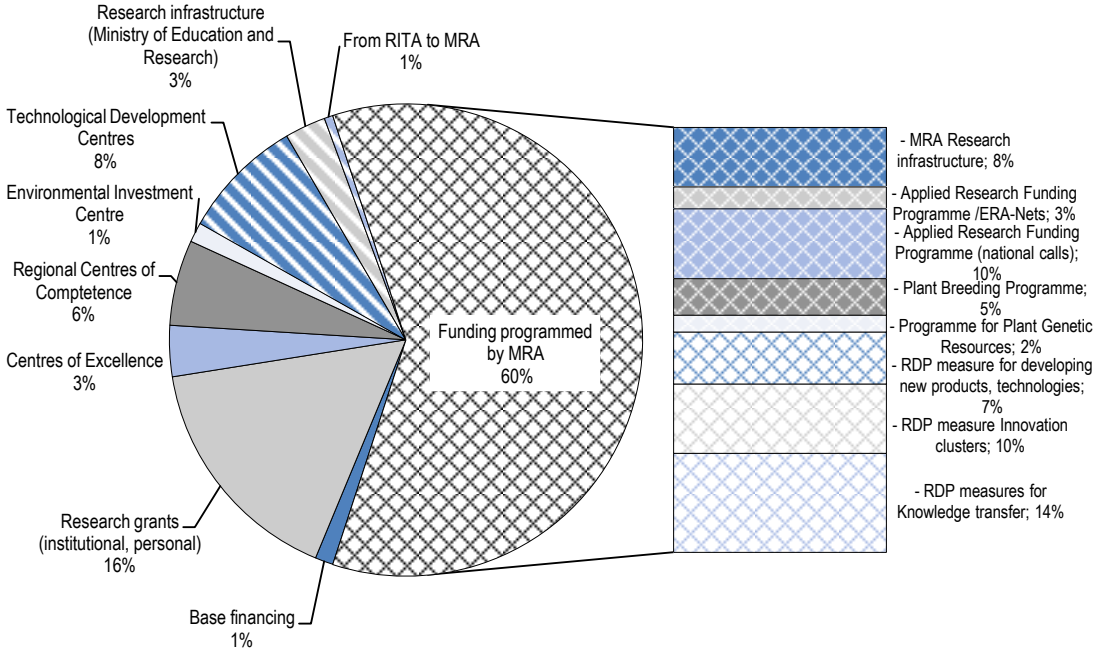
The MRA funds applied research, knowledge transfer and innovation in agriculture, food and fisheries through various national and EU programmes as shown in Figure 7.6. The three national programmes below are included in the framework for research and knowledge transfer in Estonian agriculture, food and fisheries sciences and fund applied research, while the main source for supporting knowledge transfer and innovation is the Estonian RDP through specific measures (Chapter 6):

- **Agricultural Applied Research and Development for 2015-21** aims to provide science-based input to the MRA for policy making, law making and monitoring; and to coordinate and to finance participation in international research cooperation (MRA, 2016a). The programme covers the following activities to pursue specific objectives:
  - Food safety, animal welfare and health; plant health and quality of production input: to ensure the safety of food produced and consumed in Estonia; to ensure animal welfare and animal and plant health; to ensure quality and safety of agricultural production inputs.
  - Rural life, agriculture and food industry: to ensure sustainable food production; to maintain traditional agricultural landscapes, a clean environment and biodiversity; to ensure balanced development of agricultural regions and improvement of rural living environment.
  - Fishing industry: to ensure competitive and sustainable fishing industry.[10]
- **Collection and Conservation of Plant Genetic Resources for Food and Agriculture for2014-20**[11] addresses the commitments that Estonia has taken with international agreements, such as the Convention on Biological Diversity, the Second Global Plan of Action for Plant Genetic Resources for Food and Agriculture, and the International Treaty on Plant Genetic Resources for Food and Agriculture. The main aims are to ensure the collection and conservation, evaluation of plant genetic resources for food and agriculture, and the wider utilisation and availability of plant genetic resources for research and study, plant breeding and to other non-profit users. The programme serves as a basis for "National Programme for Plant Breeding 2009-19" as well as contributes to overall goals of sustainable development of plant breeding and conservation in Estonia, healthy and safe food, the sustainable use of natural resources, the maintenance of genetic and landscape diversity, and the reduction of climate change hazards (MRA, 2013a).

- **National Programme for Plant Breeding for 2009-19** mainly aims to ensure the sustainable development of Estonian plant breeding and to preserve existing varieties; to breed varieties that help to increase the competitiveness of agricultural sectors; healthy and safe food; sustainable use of natural and environmental resources and the preservation of genetic and landscape diversity; and reduce the threats of climate change (MRA, 2008).

The **Estonian agriculture, food and fisheries science and knowledge transfer development plan for 2015-21** (MRA, 2016b) is a framework document that sets the objectives for research and knowledge transfer in MRA's governance area and directions for planning and coordinating different research measures in order to achieve their cohesiveness, including with EU and national horizontal and sectoral strategies, and the Rural Development Programme (RDP) 2014-20 (Figure 7.A1.1). The development plan addresses research in veterinary medicine; food technologies and food safety; animal production, including animal breeding; crop production, including plant breeding; horticulture (berries, fruits, ornamental horticulture); fisheries science, including aquaculture; and rural economics. The priority fields for agricultural sciences (stemming from Europe 2020) are climate change and resource efficiency, food safety, health care and aging, environmentally friendly production methods and land use (MRA, 2016c).

Figure 7.6. Main funders and programmes for agriculture-related research, 2017[1]



1. 2017 or annual average of programme period.
RITA: a programme that has been developed for 2014-20 to support more efficient collaboration between public sector decision makers and R&D institutions.
Numbers may not add up due to rounding.

Source: Communication from MRA.

StatLink http://dx.doi.org/10.1787/888933654845

Research funding instruments

The MEAC and the MER are responsible for most of the public research funding streams and horizontal policies as they design the policy and research funding instruments, distribute funds to their implementing agencies (Enterprise Estonia, Kredex for MEAC; ERC, Archimedes Foundations for MER), and distribute certain funds directly (ERC, 2013). The MER is counselled by the Research Policy Committee that also makes proposals on policy, R&D financing principles and strategies (MER, 2015a). The MRA is responsible for supporting research in agriculture-related areas, programming 60% of funds (Figure 7.6).

The main research funding instruments financed from the Estonian state budget are: block funding; grant research funding — institutional research grants and personal research grants; national R&D programmes; financing of centres of excellence and doctoral schools; and covering the expenses of R&D infrastructure (MER, 2015a).

The majority of public research funding in Estonia is project-based and is distributed through competitive calls in which applicants are evaluated by peer-review. Table 7.2 summarises the main research funding instruments funded through the MER, MEAC and MRA.

In addition, RDP funds are increasingly used to finance knowledge transfer. The Estonian RDP 2014-20 allocates 3.9% (4.0%) of total expenditure to three measures that can fund knowledge transfer: Knowledge transfer and information; Advisory services, farm management and farm relief services; and Cooperation, compared to 1.5% for knowledge transfer in the RDP 2007-13 (MRA, 2016d) (Chapter 6). This is still lower than the EU average of 4.9%, but higher than in other Baltic countries.

Trends in expenditures on R&D

Estonian gross domestic expenditure on R&D (GERD)[12] grew rapidly in the 2000s, increasing ten times in ten years. Fast growth can be partially attributed to the very low level of expenditure on R&D in the beginning of this period. Estonian GERD accounted for 0.6% of GDP in 2000, compared to 2.1% on average in OECD countries. While expenditure on R&D in government and higher education grew steadily during the 2000s, the most spectacular increase was in business enterprise R&D. The significant spike of R&D investments in 2010-12 was caused by a one-time large investment in oil shale industry (Statistics Estonia, 2015b). With those investments, GERD briefly reached 2.3% of GDP, but declined from 2012 to 1.5% in 2015, remaining below the OECD and EU28 averages of respectively 2.4% and 2% (Figure 7.7).

Estonia has set the target to increase R&D investments to 3% of GDP in 2020. Estonia 2020 estimates that this would mean quadrupling of R&D spending compared to 2009 (Government Office, 2014). The target of 2% of GDP for 2015 was not met, raising doubts about meeting the 2020 target.

Table 7.2. Most relevant funding measures for agricultural innovation

Types of funding/programmes	Purpose	Financing/ connection with AIS	Evaluation of applications
Block funding	To provide funding for organisations to attain their strategic development goals, for co-financing foreign and domestic projects and for opening up new research directions	2005-15: EUR 77.7 million Agricultural sciences[1] EUR 1.46 million	Main institutional, non-competitive instrument, distributed by the decision of the minister. The funds allocated for block financing from the state budget are provided to applicants based on the results of their R&D activities in previous three years (publications, patents, R&D funding, PhD defences).
Institutional research grants (replacing the previous target financing)	To finance high-level R&D, and related activities (research themes) of an institution to ensure the consistency of the R&D and to supplement and maintain the necessary infrastructure	Most sizeable research support measure. 2007-15: EUR 207.2 million (including target financing). Agricultural sciences: EUR 13.5 million	Competitive, project-based. Applications are evaluated by committee of national and international experts
Personal research grants	Innovative or high-risk research projects carried out by researchers or small research groups	2009-15 EUR 53.5 million (including ERC grants) Agricultural sciences: EUR 1.7 million	Competitive, project-based. Applications are evaluated by committee of national and international experts

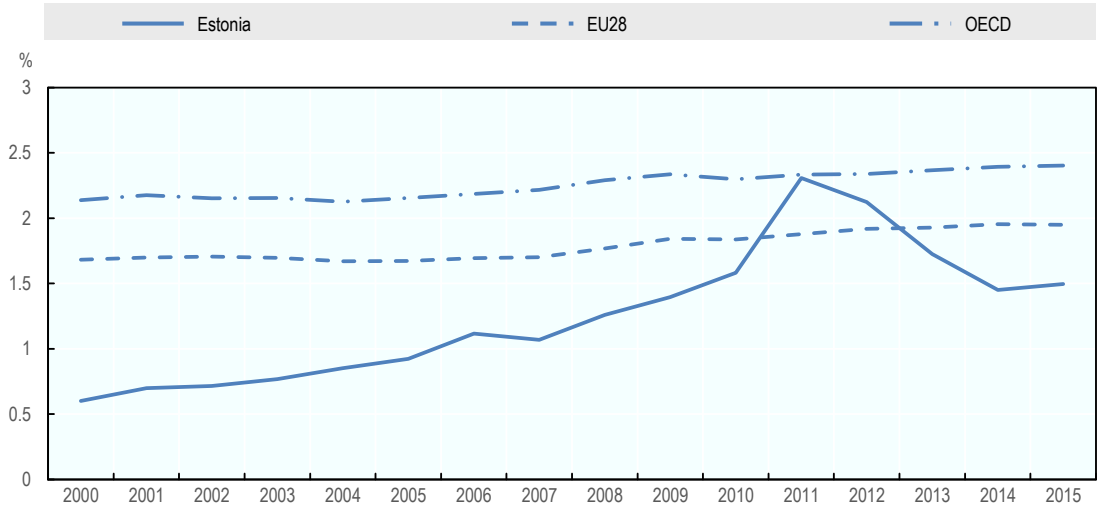
Table 7.2. Most relevant funding measures for agricultural innovation (cont.)

Types of funding/programmes	Purpose	Financing/ connection with AIS	Evaluation of applications
Centres of Scientific Excellence	Formation of consortium by internationally recognised research groups to improve the quality and efficiency of scientific research through cooperation	2008-15: EUR 44.7 million; max. amount per project EUR 7.7 million, at least 5% co-financing requirement Centre of Excellence in Environmental Adaptation ENVIRON coordinated by EMÜ is one of the 12 centres created; funding EUR 3.0 million	Applications evaluated by committee of national and international experts
Competence centre programme	Formation of competence centre by consortium of enterprises and R&D institutions for innovative product development and cooperation	2014-20: EUR 40 million, maximum amount EUR 7 million per centre; at least 40% of financing from the consortium partners Out of the 8 centres established, three are related to AIS: The Centre of Food and Fermentation Technologies (TFTAK); The Competence Centre on Health Technologies (CCHT); and The Bio-Competence Centre of Healthy Dairy Products LLC (BioCC)	Applications are evaluated by committee of national and international experts
Regional Competence Centres	Support to regional entrepreneurship and labour market through cooperation between enterprises and R&D institutions to create knowledge intensive entrepreneurship (outside largest cities Tallinn and Tartu)	2014-20: EUR 14 million Maximum support per centre EUR 0.7 million; at least 15% self-financing from partners. In 2009-14 maximum support per centre EUR 3.19 million Out of six centres established since 2009, one is part of AIS: The Competence Centre for Knowledge-Based Health Goods and Natural Products	Application are evaluated at first by two appointed experts; followed by evaluation by a committee formed by EE.
Agricultural Applied Research and Development for 2015-21	Competent scientific input for agricultural policy and law making and monitoring; and coordination and financing of participation in international research cooperation	2015-21: EUR 9.61 million (2009-14: EUR 7.4 million)	Competitive, project-based. Steering committee decides on project calls and ordering of ongoing expert opinions and participation in international network projects.
Collection and Conservation of Plant Genetic Resources for Food and Agriculture for 2014–20	Collection, conservation, evaluation, and wider utilisation and availability of plant genetic resources for food and agriculture	2014-20: EUR 1.76 million (2007-13: EUR 1.35 million)	Non-competitive; but applications are evaluated by different departments of the MRA
National Programme for Plant Breeding for 2009–19	To ensure the sustainability of Estonian plant breeding and to preserve existing and breed new varieties	2009-12: EUR 3.6 million	

1. Frascati Manual classification, where agricultural sciences includes agriculture, forestry, fisheries and allied sciences (agronomy, animal husbandry, fisheries, forestry, horticulture, other allied subjects); and veterinary medicine.

Sources: compiled using MER-ERC (2014, 2015c, 2016a), EE (2016a, b); Etis (2016); MER (2015a); MRA (2013b, 2016c, 2016d).

Figure 7.7. Gross domestic expenditure on R&D as a percentage of GDP, 2000 to 2015



Source: OECD (2017b), *Main Science and Technology Indicators,* http://dx.doi.org/10.1787/msti-v2016-2-en.

StatLink http://dx.doi.org/10.1787/888933654864

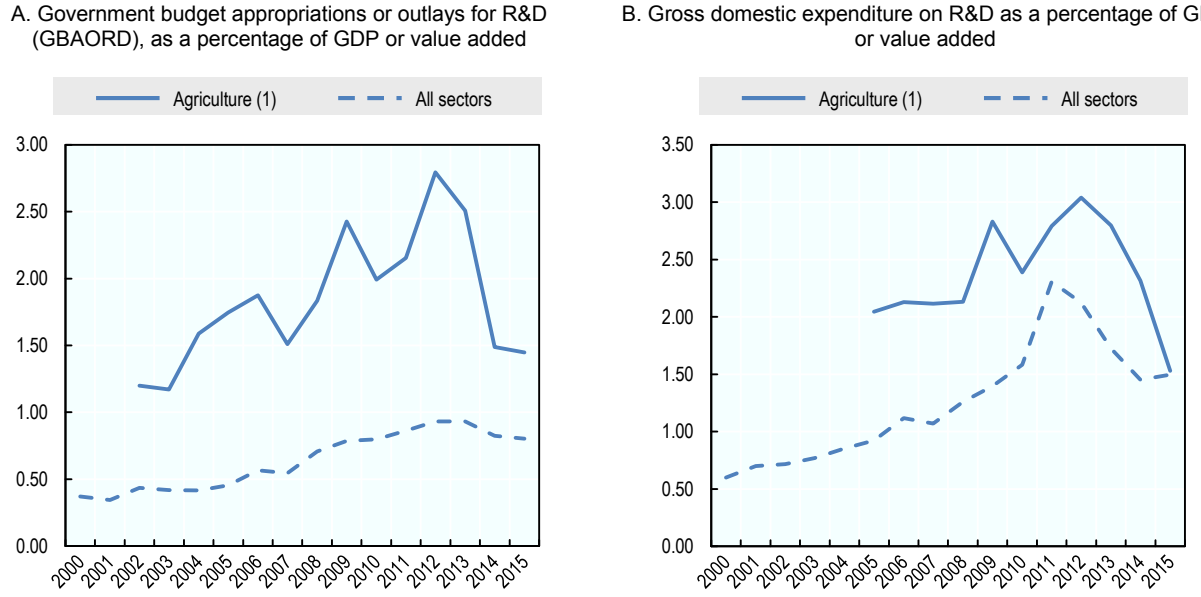
Trends in public expenditures on agricultural R&D

Most agricultural R&D in Estonia is conducted in government and higher education organisations. GERD for agriculture in Estonia includes national estimates of expenditure on R&D performed in business enterprises, accounting for less than 1% of the total. GERD for agricultural sciences is only available for R&D conducted in government and higher education organisation. It is about 80% the equivalent GERD for agriculture as a socio-economic objective, illustrating that the sector relies on more than agricultural sciences. Budget appropriations are also used to have a broader picture of public investment in agricultural R&D, in particular for comparison purpose.

Public expenditure on agricultural R&D as a share of agricultural value added (research intensity) has increased rapidly between 2002 and 2012, with variations partly due to programming cycles (Figure 7.8.A). Research intensity more than doubled to reach 2.8% in 2012, but following a sharp decline, it settled at about 1.5% in 2014-15. The rapid increase in research intensity is mainly because R&D expenditure grew at a considerably higher rate than agricultural value-added. Public expenditure on agricultural R&D in real terms increased by 11% per year from 2003-05 to 2013-15, one of the highest growth rates among OECD countries in the last decade, together with Germany (13%), Mexico (10%), Korea (9%) and Norway (9%).

GERD for agriculture, which is mainly conducted in government and higher education organisation, whatever the source of funding, also reached a peak of 3% of agricultural value added in 2012, to be scaled back to 1.5% in 2015 (Figure 7.8.B).

Figure 7.8. Developments in agriculture and economy-wide R&D intensity in Estonia, 2000 to 2015



1. Agriculture as a socioeconomic objective in NABS2007.

Source: OECD (2017c), OECD statistics [Research and Development, OECD National Accounts], http://stats.oecd.org/ (accessed June 2017).

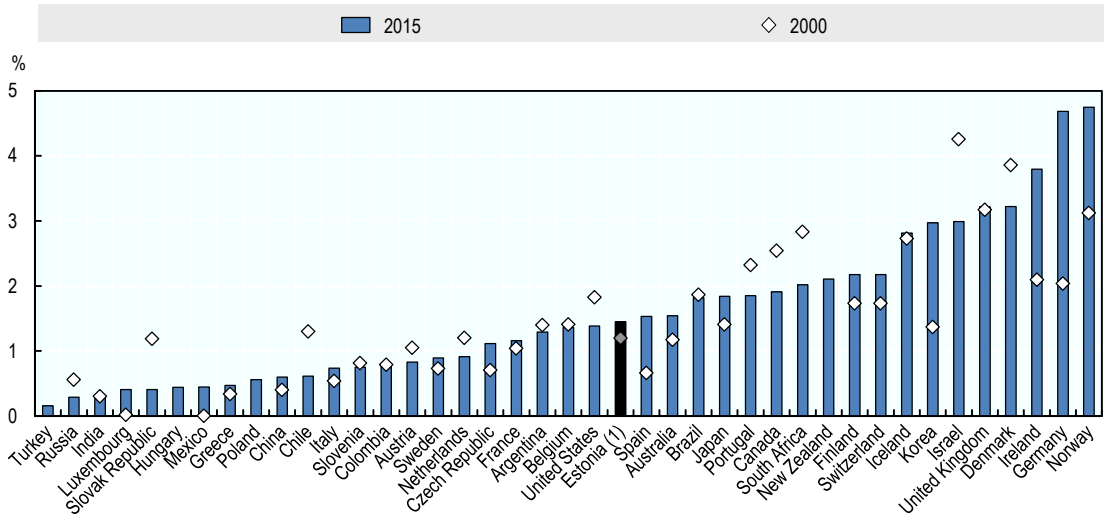
StatLink http://dx.doi.org/10.1787/888933654883

While in 2012-13, Estonia was among the countries with relatively high agricultural research intensity comparable to that in Denmark and Finland, by 2015 it was in the middle pack (Figure 7.9).

The intensity of public expenditure on R&D for agriculture is well above economy-wide R&D intensity, except in 2015 when agriculture is aligned with all socio-economic objectives (Figure 7.8). Public institutions play a larger role in R&D for agriculture than on average with less than 1% of R&D taking place in business enterprises compared to 40-60% overall.

While as a share of agricultural value-added, public expenditure on agricultural sciences increased, the share of agricultural sciences in total GERD decreased. With strong fluctuations in some years, Estonian (GERD) expenditures on agricultural sciences increased more slowly than in other sciences. In 2000, agricultural sciences accounted for 9.6% of all R&D expenditures in higher education and 15.4% in the government sector, but by 2015, their share had decreased to 4.1% in higher education and 6.6% in the government sector (Figure 7.10).

Figure 7.9. Share of budget expenditures on agriculture R&D as a percentage of agricultural value-added, 2000 and 2015

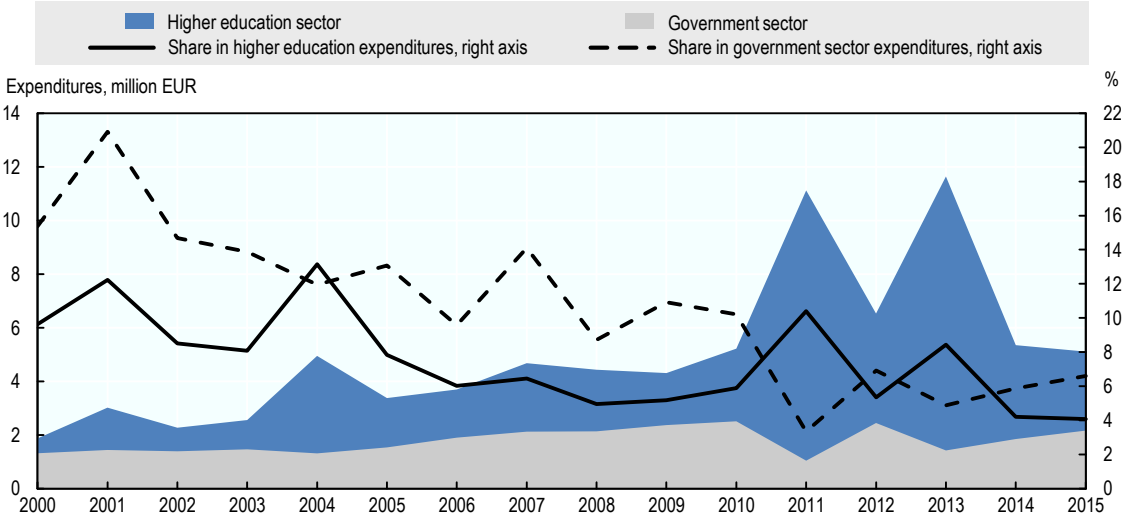


1. For Estonia, 2002 data are used for 2000.

Source: OECD (2017c), OECD statistics [Research and Development, OECD National Accounts], http://stats.oecd.org/; and ASTI (2017) for Argentina, Brazil, Chile, China, Colombia and South Africa (accessed June 2017).

StatLink http://dx.doi.org/10.1787/888933654902

Figure 7.10. Public expenditure on R&D for agricultural sciences, 2000 to 2015



Source: Statistics Estonia (2017), on-line statistical database, www.stat.ee/en (accessed 13 June 2017).

StatLink http://dx.doi.org/10.1787/888933654921

Funding mechanisms and sources

The share of **project-based funding** of Estonian R&D is extremely high. Estimates for 2014 indicate that around 80% of R&D funding was project-based on average, over 90% in all public universities and 100% in some R&D institutes. This raises growing concerns for long-term strategic planning and sustainability of R&D institutions (Ukrainski et al., 2015b). The main funding measures are all project-based and competitive (Table 7.2). Block funding is the main non-competitive instrument. Its share in the total funding of R&D institutions was relatively small in 2005-13, remaining between 4% and 6% in most of the institutions (MER-

ERC, 2014). This information is not available by field of science, but as agriculture is integrated in the general system, this structure is likely to apply to agricultural sciences.

Following suggestions from the RDC, the Estonian Government plans considerable changes in research financing instruments. These include a significant increase in the share of block funding in order to achieve more stability in research funding (MER, 2015b). The aim is to achieve a 50:50 ratio between project-based funding (institutional funding grants and personal research grants) and block funding. In 2016 block funding was increased by 50%, resulting in a ratio of institutional funding and personal research grants to block funding of 73:27, compared to 80:20 in 2015 (Koppel, 2016).

There are various **public and private sources of R&D funding**. Overall, the state budget contributed to close to half of total R&D funding in 2014, while the business sector played an important role (41% of all R&D funding), followed by EU structural funds and foreign sources (Table 7.3). Structural funding through MER and foreign sources accounted for half of public funding in 2014 (Table 7.3). The government's share of R&D funding is likely to be higher for agriculture research as is the case in many countries where data are available, in particular given the low capacity of Estonian agri-food enterprises.

Table 7.3. Sources of R&D funding, 2010 and 2015

	Share in total funding (%)		Share in public funding (%)	
Sources	2010	2015	2010	2015
Business sector	41	39		
Personal research grants/Estonian Science Foundation grants	3	3	5	5
Institutional research grants/target financing	9	9	16	1
Block funding	3	3	5	5
Co-financing of structural funds and other R&D expenditures	11	7	18	12
Ministry of Economic Affairs and Communication	8	3	14	5
Other ministries	4	7	6	12
Foreign and EU sources	11	12	18	19
Structural funding through Ministry of Education and Research	7	17	13	27
Research infrastructure supports	3	0	5	0

Source: ERC (2016b), www.etag.ee/tegevused/uuringud-ja-statistika/statistika/teadus-ja-arendustegevuse-rahastamine-eestis.

The high share of foreign sources in Estonian research reflects the importance of EU structural funds in the national budget. The overall share of foreign financing in Estonia started to grow rapidly with the implementation of EU pre-accession programmes at the beginning of the 2000s. Over 2000-13, Estonia received more than EUR 5.4 billion in foreign assistance, mainly from EU structural funds (MoF, 2016). Estonia received EUR 802 million from EU structural funds for 2004-06 and EUR 3.4 billion for 2007-13 (EUSAE, 2015). The importance of foreign funding grew especially with the onset of recession in 2009, as this funding became the main source for financing public investments (Varblane, 2014). From 2009, the share of foreign support in the annual state budget has fluctuated between 11.2% and 13.8%; in 2015, foreign support amounted to EUR 1 billion and accounted for 11.8% of state budget expenditures (MoF, 2015).

For the programming period 2014-20 Estonia will receive EUR 4.4 billion from the five EU structural and investment funds. That includes EUR 725.8 million allocated to the development of the agricultural sector and rural areas from EAFRD, and EUR 100.8 million for the fisheries and maritime sector from EMFF (EC, 2014). Estonian research and higher education will receive EUR 359 million from structural funds over 2014-20 (MER, 2016a).

Support to knowledge infrastructure

Core infrastructure refers to infrastructures belonging to the R&D institutions, and which have been established in the public interest for the purpose of pursuing research themes, and can be used by other persons on the terms and conditions established by the owner institution (MER, 2015b). It includes high-class research equipment or technologies and a highly qualified workforce, which assist researchers, R&D teams, and the business sector by making expertise and analytical resources available.

General maintenance and funding of Estonian research infrastructure is addressed through a variety of instruments: the covering of infrastructure costs, the research infrastructure roadmap, core infrastructure supports, supports to scientific collections, and research libraries (MER, 2016b).

The infrastructure costs of public R&D institutions are funded from the budget of the umbrella ministry, mainly the MER. Private R&D institutions use private sources to cover infrastructure costs, although they may receive earmarked support from state budget and local government (Masso and Ukrainski, 2008). In 2012, research infrastructure support accounted for 5% of total government spending on R&D (ERC, 2016b). Since 2013, infrastructure costs are part of institutional and personal research grants (ERC, 2013).

In 2010, Estonia prepared the first research infrastructure roadmap, which is used as a long-term planning tool for investment decisions (MER, 2016b). The roadmap identifies the infrastructure items of national importance that are new or require modernisation (ERC, 2016c). The list is updated every three years. In 2014, the roadmap contained 18 items. EMÜ is a partner in four: Natural History Archives and Information Network (NATARC); Plant Biology Infrastructure — from Molecules to Crops; National Centre for Translational and Clinical Research (SIME); and Estonian Environmental Observatory (MER, 2016b). Estonia also participates in several international research infrastructures, including six European Strategy Forum on Research Infrastructures (ESFRI) items (ERC, 2016c).

Applications for core infrastructure support are submitted through institutional research grants (MER, 2015a). In the 2013 call for funds, the budget for core infrastructure support was EUR 0.5 million (ERC, 2016c).

From 1990 to the mid-2000s, Estonian R&D infrastructure suffered from underinvestment. Research infrastructure has been one of the main targets of EU structural funding (Christensen et al., 2012; Ruttas-Küttim, 2014). Over 2007-13 EUR 29 million from structural funds were invested for supporting research infrastructure of national importance (MER, 2016b). On the basis of the roadmap, for 2014-20 ERC administers EUR 30.9 million in support of investment plans for research infrastructures of national importance (ERC, 2016c). Overall, recent infrastructure investments have been generally sufficient to cover the previous underinvestment, but care should be taken to ensure the future sustainability of research infrastructure (Ruttas-Küttim, 2014).

R&D infrastructure improvement needs will also be addressed by a new programme –"Institutional development programme for R&D and higher education institutions" (ASTRA), which allocates EUR 122 million — one of the largest investments from EU structural funds in 2014-20 — for the construction of research and teaching facilities in R&D institutions, facilitating structural reorganising, improvement of quality and efficiency of teaching and research quality, modernising infrastructure, and for internationalisation, and increased cooperation, including between businesses and higher education institutions (MER, 2016a).

Regarding AIS institutions, MRA and EU structural and investment funding have modernised R&D infrastructure, but some laboratories and buildings remain outdated rendering them uncompetitive and unable to provide scientific support for the public and private sectors. EMÜ provides R&D infrastructure and competence for veterinary medicine, animal breeding, food science and technologies, and plant breeding, aquaculture and rural economics. Some of the facilities for food technology and product development for meat and fish products, bakery products, beverages, nature and plant products; aquaculture, and experimental stations need modernisation or expansion. The renovation of certain EMÜ buildings to establish a food centre with necessary laboratories and facilities for research on food technologies is in progress. Research in food technologies, including food safety, and development of products with high export potential, is also supported

by some of the established competence centres. The Bio-Competence Centre of Healthy Dairy Products, the Centre of Food and Fermentation Technologies, and the regional Competence Centre for Knowledge-Based Health Goods and Natural Products Research have modernised facilities. In plant breeding, ECRI has facilities and suitable test fields, however, test apparatus and laboratories are in urgent need of modernisation (MRA, 2016b).

MER funds the maintenance of scientific collections that have passed evaluations with approximately EUR 0.8 million per year. EMÜ has the following scientific collections: The Estonian soil museum, mycological collection, botanical collection, and zoological collection that are part of the larger national collections (MER, 2016b).

The EMÜ library is one of the six research libraries responsible for the collection, preservation and processing of scientific information, and for making such information available to the public (MER, 2016b). The libraries are also financed from the MER budget.

Trends in funding and structure of agricultural knowledge institutions

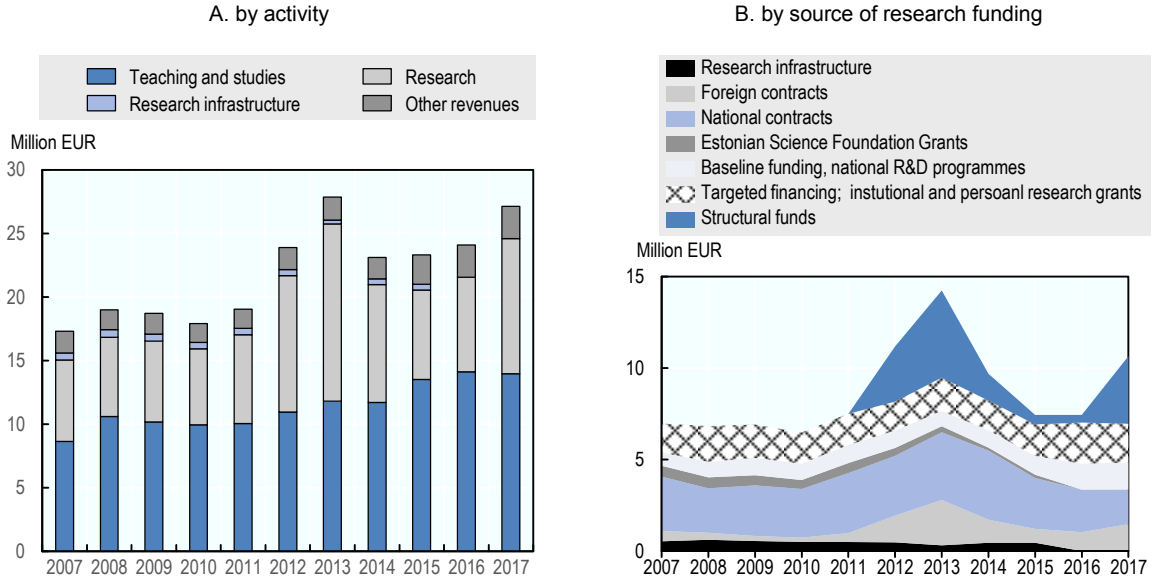
The budget of R&D institutions reflects the strong fluctuations in research funding, due to the high contribution of EU funding, which follow programming period cycles.

The Estonian University of Life-Sciences (EMÜ) is the main institution in Estonia carrying out agricultural research and providing higher education in agriculture. EMÜ's budget has increased from EUR 17.3 million in 2007 to EUR 27.1 million in 2017 (Figure 7.11). Government financing for teaching undergraduate and graduate students, which accounts for half of the university's budget, has been steadily increasing. The research budget, however, has been fluctuating strongly. The disbursements from structural funds and foreign contracts at the end of the EU seven-year budget cycle 2007-13 sharply increased the EMÜ research budget from EUR 7.5 million in 2011 to EUR 14.2 million in 2013. But the disbursements fell back to 2011 levels in 2015 and 2016 due to delays in the implementation of measures for 2014-20, and started to increase again to EUR 10.7 million in 2017.[13] Structural funds were mostly used for investments, including in infrastructure.

One of the distinctive features of research funding in EMÜ is the high share of national contracts in research budget, which represented around 40% of annual research funding over 2007-15. In comparison, national contracts accounted for around 10% of the research budget of the TU in 2014 and 2015 (TU, 2016).

The Estonian Crop Research Institute, ECRI, specialises in applied and basic research for the development and upgrade of agrotechnologies, improvements in yield and quality of used varieties and agrotechnologies; and on plant protection, plant health, agrochemistry, fertilisation, and agrometeorology. The institute also breeds new varieties of agricultural crops, is responsible for the maintenance breeding of registered varieties and preservation of plant genetic resources, and produces and distributes certified seeds of various agricultural crops (ECRI, 2015).

Figure 7.11. EMÜ budget, 2007 to 2017

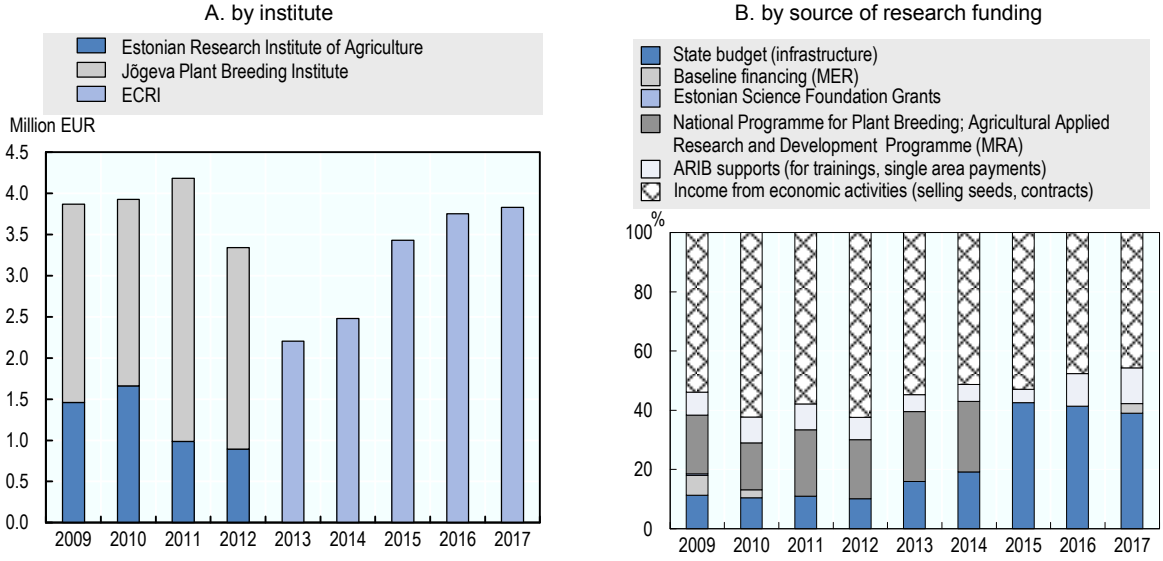


Source: Update from EMÜ (2015b), www.emu.ee/ylikoolist/yldinfo/eelarve/.

StatLink http://dx.doi.org/10.1787/888933654940

ECRI results from the merging of the Jõgeva Plant Breeding Institute and the Estonian Research Institute of Agriculture in 2013 (ECRI, 2015). The aim of the merger was to improve cooperation and efficiency, but it also allowed reducing costs (Figure 7.12). Around half of ECRI's revenues come from economic activities, including seed sales, different contracts and training. The research revenues are dominated by the MRA's applied science programmes and allocations from the state budget for research infrastructure (Figure 7.12).

Figure 7.12. ECRI budget, 2009 to 2017



2009-13 Jõgeva Plant Breeding Institute; 2014 ECRI.

Source: Based on MRA (2016c), www.agri.ee/et/ministeerium-kontakt/majandusteave, and ECRI (2017).

StatLink http://dx.doi.org/10.1787/888933654959

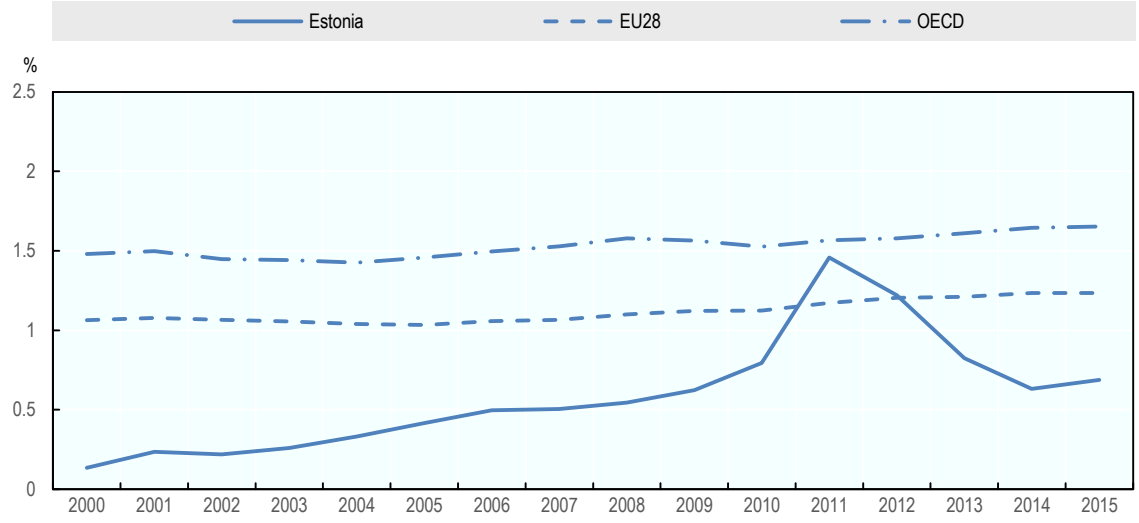
Trends in private expenditures on R&D

Estimates of Estonian R&D expenditures in the business enterprise sector for enterprises in the field of agriculture, forestry and fishing are available only for some years. In 2007 and 2008 intramural expenditure of agriculture, forestry and fishing enterprises accounted for less than 1% of the total expenditures in the business enterprise sector. Similarly, private companies are estimated to account for a minor share of R&D for agriculture (less than 1% of GERD).

General trends in BERD may concern food processing companies. Data on GERD and BERD come from surveys of enterprises. The number of enterprises reporting R&D expenditures to Statistics Estonia is small. There is no enterprise whose main activity is agriculture, forestry and fisheries, and statistics on their R&D activities on agricultural sciences is not available. Among the enterprises making R&D investments, the 50 largest enterprises made 85% of R&D investments (Varblane and Ukrainski, 2016). Out of 259 enterprises, 43% were manufacturing enterprises, followed by enterprises specialised in professional, scientific and technical activities (21%) and ICT (16%). Among the manufacturing enterprises reporting R&D expenditures, 17 enterprises were in the food industry (6.5% of enterprises reporting R&D expenditures) (Mürk and Kalvet 2015).

Starting from a low level, BERD as a percentage of GDP grew rapidly throughout the 2000s. However, its share in GDP is still lower than the OECD and EU28 average in 2015 (Figure 7.13). The peak in 2011 reflects the one-time investment in the shale oil industry, which also shows in GERD development (Figure 7.7).

Figure 7.13. Business enterprise expenditure on R&D (BERD) as a percentage of GDP, 2000 to 2015



Source: OECD (2017b), main science and technology indicators, http://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB (accessed on 16 June 2017).

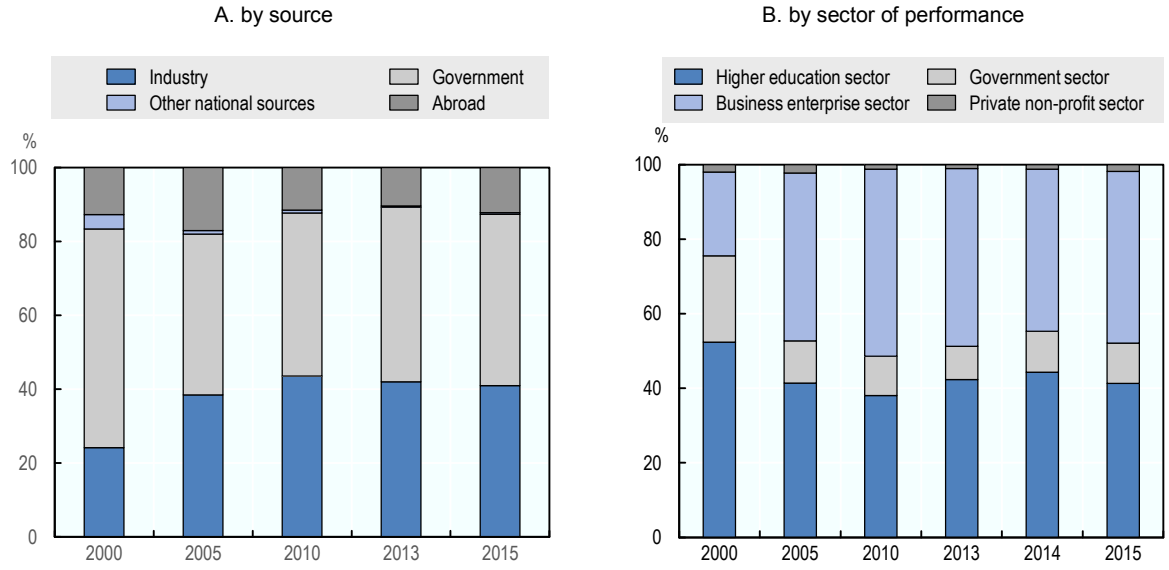
StatLink http://dx.doi.org/10.1787/888933654978

ERC estimates that in 2014, 90% of government funding was directed to the higher education and government sectors and 10% was used to fund R&D in the private sector (business, private non-profit). Most private expenditures fund research activities in the private sector and only 6% is used to procure R&D services from universities and public research institutions (Koppel, 2016).

As the Estonian economy is dominated by microenterprises and with low industrial concentration in most sectors, the majority of firms lack the capacity to finance or perform R&D. The Estonian R&D system is more dependent on public funds than the OECD or EU average. However, as BERD increased in the last decade, the percentage of Estonian GERD financed by the industry increased from 24% in 2000 to 41% in

2015 (Figure 7.14.A). The growing importance of the role of businesses in the Estonian R&D system can be observed also from the increasing share of R&D carried out in business enterprises. In the early 2000s, 22.5% of expenditures concerned R&D in businesses, while higher education counted for over half of GERD (Figure 7.14.B). In over a decade, the share of expenditures on R&D made in the business sector almost doubled to reach 46% in 2016.

Figure 7.14. Estonian GERD financing by source and sector of performance, selected years



Source: OECD (2017b), Main science and technology indicators, http://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB (accessed 16 June 2017).

StatLink http://dx.doi.org/10.1787/888933654997

Public incentives to private investment in agricultural R&D

In Estonia, the main incentives for private investments in R&D are different research grants and supports for innovation. Smart specialisation growth areas are prioritised in innovation support measures (e.g. competence centres, applied research in smart specialisation growth areas, applied research in smart specialisation growth areas).

Different tax incentives are common instruments for encouraging R&D investments. Most commonly used R&D tax incentives aim at reducing corporate income tax liability of the company incurring R&D expenses, and labour tax incentives (Staehr, 2010). Estonia does not employ tax incentives specifically directed at R&D, and thus 100% of government support to BERD is direct funding. However, although the measure is not specifically aimed at R&D investments, they are supported by the exemption from taxation of all reinvested business profits since 2000. Business profits are taxed when they are distributed (e.g. as dividends) or transferred abroad (Sepp and Wrobel, 2011). On the negative side, there is no incentive to invest in R&D as opposed to any other investment opportunity that may provide faster profits (Staehr, 2010).

Role of public procurement and other "pull mechanisms" in research funding

Pull-mechanisms, such as innovation prizes, reward research output tax credits on sales, or patent buyouts, reward successful innovations *ex post*, while push mechanisms fund potential innovations *ex ante* (OECD, 2013; Rietzke, 2015).

Estonian innovation policy has so far used mostly supply-side policy instruments or "push mechanisms" in the form of research and innovation grants (Romanainen et al., 2014b). The main focus of RDI policy has been on strengthening the systemic linkages by focusing on supply-side measures, such as R&D

infrastructure, support to Competence Centres and centres of excellence and provision of R&D grants (Lember and Kalvet, 2014).

The previous Estonian RDI strategy Knowledge-based Estonia 2007-13 (MER, 2007) emphasised that the state must be "a role model and a competent innovation consumer, whose procurements significantly emphasise innovativeness, quality and good design". It also outlined the need for public procurements to be more diversified, and the importance of the participation of enterprise offering innovative products and services. The importance of the public sector as "a smart customer, ensuring that in public procurements as much freedom as possible is left for offering innovation solutions" is also one of the principles for the development of information society expressed in the Estonian Information Society Strategy 2013 (MEAC, 2006) as well as the follow-up strategy Digital Agenda 2020 (MEAC, 2013b). However, those ideas have been mostly left unimplemented and public procurements have not been systematically used for facilitating innovation (Lember and Kalvet, 2012).

So far public procurement has been successfully applied in ICT and moderately in the defence sector (Lember and Kalvet, 2014). There are also some examples of innovation procurement initiatives supporting usage of local energy resources and waste collection; however, these mostly reflect the impact of EU-level policies (Roolaht, 2012). A feasibility study for smart procurement ordered by MEAC recommended focusing on e-government (ICT), e-health (ICT and health technologies) and construction (efficient use of resources) as there is already sufficient competence, readiness and knowledge in these sectors for stimulating demand (Eljas-Taal, 2014).

Estonian public procurements are registered in the Public Procurement Registry. However, the registry does not distinguish whether the procurement was innovative or not, and this makes it impossible to track procurement of innovation (Romanainen et al., 2014b).

A specific support measure for smart procurement to support innovation has been planned for the period 2014-20, and will be managed by Enterprise Estonia. EUR 20 million are budgeted, with a maximum of EUR 500 000 per application and 50% of self-financing (EE, 2016b). The measure is targeted to the public sector organising tenders and to enterprises offering innovative solutions. The aim is to improve the public sectors' ability for procuring innovative solutions as well as to support enterprises' abilities to develop new products and services (EE, 2016c).

7.4. 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 (OECD, 2015).

Policy regarding access to knowledge

Public access to scientific information is not a new phenomenon in Estonia. For example, the majority of Estonian scientific journals have been *de facto* open to the public since the electronic versions of articles emerged more than ten years ago. Research libraries have actively promoted open-access by organising traditional workshops and information days in the framework of the international Open Access Week.

Estonia is following the concept of the European Research Area (ERA), for which ensuring open access to knowledge, optimal knowledge circulation and transfer through the application of digital ERA is a priority. The underlying principle is to make research data, created or obtained with public funding publicly accessible. Plans related to the creation, preservation and dissemination are becoming an integral part of research projects (ERC, 2015c).

Estonia is preparing policy recommendations on open science, with a view to create a common framework for handling open science in Estonia. The document will define the strategic objectives until 2025, setting separate objectives for scientific publications and research data:

- Open access to scientific publications: The research community knows and accepts the principles of open science and open access. Scientific articles published with the help of national funding are freely accessible to the public one year after their first publication at the latest, whereas at least half of the articles become immediately and permanently available. All publicly funded scientific journals, and scientific journals published in Estonia, adhere to the principles of open access and a free content license.
- Open access to research data: The research community knows and accepts the principles of open science and open access. Research data resulting from nationally supported research are freely accessible and reusable. Research data are stored in trusted and open repositories and are made available as soon as possible (ERC, 2015c).

Farmers have free access to research information on the website of the Estonian Agricultural and Rural Advisory Service (www.pikk.ee). This page includes agriculture-related applied research reports, collections of national variety tests, publications, articles, presentations, dissertations, defended theses and project descriptions issued by different agriculture-related R&D institutions.

Access to R&D material

From 2013 onwards, a prerequisite for receiving competitive research funding in Estonia — institutional research funding (IRF) and personal research funding (PRF) — is open access. Both IRF and PRF allow to cover the article processing charges of the open-access articles form the grant budget, but this practice is so far not very widely spread (ERC, 2015c).

In the last decade Estonian scientists have published articles in more than 4 200 different journals, 355 of which (8%) are the so-called gold open access.[14] As of the end of 2015, Estonian scientific publishers issued 46 peer-reviewed scientific journals and nearly three-quarters of them are *de facto* gold open access. Out of the 11 Estonian scientific journals, which are listed in the Thomson Reuters Web of Science, nine are open access journals. Only part of the Estonian open-access journals have clearly defined copyright ownership and licensing conditions, and not all of them are properly reflected in the Directory of Open Access Journals (DOAJ) list and the SHERPA/ROMEO register (ERC, 2015c).

The status of research data has not been legally regulated in Estonia. The MEAC has compiled the first nation-wide policy document on open data, "The Green Paper on Open Data". However, in this document the topics related to research data remain in the background. Infrastructure for the preservation of scientific data and for making them available have already been or are still being created, including the "Natural History Archives and Information Network (NATARC)", the Estonian Language Resource Centre, the Estonian Biocentre, the Estonian e-Repository and the Conservation of Collections (ERC, 2015c).

In 2014, Estonia joined the international consortium DataCite under the research infrastructures roadmap initiative. The consortium DataCite Estonia, which has the right to assign unique scientific data identifiers (DOI), was launched at the beginning of 2015. DataCite ensures the visibility and usability of the high-quality research resources created by affiliated research institutions. To date, a number of professional interfaces have been worked out and more than 500 000 data sets in Estonia have been allocated a DOI identifier, most of them via the biodiversity database PlutoF and research infrastructure roadmap NATARC. The Estonian State and the national research institutions are actively collaborating with a number of pan-European research infrastructures (ERC, 2015c).

In order to preserve biodiversity and promote sustainable agricultural production, genetic resources of agricultural crops are collected and preserved. Since 1999, Estonia has participated in the European Cooperative Programme for Plant Genetic Resources (ECPGR) as a full member (MRA, 2013a). In Estonia genetic resources of agricultural crops are collected and preserved by the following institutions:

- The Gene bank of the Estonian Crop Research Institute collects and preserves the genetic resources of cereals, legumes, oil crops, grasses and legumes, as well as vegetable genetic resources outside their natural habitat (seeds in *ex situ* gene bank). 2 800 accessions of 57 species are deposited in the gene bank.
- The Department of Biotechnology of the ECRI manages the collection of different potato and horticultural plant varieties and breeds and the conservation of their genetic resources as meristem plants in test tubes (*in vitro*). The collection includes 490 potato and 118 horticultural and decorative plant accessions.
- The Polli Horticultural Research Centre of the EMÜ collects and preserves genetic diversity and cultivar resources of fruit and berry crops of Estonian origin. The collection includes 1 145 items of 17 plant species, including 136 varieties bred in Estonia.
- The Botanical Gardens of the TU preserve medicinal herbs, aromatic and ornamental plants in *ex situ* collections. The collection contains 387 varieties of ornamental plants originating from Estonia, and 55 species of medicinal plants and herbs.
- The Department of Gene Technology of the TUT studies and describes plant material using molecular biology techniques.
- The Non-Governmental Organisation (NGO) Maadjas collects, preserves and exchanges threatened native breeds, plant seeds and plant material.

Intellectual property protection

Intellectual property rights (IPR) in the Estonian agricultural and food sector are related to industrial property, which includes: the rights to patent protected inventions, useful models, trademarks, the use of geographical indications and new plant varieties.

These IPRs are regulated by various laws.[15] The most important treaties are the Paris Convention for the Protection of Industrial Property (1883), the TRIPS Agreement, and the European Patent Convention (1973). Estonia has also joined the Madrid Agreement Concerning the International Registration of Marks Protocol (1989) and the Hague Agreement Concerning the International Registration of Industrial Designs (1925) (Hanson et al., 2015).

Protection documents valid in Estonia are patent certificates for invention and trademark registration certificates for utility models or geographical indication.

Patents

The Estonian Patent Office (EPO) is a government agency that operates in the Ministry of Justice and provides legal protection to patents, trademarks, utility models, industrial designs, geographical indications and topology of micro-switches (EPO, 2016). The Estonian Intellectual Property and Technology Transfer Centre (EIPTTC) offers a wide variety of intellectual property (IP) and technology transfer support services. For example, it performs IP studies, advises enterprises on IP issues, and provides training and education. EIPTTC conducts research on a variety of patent related issues, supports trademark and design search, and helps the entrepreneurs to make right decisions in the development and creation of IP in their enterprise (EIPTTC, 2016). In addition, patent attorneys provide legal services in the field of industrial property.

There are two important issues concerning IPR: time and territoriality. A registered trademark is valid for 10 years, a patent and a utility model for 20 years and the protection of geographical indications is perpetual. Territoriality is an important principle, which means that a patent registered in Estonia does not confer any rights in other countries (Hanson et al., 2015).

Over 1994-2013, 3.1% of registered patent and utility model applications submitted in Estonia were in the agricultural sector (mainly patents in plant breeding) and 2.9% in the food sector.

According to Patent Co-operation Treaty (PCT) statistics[16] during the period 2006-11, the number of patent applications from the Estonian agricultural sector was 31, accounting for a very small fraction of the global PCT patent applications. However, the PCT patent applications in agriculture and food sciences comprised 12% of Estonia's total patent applications, which is double the OECD average (Table 7.6). Most of these (10.3% of total Estonian applications) were in food sciences.

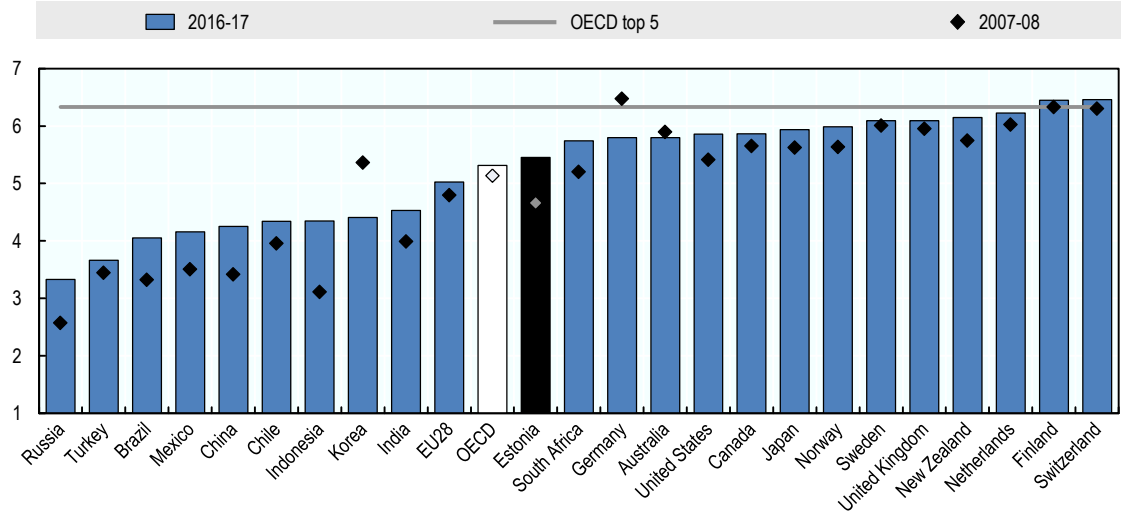
The total number of food and agriculture patents developed in cooperation with foreign partners was 15 in 2006-11, accounting for 0.039% of the total world agricultural joint patents. Joint food patents applications comprised 13.8% of the national total joint patents, and there were no joint patent applications in agricultural sciences. These figures were significantly below the OECD average (Table 7.7).

In addition to the size of the country, other reasons explain the relatively low number of patents in Estonia:

- Holding a patent requires large investments from the patent holder over a long period of time.
- After patenting, the patent holder has to see to the issues of marketing and selling (commercialisation), but the research community lacks adequate experience and knowledge, as well as the human, time and financial resources.
- The patent value of an invention is changing. The present trend is that inventions are immediately geared to production and, for example, high-tech inventions are patented.

In summary, an IPR system is in place in Estonia that ensures IP protection, although the number of Estonian agricultural patent applications is modest. According to the Intellectual Property Protection Index estimated by WEF, IP protection has increased in Estonia over the last decade, and is equivalent to the average of OECD countries and slightly higher than the average of EU28 countries (Figure 7.15).

Figure 7.15. WEF Intellectual Property Protection Index, 2007-08 and 2016-17



Countries are ranked according to 2016-17 levels.
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) for 2016-17.
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*, www.weforum.org/reports/the-global-competitiveness-report-2016-2017-1.

StatLink http://dx.doi.org/10.1787/888933655016

Plant breeding and IPR

The Estonian plant variety protection system was introduced in 1994. Plant breeding is regulated by the Plant Propagation and Plant Variety Rights Act and the Regulation of the MRA on the list of plant species the seed and propagating material of protected varieties of which may be grown in small quantities. Plant varieties entered in the Register of Plant Variety Rights remain under protection for 25 years, with the exception of vines and tree crops which remain under protection for 30 years (EIPTTC, 2016).

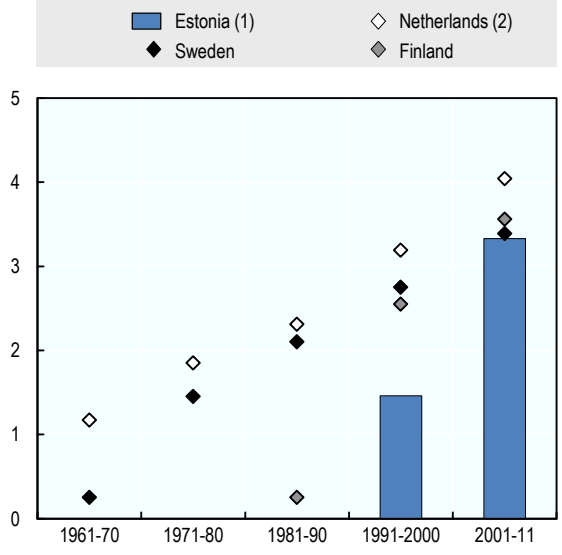
The principles for the EU plant variety protection system are laid down in Council Regulation (EC) No. 2100/94 on Community plant variety rights, and the EU and the EC Regulation No. 1768/95 on agricultural exemption (Rand and Ardel, 2010).

Estonia became a member of the International Union for the Protection of New Varieties of Plants (UPOV), which offers strengthened protection and improves the plant breeders' ability to recover their initial costs of variety breeding and development, and generate the funds necessary for further re-investment in this activity by signing the UPOV Convention 1991 Act in 2000 (UPOV, 2016). The Plant Variety Protection Index of Estonia is lower than in Finland and the Netherlands, mainly reflecting more recent participation (Figure 7.15).

Estonia is a member of the OECD Schemes for the Varietal Certification of Seed Moving in International Trade, which promotes the use of agriculture seed of consistently high quality. The OECD certification provides for official recognition of "quality-guaranteed" seed, thus facilitating international trade and contributing to the removal of technical trade barriers.[17]

Figure 7.16. Plant Variety Protection Index

Score 1-5 (best)



1. For Estonia, data prior to 1991 are not available.
2. For Finland, data prior to 1981 are not available.

Source: Campi and Nuvolari (2013), "Intellectual property protection in plan varieties: A new worldwide index (1961-2011)", http://hdl.handle.net/10419/89567.

StatLink http://dx.doi.org/10.1787/888933655035

The registration and cataloguing of varieties, and organising their protection are the responsibilities of the Agricultural Board (AB, 2015). The AB keeps a record of the varieties under protection in a catalogue, which is publicly available on the AB website (Rand and Ardel, 2010).

The programme "Genetic Resources for Food and Agriculture 2014-20" has been introduced, whose main objective is to grant the collection, preservation and study of the plant genetic resources for food and agriculture of Estonian origin as a fund for variety and species diversity, thereby creating conditions for sustainable development. The key activities for achieving the objectives include the collection of genetic resources of agricultural and food crops, management of collections, international cooperation, promotion, organisation and communication (MRA, 2008).

Co-operation between public and private actors

Investments in R&D have created a modern and attractive environment for research in Estonia and have strengthened the research community. Cooperation between R&D organisations is comparatively good, but collaboration between private companies and R&D institutions is low, as pointed out in current and previous national R&D strategies.[18] Lack of public-private collaboration can be explained by the low research capacity of Estonian SMEs and the disproportionate public funding of basic research compared to applied research and technological development. In addition, there are a few domestic capital-based industries in Estonia and as to product development, branches of foreign companies predominantly get their R&D support from the parent company (Vooremäe, 2011). The fact that most support for conducting studies and trials (product development), carrying out analysis, as well as providing consulting services and training, is project based may also cause problems for cooperation between academia and enterprises (EMÜ, 2010). Lack of public-private collaboration has not facilitated the emergence of economically viable end-results of research projects (MER, 2014b). As indicated below, efforts were made for the 2014-20 programming period to improve the situation (MRA, 2015a).

The main form of collaboration is through participation of private sector representatives in the different advisory councils that contribute to the formulation of financing policies in Estonia, for example in RDC and the Research Policy Committee. The Council of Agricultural Sciences at the MRA includes representatives of farmers' organisations. At present, out of 14 members (including chair and vice-chair) of the Council of Agricultural Sciences, three members are representatives of the sector (representing the Estonian Chamber of Agriculture and Commerce, the Central Union of Estonian Farmers, and the Estonian Farmers Federation); one represents the advisory system (RDF); four represent the MRA, and six represent R&D institutions (MRA, 2016a).

Different financing measures are available in Estonia to facilitate research collaboration between public and private actors, including centres of excellence, competence centres, regional competence centres, clusters, innovation and development vouchers; as well as applied research programmes on smart specialisation growth areas. They also facilitate international cooperation.

The **Competence Centre** (CC) programme administered and supported by Enterprise Estonia was launched in 2004 to create a link between research and entrepreneurship. In addition, Enterprise Estonia administers a separate programme for **regional competence centres** since 2009 (Box 7.3).

At present, there are six CCs in Estonia, including three in the agricultural and food sector (MRA, 2016e). There is also a regional CC and a Centre of Excellence with activities related to plants:

- The Competence Centre of Food and Fermentation Technologies,[19] deals mainly with research on the metabolism of lactic acid bacteria and yeasts.
- The Bio-Competence Centre of Healthy Dairy Products, LLC[20] has five partners and its activities encompass the whole chain, from cattle breeding, nutrition and dairy technology to functional food. In cooperation with universities (EMÜ, TU), the CC has registered 14 patents.
- The Competence Centre on Health Technologies[21] is a research and technology organisation focused on applied research and product development in personalised medicine, drug development and reproductive medicine, both in human and veterinary medicine.
- PlantValor is a regional Competence Centre for Knowledge-Based Health Goods and Natural Products that belongs to the EMÜ. The Centre focuses on the sustainable use of plant material in

food and non-food products by raising the quality, functionality and storing properties of the plant material (PlantValor, 2016).

- The Centre of Excellence ENVIRON is a consortium led by the EMÜ, bringing together five leading research groups from the EMÜ, TU and TUT. The interdisciplinary research goal of ENVIRON is to study how plants and ecosystems cope with and adjust to stress induced by changing environmental conditions. The research results form a basis for the sustainable management of Estonian natural resources in forestry crop production in view of the future climate.

Box 7.3. Competence Centres in Estonia

Competence Centres (CCs) are private entities established by a consortium of R&D institutions and enterprises. CCs are research institutions oriented at long-term cooperation between academia, industry and the public sector, and focusing on applied research (Arnold et al., 2008). They can be regarded to some extent as public-private Partnerships (PPPs).

CCs are involved in multiple activities: pooling of knowledge, creation of new knowledge by performing different types of research, training and dissemination of knowledge and networking. CCs are involved in developing new technologies and looking for new and innovative technological solutions in the partners' key areas. Some CCs are also related to innovation clusters and the European Innovation Partnerships (EIP).

In addition to supporting research for the development of new and high value-added products, services and technologies, the measure promotes technology transfer and mobility of researchers among research and private business organisations and provides research opportunities for graduate students (MER, 2013). From 2007-13 CCs created 350 jobs (Pakkas, 2014). However, research jobs in CCs were often part-time and in some centres, teams were fragmented across high number of part-time contributors (Arnold et al., 2008).

The CC programme implemented by Enterprise Estonia was launched in 2004 and is directed at cooperation in the fields of smart specialisation. The maximum share of public support for the period 2014-20 is 60% and EUR 7 million per centre (EE, 2016a). The total budget for CCs over 2015-22 is EUR 40 million and six centres have received funding from Enterprise Estonia during this period, including three agriculture-related ones (EE, 2016a). In comparison, five CCs received a total of EUR 11.8 million of public support in 2004-08, and in 2009-15 eight CCs received EUR 57.7 million (Pakkas, 2014). After the 2014-20 programming period, Enterprise Estonia will no longer support CCs, which will have to find their own resources.

The CC programme has provided an overall positive experience for increasing R&D collaboration between private enterprises and public organisations. While the first financing period of 2004-08 was a first learning experience for establishing common interests and long-term cooperation; the second period of 2009-15 was characterised by the development of human resources, facilities and organisational structures; and a considerable increase in the number of private partners as well as their growing capacities and funding resources for implementing the R&D results (Pakkas, 2014). The number of private businesses participating as partners grew from 27 in 2004-08 to 100 in 2009-15, while their financial contribution increased from EUR 5.8 million to EUR 25.4 million (Pakkas, 2014). The programme strengthened links between universities and industry, encouraged concentration of research and educational resources in the smart specialisation growth areas, and increased the research output and R&D capabilities of partners (Arnold et al., 2008).

Enterprise Estonia also administers a separate programme for regional competence centres since 2009. The aim of the regional centres is to support regional entrepreneurship and labour market development through cooperation between enterprises and R&D institutions and to create conditions for knowledge-intensive entrepreneurship outside the areas of two largest cities in order to increase regional competitiveness (EE, 2016a). The maximum support per centre for 2009-14 was EUR 3.2 million and the maximum share of public subsidy for an application was 85% of eligible costs (EE, 2016a).

Issues with CC implementation included the bureaucracy, shortcomings in inter-ministerial coordination regarding the monitoring of the CCs, and conflicts over ownership of results (Huisman et al., 2007). The latter issue has been amplified by the fact that many employees worked part-time in university and part-time in CC. In addition, centres research output remained below the level initially expected (Arnold et al., 2008).

The sustainability of the CCs may cause problems as CCs do not have enough projects to cover their fixed costs and funding is not stable. Applied research can be financed from two sources: contributions from businesses, and support from various support measures, which require the recipient's own contributions. Corporate-funded R&D activities are primarily carried out in global corporate groups. It is very difficult for domestically owned companies to get funding. It has been suggested that an outreaching CC-wide organisation could offer CCs marketing and generic services. The overall objective is that the competence centres receiving support in the period of 2015-22 should grow strong enough to manage without public support from EE after the end of the programming period (Pakkas, 2014).

The objective of these centres is, by integrating the knowledge and experience of enterprises and R&D institutions, to create new food- and feedstuffs with high export potential, to improve the quality, functionality and storage characteristics of food and to develop new technologies. One of the aims of applying the research in practice is to make the production and processing of raw materials more efficient. To achieve this, R&D activities cover the whole food chain: from animal breeding, feeding and keeping, to the creation of health

promoting food products and conducting clinical and physiological trials to prove their health promoting qualities (BioCC, 2016; TBP, 2015a).

The **Innovation voucher** programme provides SMEs with grants (maximum EUR 4 000, maximum share of support 80%) for cooperating with a higher education institute, test laboratory, or intellectual property experts to develop innovative solutions for development obstacles, carry out tests with new materials, gather knowledge on technologies, and conduct studies in intellectual property databases (EE, 2016b). 884 innovation vouchers were financed with the total amount of EUR 4.55 million in the period 2008-12 (MER, 2013). At present, the data on the funded innovation vouchers does not specify the field of activity; and so it is not possible to distinguish the number of innovation vouchers connected with the AIS without a separate survey.

The total budget for this programme increased to EUR 10 million for the 2014-20 period, and an additional measure was introduced offering larger grants for preliminary research in SMEs, whose development ideas need advanced professional know-how (EE, 2016c, OECD, 2017a): **Development vouchers** offer grants of maximum EUR 20 000 per voucher, maximum share of support 70% of total costs. Four enterprises out of the first 26, who received first development vouchers in 2015 (EE, 2016d), are connected with food and agricultural technologies, and vouchers are used for developing malt processing technology, food packaging designs, developing greenhouse and smart gardening technologies.

The application of innovation vouchers has contributed to enhanced cooperation between academia (including the EMÜ) and industry in terms of putting knowledge and know-how into practice. Innovation vouchers give SMEs access to research and innovation services. They can, in collaboration with universities, testing laboratories and intellectual property experts, develop innovative solutions to obstacles, experiment with new materials, gathering information on innovative technologies, and research intellectual property databases. According to a recent evaluation, the innovation voucher scheme has proved successful and, as an independent measure, received relatively positive feedback. However, only in a few cases has this short-term and small-scale scheme developed into a longer-term and more systematic collaboration with universities (Lember et al., 2015).

Enterprise Estonia also implements a **cluster programme**, under which 20 clusters and 49 pre-projects for preparation for establishing a cluster received a total of EUR 10.4 million during the period of 2008-12 (Mihkelson et al., 2013). The maximum share of public financing was respectively 70% and 75% of total project costs. The EMÜ is one of the partners of the Estonian Waste Recycling Cluster (Jäätmete Taaskasutusklaster 2016) and the pre-project for establishing Estonian Organic clusters (Eesti Maheklaster 2016). Other projects connected food and agriculture were pre-projects for a milk cluster, a soy cluster, and a food cluster in southern Estonia (EE, 2016d).

Agricultural enterprises were not eligible for subsidies under this cluster programme implemented by Enterprise Estonia, but they are under the cooperation measure of the Estonian RDP 2014-20 (see below).

In the programming period 2014-20, Estonia has developed additional measures specifically addressing cooperation between R&D institutions and enterprises in the smart specialisation growth areas. Those include:

- **NUTIKAS**, a measure for applied research in smart specialisation growth areas. The funding of EUR 41 million is allocated to businesses for commissioning necessary applied research or product development projects from R&D institutions (ERC, 2016d). The self-financing rate depends on the size of enterprise. In applied research, the maximum public support is 70% of eligible costs for small enterprises, 60% for medium-sized enterprises and 50% for large enterprises. For product development, public support rates are 45%, 35% and 25% respectively (SA Archimedes 2016).
- **NUTIPRO** with EUR 10 million specifically addressing large-scale projects. The programme supports R&D initiatives with large-scale impact and coordination of applied research projects and targets R&D institutions and enterprises (MER, 2016a).

A separate programme, **RITA**, has also been developed for 2014-20 to support more efficient collaboration between public sector decision makers and R&D institutions. EUR 28.1 million will be allocated

to support the government in strategic management of research and the capacity of R&D institutions in carrying out social- relevant research (MER, 2016a; ERC, 2016e). The ministries will select topics for applied research on the basis of needs of their governance area. The applied research will be carried out by R&D institutions (ERC, 2016e). This programme will finance a study on the prospects of the bioeconomy in Estonia

EU programmes also emphasise research collaboration as Estonian national horizontal and sectoral strategies and plans. Horizon 2020, previous **EU Framework Programmes for Research**, other EU programmes as well as specific programmes provide a variety of measures open to researchers in the private and public sectors (described also in the sub-chapter on International cooperation). Foreign contracts have been also an important source of financing.

In the EU 7th Framework Programme (FP7) 2007-13, there were 541 Estonian participants in 451 successful applications receiving EUR 88.6 million. The EMÜ took part in 12 projects (in thematic areas "Food, agriculture and fisheries, biotechnology" and "Environment"), and the Estonian Crop Breeding Institute in two projects. Twenty-nine successful projects with 30 Estonian participants belonged to the FP7 thematic areas "Food, agriculture and fisheries, biotechnology" (6.4% of successful applications). Out of those 30 participants eight were higher and secondary education institutes; eight private for profit organisations, six public bodies, four research organisations, four other organisations. The successful applications received EUR 2.6 million and the success rate of applications was 25%. The eight private for profit organisations were all SMEs participating in 26.7% of all successful projects in "Food, agriculture and fisheries, biotechnology". SME's overall participation rate in successful projects was 33%, however, it varied strongly by area, for example, SMEs participated in 8.7% of successful projects in the area of "Environment". The MRA was the most active participant among the Estonian public bodies (ERA-NET projects), followed by the MER (mostly research infrastructure projects). The EMÜ was the most active Estonian participant in "Food, agriculture and fisheries, biotechnology" (Must et al., 2014). Moreover, out of three European Research Council individual grants received by Estonian researchers, one — "Stress-Induced Plant Volatiles in Biosphere-Atmosphere System" (EUR 2.26 million for 2013-18) — was awarded to EMÜ's Professor Ülo Niinemets (EC, 2016).

As of October 2016, Estonia participated in 170 successful applications in Horizon 2020 (ERC, 2016e). Fifteen successful applications (9% of Estonian successful applications so far) belong to the thematic section "Food Security, Sustainable Agriculture and Forestry, Marine, Maritime and Inland Water Research and the Bioeconomy". The successful participants included five private sector enterprises, five universities, the MRA, a state agency, two non-profit organisations; the total amount of EU funding for those successful Estonian applicants was EUR 2.6 million.

While both private and public actors can participate jointly to projects funded by EU Framework programmes for research, European Union has also developed programmes that encourage research partnerships more specifically. **EU Joint Programming Initiatives (JPI)** fund partnerships between public and private researchers, with one being dedicated to Agriculture, Food Security and Climate Change (JPI-FACCE). The MRA represents Estonia at the FACCE-JPI, that sets the strategic priorities for trans-disciplinary and innovative European research on agriculture, food security and climate change (MRA, 2016b). The FACCE-JPI provides a framework for the alignment of national programmes and joint research efforts, under five core themes: sustainable food security under climate change; environmentally sustainable growth and intensification of agricultural systems under current and future climate and resource availability; assessing and reducing trade-offs between food production, biodiversity and ecosystem services; adaptation to climate change; greenhouse gas mitigation (FACCE-JPI, 2016).

The European Innovation Partnerships (EIP) bring together all relevant actors across the whole research and innovation chain, at EU, national and regional levels, in order to: 1) step up research and development efforts; 2) coordinate investments in demonstration and pilots; 3) anticipate and fast-track any necessary regulation and standards; and 4) mobilise "demand" in particular through better coordinated public procurement to ensure that any breakthroughs are quickly brought to market. One of the EIPs concerns agricultural sustainability and productivity (EIP-AGRI). The RDP measure "Co-operation" (16) can fund its networking activities (Box 6.4). It includes the sub-measure "Development of new products, processes and

technologies", which provides support to innovation cooperation, such as EIP operational groups; as of 2017, 22 cooperation projects were being funded. Innovation cooperation is supported also by another RDP sub-measure – the Innovation clusters sub-measure. By June 2017 six innovation clusters had been approved for financing (ARIB, 2017):

- Dairy Cluster.
- Estonian Field Crops Innovation Cluster.
- Horticulture Cluster.
- Organic Farming Cluster.
- NGO Liivimaa Lihaveis (Beef Cattle Cluster).
- Field Crops Cluster.

Agriculture-specific measures facilitating cooperation and knowledge flow

Some agricultural policy measures support specifically research cooperation and knowledge transfer in the food, agriculture and forestry sector. Innovation is an important priority of the Estonian RDP 2014-20. One of its objectives — functioning cooperation, timely research and development, and knowledge transfer between the manufacturer, the processor, the adviser and the researcher — is also aimed at innovation. The main focus is to enhance cooperation between the various parties (producers, consultants, academics), and thus applying the research results into practice. Three measures in particular contribute to this objective: knowledge transfer and information (budget of EUR 12 million), extension services (budget of EUR 8.6 million) and cooperation (budget of EUR 18.7 million) (MRA, 2016d).

The measure "Knowledge transfer and information actions" offers support for:

- The organisation of one- or multi-day training sessions allowing the acquisition and upgrading of vocational, occupational or professional knowledge and skills, as well as retraining;
- The organisation of presentation and outreach activities introducing already existing innovative technologies and modes of action or production. Outreach activities arranged to inform target groups on the topics relevant to their work are also supported;
- The organisation of visits to companies and workshops focusing on raising environmental awareness in agriculture and forestry, production methods or technologies, the diversification of agricultural production, and short supply chains;
- The publication of training and teaching materials;
- The organisation of long-term training programmes (duration of up to seven years), which combines all the above-mentioned activities; and
- The following long-term training programmes are being prepared: plant cultivation, livestock farming, organic farming, horticulture, food safety, cooperation and agricultural policy (MRA, 2015b).

The measure "Advisory services, farm management and farm relief services" offers support to farm advisory services for delivering individual advice in various areas including sustainable plant protection and household or enterprise management, and for cooperation, governance of business processes or technologies, management structure, market analyses or work organisation analysis, strategic planning and consultancy on the introduction of amendments. The Estonian advisory system is described in the following section on innovation adoption.

The "Co-operation" measure supports co-operation approaches among different actors in the union agriculture sector, forestry sector and food chain and with other actors that contribute to achieving the

objectives and priorities of rural development policy, including producer groups, cooperatives and inter-branch organisations. The measure supports:

- Innovation clusters: the clusters that have drawn up a four-year action plan for the development of new products, processes or technology, small business collaboration, diversification of agricultural activities, collaboration between small-scale enterprises, etc. are supported. The action plan includes the division of tasks concerning fostering innovation between the members of the cluster. The activities in the action plan must be geared towards the practical needs of the company.
- Short supply chains and the development of local markets: promotion activities such as the organisation and participation in exhibitions, competitions, fairs, investments into equipment necessary for product distribution, Information Technology (IT) solutions, etc. are supported.
- The development of new products, practices, processes and technologies: the aim is to support individual projects, which promote cooperation and develop innovation, especially in the agriculture, food and forestry sectors, and solve specific producer- and processor-related challenges (MRA, 2015b). These projects can be developed as part of the EIP-AGRI, the measure supporting the activities of EIP Operational Groups.[22]

The interest for the sub-measure of innovation clusters has been high: ten action plans for the total sum of EUR 7.5 million were submitted in the first call in 2015. Those include three for crop production and processing clusters, two for meat production and processing, and two for organic production and processing clusters; one application for horticultural production and processing; milk production and processing; and other agricultural activities each (ARIB, 2016). However, only two applications — for a milk and a crop production and processing cluster — received financing. Competition for the sub-measure "Development of new products, processes and technologies" has also been very high.

Investment measures, which support different technologies, contribute to innovation indirectly, thereby facilitating the introduction of different innovation into production. Innovation is at the heart of LEADER 'local development' measure (CLLD), which endeavours to foster finding innovative solutions and their application. To this end, the local action groups should also describe innovative elements in the strategies they are compiling. In addition to that, the LEADER programme focuses on how to take advantage of local resources for the development of the local business and social environment, with an emphasis on innovative solutions (MRA, 2016d).

7.5. Facilitating the adoption of innovation in food and agriculture

The potential benefits of innovations are only realised if effectively implemented. 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. These services are critical to facilitate farmers' access to technology and knowledge and contribute to facilitate farmers' effective participation in innovation networks and ability to formulate their specific demands. It is also important to support the diffusion of innovation in small agri-food firms (OECD, 2015).

Knowledge transfer and advisory system

Several organisations provide policy advice and monitor developments in knowledge transfer and advisory services in the field of agriculture:

- **Council of Agricultural Sciences.** The Council advises the Minister of Rural Affairs on RDI activities within the scope of the MRA, and monitors the implementation of the RDI measures funded by the MRA.

- **Advisory Board of EMÜ.** The EMÜ Advisory Board links the university and society, whose members are appointed by the Council of the EMÜ, after hearing the opinion of the University. The term of office of the members of the Advisory Board is three years (EMÜ, 2016a).
- **Knowledge Transfer Council.** The Knowledge Transfer Council monitors the development of agricultural sciences, knowledge transfer and advisory services with regard to the producers' needs and environmental awareness. In addition, the Council keeps account of the implementation of the priorities of relevant national strategy documents and makes recommendations concerning the implementation of the Estonian RDP 2014-20 knowledge transfer and consultancy measures. The Council comprises of representatives of the MRA and the MER, farmers' associations and agricultural producers and farmers (MRA, 2016c).
- **The Consultative Council of the Rural Development Foundation** (RDF). The RDF Consultative Council is an advisory body to the RDF in all matters concerning advisory services. The representatives of farmers, processors of agricultural products, research and development institutions and the MRA belong to the Council. The activities of the Council are aimed at attaining the overall objective of advisory services, which is to develop a sustainable agricultural and rural economy in Estonia through providing advice (RDF, 2016).

Education institutions offer co-ordinated and regulated knowledge transfer and promotion services, including training. These institutions may be universities, vocational schools, or associations of producers. In 2007-13, universities and R&D organisations that had their own knowledge and/or technology transfer departments, played a more active role in knowledge production and they were highly ranked among the farmers and food processors (EMÜ, 2012). The EMÜ, the ARC (mainly environmental-education training) and the ECRI have been among the most active trainers in agriculture and the food industry and they have provided training all over Estonia. Producer associations have also played a significant role in knowledge transfer by arranging training activities at the municipal and county levels.

The **Advisory Centre of RDF** also provides co-ordinated and regulated advisory services to farmers and rural entrepreneurs. Local contact points of the Advisory Centre are located in every county of Estonia, which give free information on the consultancy services on offer. It is also possible to order advisory services.

In the last 25 years, the advisory system has been reformed and has changed hands several times, which has hindered the natural development of the system (Box 7.4). The performance of advisory centres in 2007-14 indicated that cooperation between the coordinating advisory centre and research and development organisations was chaotic. It was difficult for individual advisory centres to employ advisors in the new fields that are important for the state, and regions where the number of agricultural producers are small. Therefore, the aim of the recent reform was to create a common countrywide agricultural and rural economy advisory organisation that would assure coordination of information and cooperation with interested parties, supportive services to advisors, and that would take care of more even workload of individual advisors. The development of services is also concentrating on facilitating access to advice by the target group, improving the relevance of advice.

Public funding for the Estonian advisory system is increasingly channelled through RDP measures (Figure 7.17). Significant changes were introduced for the programming period 2014-20, as outlined in Table 7.4. They include the introduction of differentiated support rates by type of advice, higher annual support for RDP measures, and advisory services development being funded by own revenues rather than the State Budget. Moreover, a new measure "Improving knowledge transfer and innovation in the agricultural and forestry sector and rural areas" offers support to farm advisory services for the delivery of advice to farmers and for advisors to acquire and develop new vocational, occupational and/or professional knowledge, skills and competences, as well as for retraining. The measure supports the services of a consultant or a mentor, as well as meeting costs (MRA, 2016c). A farmer may be supported with extension services for up to EUR 3 000 per calendar year (MRA, 2016d).

The farmers who applied for support from the sub-measures of the Estonian RDP 2007-13 Environmentally friendly management, Organic farming and Maintenance of semi-natural habitats, were

obliged, dependent on the sub-measure, to go through a certain number of seminars and training sessions regarding the environmentally friendly management, organic production or maintenance of semi-natural habitats, respectively. The same system is followed in the RDP 2014-20. Since horticultural enterprises were added to the list of businesses eligible for support for environmentally friendly management, it is compulsory for the horticultural entrepreneurs to undergo training on environmentally friendly management as well.

Large-scale farmers approach researchers directly. Constructive advice can also be obtained from farm inputs providers, but commercial interest may lead producers to pay unnecessary costs and result in an excessive burden on the environment. Larger cooperatives have their own advisers who try to generate more interest for advice among producers.

In addition, RDF local advisory centres, start-ups and operating businesses may get free advice from municipal development centres. The centres share information on funding opportunities and entrepreneurship. Novice entrepreneurs are supported in starting a business and compiling a business plan. Municipal development centres operate as a network in every county. Enterprise Estonia coordinates the activities of the network (CDCIS, 2016).

Table 7.4. Measures supporting the advisory system in the Estonian RDPs 2007-13 and 2014-20

2016 (Estonian RDP 2014-20)	2013 (Estonian RDP 2007-13)
The Estonian RDP 2014-20 introduced different support rates depending on the type of advice: Support for most advisory services, covering animal and plant production, and organic farming for example, covers 90% of the total fee (farmers and producers paying 10%); Support for advice on management issues and drawing up a business plan covers 50% of the total fee and support for mentoring covers the total cost (RDF, 2016).	In the Estonian RDP 2007-13, support covered 75-80% of the total cost of receiving advisory services.
For the period 2014-20, the government signed a contract with the RDF for delivering advisory services. RDF has 54 certified advisors.	The supported advisory services were provided by recognised advisory centres.
For the period 2014-20, support amounts to up to EUR 8.2 million, i.e. around EUR 1 million a year, depending on the amount of advisory services provided.	Annual RDP support amounted to around EUR 770 000.
The aim is to reach 1 000 advisory contracts a year (in 2016 the number of advisory contracts was 699). In case the number of advisory contracts is less than 90% of the set target, the amount of support will be decreased by 3%.	The number of advisory contracts varied between 950 and 1 050 per year.
The development of the advisory system will be covered by revenues from advisory activities (at least 10.1% will be used for developing the system and at least 72.1% will be paid to advisors).	For the development of the advisory system, EUR 547 000 were allocated annually from the state budget, including for covering information requests in regional centres (EUR 157 000), administration, costs of internet portal pikk.ee (EUR 158 000), marketing, development of advisory products, procurement of tools, start-up support for new advisors and internship (EUR 97 500).
A new RDP measure with a budget of EUR 400 000 supports the training of advisors. The number of certified advisors is 153, including 45 forestry advisors. Procurement for training will be carried out by ARIB.	EUR 50-65 000 per year were allocated in the State budget for the training of advisors and extension officers.
From 2014, advisors will mentor clients on the use of ARIB e-services. In 2016, 3 714 clients received mentoring, and 3 657 submitted application using ARIB e-services. Provision of advice on African Swine Fever continued (each pig farmer was directly contacted). End of the year, unused funds were directed to internship support for advisors.	EUR 50-70 000 per year (without administration expenses) were allocated in the state budget for short term consultations during the application period of area payments.

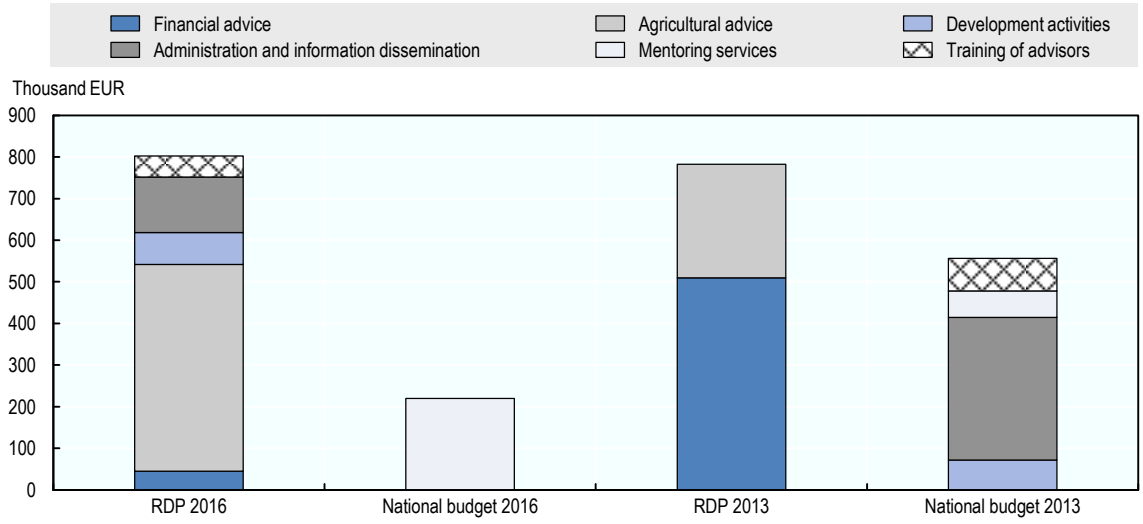
Source: MRA (2013b, 2016d).

As a supporting structure, the Estonian National Rural Network (NRN) also contributes to the knowledge and innovation transfer (RERC, 2016), including the promotion of innovation in agriculture. In order to achieve the set objectives, the NRN collects, aggregates and disseminates best practices, examples of networking and innovative approaches, helps to find partners (also for innovation clusters) and participates in the work of the Innovation Network. In 2012, the NRN issued the publication "Take notice of innovative agriculture" (NRN, 2013). In the framework of the activities of the NRN, the Agricultural Innovation Network (AIN) was established in 2014. AIN fosters co-operation between the manufacturer, processor, adviser and

researcher and the implementation of the European Innovation Partnership (EIP) operational groups' action plans and information clusters. The latter encourages a faster and wider transposition of innovative solutions into practice and contributes to the product, market, operational, organisational or personnel innovation is rural economy.

Particular attention should be paid to training, extension and advisory services that can facilitate the transfer and successful adoption of innovation. The potential benefits of innovations are only realised if effectively implemented.

Figure 7.17. Funding of advisory activities, 2013 and 2016



Source: MRA (2017), Compiled by MRA from various sources.

StatLink http://dx.doi.org/10.1787/888933655054

Box 7.4. Main steps in the development of the Estonian farm advisory system

- 1991: The creation of the first advisory services system, the Estonian Farmers' Federation (EFF), under the aegis of a project. The system joined the advisory stations of regional farmers' unions, two training centres working at the farmers' unions (Harju and Viljandi) and the Jäneda Training and Advisory Centre.
- 1993: A cooperation project between the Estonian Farmers' Federation and the Danish Agricultural Advisory Centre was launched to build up an advisory system based on the farmers' associations. The structure of the advisory system was interfaced to the structure of the farmers' union.
- 1994: Advisory unions were formed in Viljandi, Tartu, Jõgeva and Järva Counties with the financial support of the mentorship programmes run by the German and Estonian Ministries of Agriculture. The Estonian Association of Rural Consultants (Eesti Konsulentide Ühing) was founded.
- 1995: National advisory programme was launched. The foundation was laid for the contractual relationships between the consultant and the producer.
- 1997: On the initiative of the Estonian Association of Rural Consultants, a system for the certification of the rural consultants was worked out, which aimed to raise the quality of advice through checking the qualifications of the consultants.
- 2000: The "Rural Development and Agricultural Market Regulation Act" that defined such terms as "advisory support", "advisory support recipient" and "requirements set for the adviser and their attestation" was adopted.
- 2002: By means of public procurement information dissemination centres are opened by the farmers' or producers' associations at the county-levels. Rural Development Foundation (RDF) took over the information dissemination programme.

Box 7.4. Main steps in the development of the Estonian farm advisory system (cont.)

- 2003: The Estonian Chamber of Agriculture and Commerce took over from RDF the activities related to the dissemination of information (Agricultural Knowledge and Information System - AKIS).
- 2005: The Minister recognises the need to have advisory centres in every county, and they are used simultaneously as information dissemination centres. The Estonian Chamber of Agriculture and Commerce is held responsible for the harmonisation of the level of information offered by the advisory centres, for the training and continuing education of advisers and for the producers' needs analysis. Regular training and development activities are introduced.
- 2006: The Ministry of Agriculture in collaboration with the Estonian Chamber of Agriculture and Commerce start the reorganisation of the agricultural advisory system to simplify administration and make the provision of extension services more flexible.
- 2007: The Agricultural and Rural Advisory Coordinating Centre was established, which has the role of a mediator between the Ministry of Agriculture and the advisory centres and the advisers.
- 2010: RDF will once again take over the coordination of the advisory services.
- 2011: RDF recognised advisory centres, producer and professional organisations signed an Agreement for Joint Activity. The parties joined the agreement voluntarily to combine their efforts to ensure the availability of high-quality advice and act towards the common goal – the establishment of a nationwide single extension system by the year 2013. The organisations acceded to the agreement of joint action devised and adopted the Estonian agriculture and forestry advisory system development plan for 2012–20, together with the Action Plan for 2012–20. Agreement for Joint Activity ceased activity in 2013.
- 2014: The Ministry of Agriculture procured a public tender to find a provider of extension services
- 2015: The Ministry of Agriculture and Rural Development Foundation signed an authorisation agreement, which establishes that the Rural Development Foundation will offer subsidised agricultural and rural economic advisory services in 2015-21. The estimated volume of extension services for the entire duration of the programme (2015-21) is 1 000 advisory cases and 1 800 unique clients per year. The value of the contract is EUR 8.2 million. Provision of advisory services is financed from the budget of the Estonian RDP 2014-20. The Advisory Council is an integral part of the RDF and comprises of the representatives of farming and processing industry, research and development institutions and the Ministry of Rural Affairs. The activities of the Advisory Council are targeted at attaining the objectives of extension services, i.e. to develop sustainable agriculture and rural economy in Estonia. The structure of the advisory services is made up of the Estonian Agricultural and Rural Advisory Service (coordinator of the advisory system, support structure for advisers and mentors) and local contact points in every county, where free-of-charge information on the advisory services and the range, nature and price list of the advisory products can be found. It is also possible to order advisory services.

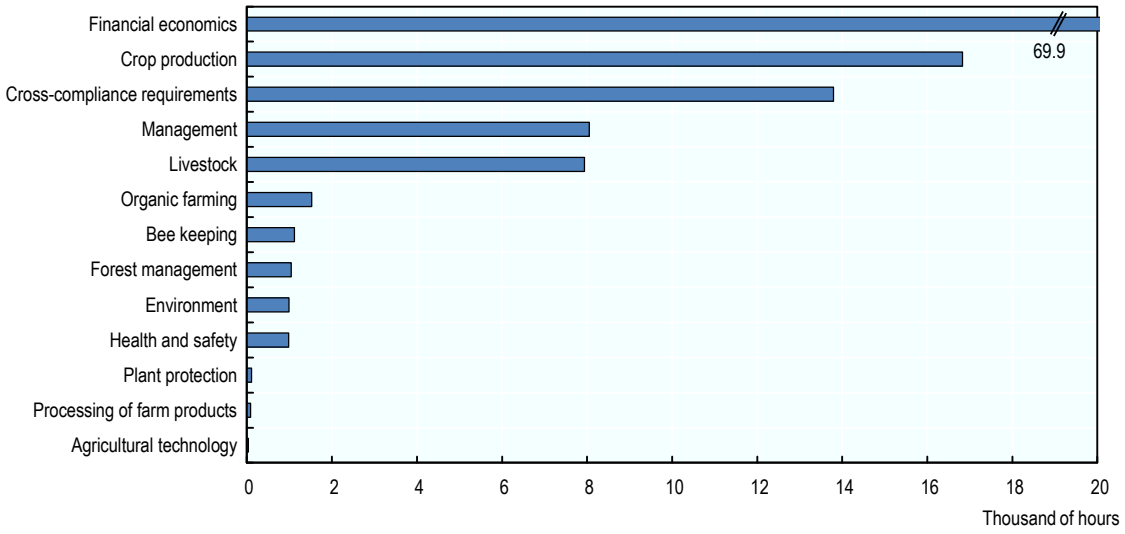
Source: Advisory service of the Rural Development Foundation, www.pikk.ee/.

Availability and use of extension services

One of the most important roles of the advisory services is the communication of research information to the manufacturer. In this area, the activities of the R&D organisations overlap, in part, with those of the advisory system, but these organisations have no direct links with advisory centres. Estonia is characterised by an open extension service market and today there is a wide range of extension services operating in Estonia, whereas each of them has their own peculiarities and target audience. Part of the research activities are carried out as direct contacts between companies and researchers and are not reflected in the statistics concerning agriculture (Vooremäe, 2011).

During the period 2008-15, 2 671 farmers used the supported extension service (CAP pillar 2 measure 114, Advisory services). The number of agricultural holdings totalled 19 186 in 2013, and a total of EUR 5.4 million was spent on extension. Entrepreneurs covered 25% of the sum, the rest constituted the EAFRD and the State's contribution. Advice on financial economics ranked first (Figure 7.18), but the advice was used to compile investment applications. In 2014−20, the emphasis is placed on principal production-related advice.

Figure 7.18. Supported advisory service capacity, 2008-15



Source: ARIB (2015), Estonian Agricultural Registers and Information Board (ARIB), www.pria.ee.

StatLink http://dx.doi.org/10.1787/888933655073

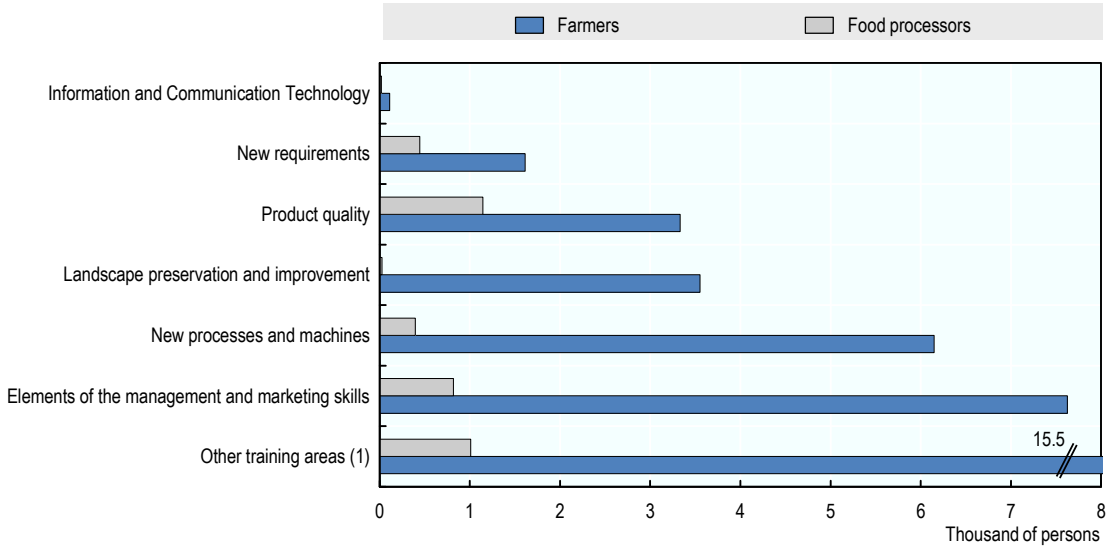
The reasons why so few farmers have used advisory services may be rooted in the bureaucracy related to the advisory support and the cost of the products and services. The farmer was paid the advisory support only after having received the service and submitting the corresponding application for payment to the paying agency (ARIB).

Dependent on their financial situation, the farmers and food processors may self-finance their training, or receive training from input salesmen, raw material suppliers or purchasing agents, whose activities are tied to the economic interests, or have received free training as supported from other EU and Estonian state funds. Farmers and food processors have been offered regulated training, dissemination and outreach activities in the Estonian RDP 2007-13 measure 111 (vocational training and information actions). This training measure was based on the initiative of trainers and sector representative organisations, thus it was a supply-side measure. The implementation of the measure can be considered very important for agricultural producers and food processors, as the training was in most cases free of charge, or training on a given topic was not provided elsewhere (EMÜ, 2012). With support from EAFRD and from the State budget in the amount of EUR 3.4 million, courses that were not part of regular agricultural education programmes were organised in 2008-15. The provided training courses were primarily meant for agricultural producers (Figure 7.19). Training was provided in other areas, such as livestock farming, organic farming, food hygiene and crop-production (EMÜ, 2013b).

In 2010-15, on average 21% of all persons employed in agriculture attended the training courses organised in the framework of measure 111, while the average participation rate in the food industry was around 3% of the employed sector (Figure 7.20).

Figure 7.19. Number of participants in training, 2008-15

Estonian RDP 2007-13, measure 111



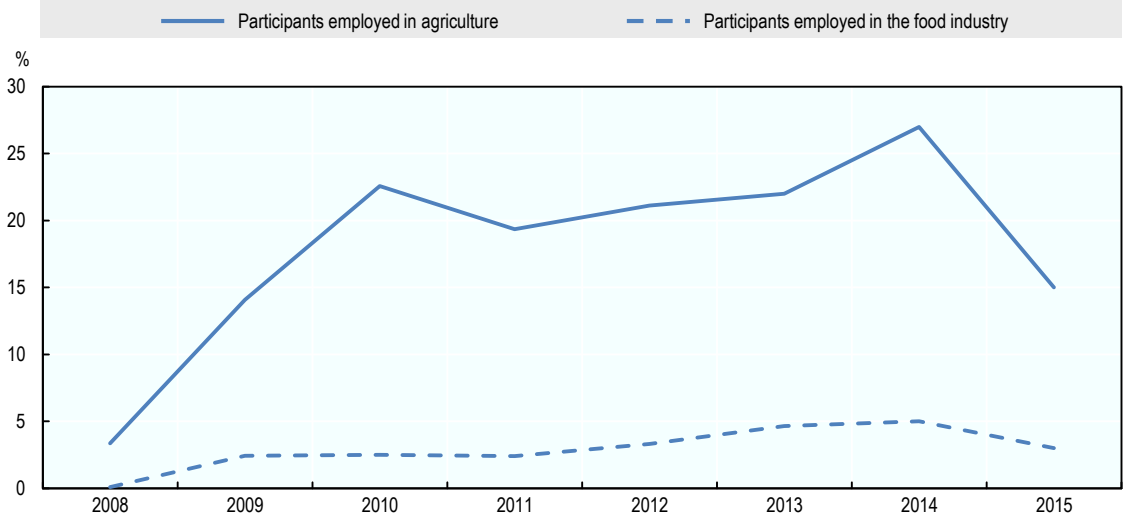
1. Other training areas include livestock farming, organic farming, food hygiene and crop-production.

Source: Estonian Agricultural Registers and Information Board (ARIB), 2015, http://www.pria.ee/.

StatLink http://dx.doi.org/10.1787/888933655092

Figure 7.20. Participants' share in the sector, 2008 to 2015

Estonian RDP 2007-13, measure 111



Source: EMÜ (2016c).

StatLink http://dx.doi.org/10.1787/888933655111

Programmes promoting the adoption of specific innovations

Strategic development documents handle innovation at a more general level. However, in a sense the implementation of the Estonian RDP 2007-13 within Pillar 2 of the CAP can be regarded as a programme fostering innovation. This programme offered training and advice for the agri-food industry sector. The investment measures of the same programme contributed to innovation, by supporting a variety of

technologies, thereby enabling the application of a variety of innovations into production or the production of new products.

Three investment measures in the same programme contributed directly to the implementation of environmentally friendly technologies (EMÜ, 2016b):

- "Bioenergy production" which the farmers used to purchase machinery or equipment for energy crops cultivation, biomass procession and bio-energy production. Preference was given to applications whose results promised a bigger effect on reducing CO_2 emissions. In the framework of this project, 79 enterprises invested EUR 17 million in bioenergy production.
- "Processing of agricultural products"[23] that food processors and feed manufacturers used mainly for the purchase, installation and application of equipment and technology necessary in food and feed production. In the application evaluation, higher scores were given for investment in environmental sustainability and innovativeness of the investment. Ninety-five companies used the support to invest a total of EUR 88 million into industry, almost all of whom launched a new product to market or introduced a new technology.
- "Livestock facilities". Preference was given to applicants who planned a bioenergy installation next to the livestock housing. These measures helped 269 farmers to invest EUR 182 million in livestock facilities.

In addition to RDP 2014-20 measures supporting innovation, a business development programme was launched in 2015, with the help of the Enterprise Estonia. It supports the elaborated development of the enterprise, better planning of activities, introduction of innovation and product development. Each company participating in the programme will launch new products and services that guarantee higher profitability. At least three-year-old enterprises with at least eight employees specialising in industrial or smart specialisation areas are eligible for the grant. The budget of the programme amounts to EUR 73 million, which come from the State and the ERDF (EE, 2016a).

7.6. R&D outcomes

Overall progress to create and adopt relevant innovations can be usefully monitored. Proxy measures, such as the number of patents of bibliographic citations, is available from international databases, including for primary agriculture and for upstream and downstream industries, and by type of innovation (OECD, 2015).

The number of patents 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 secrets, rather than patents, are frequently used for food processing innovations. In addition, numbers should be complemented with indicators of patent quality, which are being developed at OECD (2013). This is, however, an informative proxy. Estonia's patent results are discussed in the section on IP protection.

Estonia has a very small share in the world's agri-food publications, remaining below 0.2% (Table 7.5).

Based on the Scopus journal classifications Estonia's share of agricultural science publications amounted to 13.7% of all science publications and agricultural publications to 12.8% of all agricultural publications in 2007-12, which is significantly higher than the OECD average. However, in a global context and given the small size of Estonia, agricultural science publications and agricultural publications make up a very small share.

Scopus journal classifications show that Estonia's share of agricultural science citations amounted to 14% of all science citations and agricultural citations to 13.1% of all agricultural citations in 2007-12, which is significantly higher than the OECD countries' average (Table 7.5). However, in view of the small size of Estonia, Estonia's agricultural science citations and agricultural citations make up a very small share from the global perspective (0.9%).

Table 7.5. Agriculture and food R&D outcomes, 2007-12

	Denmark	**Estonia**	EU15 average	Finland	Germany	Latvia	Nether-lands	Sweden	**OECD average**
Agro-food specialisation: Agro-food science outputs as a share of country's total (%)									
Patents	11.3	**12.0**	6.9	3.4	4.4	3.1	8.8	3.6	**5.6**
Publications	10.2	**13.7**	8.4	9.7	6.4	6.9	6.9	7.9	**9.4**
Citations	8.7	**14.0**	10.8	9.3	16.9	8.3	6.4	20.4	**11.9**
Country's contribution to world agro-food science output (%)									
Patents	0.5	**0.02**	0.6	0.2	2.7	0.03	1.0	0.4	**0.7**
Publications	0.9	**0.13**	1.9	0.75	4.5	0.03	1.6	1.2	**2.0**
Citations	1.1	**1.0**	2.4	0.8	5.7	0.02	2.8	1.4	**2.4**

Source: OECD Patent Database, January 2014; SCImago. (2007). SJR — SCImago Journal & Country Rank, www.scimagojr.com (accessed 19 March 2014).

7.7. International co-operation in agricultural R&D

International co-operation on agricultural research and development 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 focus on better taking into account local specificities (OECD, 2015).

Mechanisms used to encourage cross-country, international collaboration

Estonia's agricultural innovation programmes include objectives regarding international co-operation and associated funding. The applied R&D Programme of the MRA for 2015-21 dedicates EUR 2.6 million (27.2% of the programme budget) for international research projects over the period. The programme states that international research collaboration and participation in international networks gives researchers (and through that to agricultural producers, food processors and advisors) experience and knowledge necessary for professional development and improves research quality. The priorities are related to the international networks and co-operation that the MRA is participating in: EU Joint Programming Activities, ERA-Net projects, and other international collaborative research projects. The programme is expected to result in increased number of international research projects and scientific publications in which Estonian researchers contribute to (MRA, 2016f).

Estonia's "Agriculture, Food and Fisheries Science and Knowledge Transfer Development Plan for the Period 2015-21" aims to increase the number of international collaborative research projects by 50% by 2021 compared to 2014. It is expected that in 2021, there will be 45 collaborative projects, of which 4 in veterinary medicine, 3 in food technology and safety, 3 in animal husbandry and breeding, 18 in crop production and plant breeding, 8 in horticulture (berries, fruits, landscape gardening), 6 in fisheries and aquaculture, and 3 in rural economics (MRA, 2016g).

In some cases, if the research topic requires cross-country comparisons (as in the case of agricultural and rural development policy analyses), the call for tenders for some specific applied research project (for example by the Standing Committee of Rural Affairs of the Parliament of Estonia) encourages international collaboration by giving additional evaluation points if foreign experts are involved in the project.

More generally, collaboration with international peers in evaluating applications in different R&D measures is general practice in Estonia. For example, the applications of the main research financing instruments — personal and institutional research grants — are first assessed by international peers, and then by a panel of Estonian scientists with the final decision made by an evaluation committee of renowned scientists (ERC, 2016b).

Policy efforts regarding exchange of staff, domestically or internationally

Exchange of research staff and students across countries provides opportunities for cross-country collaboration with long-term benefits (OECD, 2015). In Estonia, participation in EU networks and mobility programmes facilitate cross-country exchanges and collaboration.

In Estonia, international staff exchange is facilitated via various programmes. In particular, ERC provides mobility grants and scholarships for Estonian and foreign researchers to carry out research in a new research environment and exchange experience, expand their co-operation networks and obtain new skills:

- The research mobility funding programme **Mobilitas Pluss**,[24] with a budget of EUR 35.4 million over 2016-21, 83.5% of which is covered by the ERDF. The programme aims to improve the international visibility of Estonian research, business and higher education and Estonia's attractiveness as a destination country for study and research; support opportunities for Estonian R&D institutions and companies to collaborate with transnational research organisations and networks, including through synergy with Horizon 2020 actions; and expand international collaboration and professional development opportunities. Mobility support schemes in Mobilitas Pluss programme include:
  - Mobilitas Pluss post-doctoral grant– support for researchers coming to Estonia to carry out their research projects. The support is aimed at researchers who have defended their doctoral degrees abroad.
  - Returning researcher grant– support for researchers who have carried out their post-doctoral research (or research at least at the same level) abroad and return to continue their research in Estonia.
  - Top researcher grant– support for top researchers who come from abroad to work in an Estonian R&D institution and to establish their own research group.
  - Support for study visits and training abroad– support for researchers working at Estonian R&D institutions to participate in training and study-visits.
- **Post-doctoral research funding**: the aim of postdoctoral grants is to support researchers with an Estonian PhD degree or those with equivalent international research qualifications to continue their independent research careers in strong collaborative research groups for up to two years. Researchers who have received their doctorate in Estonia cannot apply for a postdoctoral project at an Estonian R&D institution.
- During 2010-15, the postdoctoral research grant programme **ERMOS** (Estonian Research Mobility Scheme) was applied to develop and diversify Estonian research potential through the mobility of researchers and exchange of experience. This was expected to strengthen international exchange of knowledge and support the career development of young researchers. The grants were co-financed through the FP7 Marie Curie COFUND the "People" Programme (ERC, 2016e).

Development plans of several Estonian research organisations (for example EMÜ) foresee that members of academic staff should participate in teaching, research or training in research institutions abroad. In addition, international competition for academic posts is fostered (EMÜ, 2016c).

The start-up research grant conditions of ERC require that a principal investigator of a start-up research grant can be a researcher who has been awarded the first doctorate or equivalent qualification at least two years before and no more than seven years prior to the call, and has completed postdoctoral studies (preferably abroad) after receiving a doctorate or equivalent qualification. The evaluation committee may, where justified, consider eligible a person who has not completed postdoctoral studies but has comparable research experience (preferably abroad) (ERC, 2016c). Therefore, the experience of working as a postdoctoral researcher in international research groups (for which the mobility programme is available) can be regarded as a precondition of starting up an individual researcher career.

In addition, Estonia participates in the EURAXESS, which is an EU wide network for researchers in motion, providing a one-stop shop for researchers seeking to advance their careers and personal development by moving to other countries (ERC, 2015c).

Participation in international and regional networks

The MRA participates in the co-ordination of several international scientific networks and joint initiatives with an aim to increase the competitiveness of Estonian researchers and develop respective scientific disciplines in Estonia (MRA, 2015c). The MRA also contribute as a funder of research.

The MRA represents Estonia in the following EU Joint Programming Initiatives (JPIs) (MRA, 2015c):

- The Joint Programming Initiative on Agriculture, Food Security and Climate Change (FACCE-JPI). Estonia was part of the first project launched in 2012.
- The Joint Programming Initiative Healthy and Productive Seas and Oceans (JPI Oceans).
- The Joint Programming Initiative on Antimicrobial Resistance (JPIAMR).

The MRA participates in the following ERA-Net co-operation networks (MRA, 2015c):

- ERA-Net SUSFOOD — SUStainable FOOD production and consumption;
- ERA-Net CORE Organic — Coordination of European Transnational Research in Organic Food and Farming Systems;
- ERA-Net C-IPM — Coordinated Integrated Pest Management in Europe;
- ERA-Net Plus Climate Smart Agriculture: adaption of agricultural systems in Europe;
- ERA-Net Cofund FACCE SURPLUS — Sustainable and Resilient agriculture for food and non-food systems;
- ERA-Net COFASP — Cooperation in Fisheries, Aquaculture and Seafood Processing;
- ERA-Net Cofund — European Research area on Sustainable Animal Production Systems

The MRA is planning to join the co-operation networks working on animal production, cereals production and Marine Biotechnology ERA-Net (MRA, 2015c).

The MRA participates in the following co-operations (MRA, 2015c):

- Euphresco — a network of organisations funding research projects and coordinating national research in the phytosanitary area.
- BONUS — the joint Baltic Sea research and development programme for years 2010-17;
- OECD Co-operative Research Programme on Biological Resource Management for Sustainable Agricultural Systems;
- Interreg Central Baltic Programme 2014-20.

In addition, Estonia participates in COST — European Cooperation in Science and Technology (ERC, 2015c).

ERC is a member of the European Science Foundation, where Estonia has its representatives (ERC, 2015c). Moreover, ERC is one of the founders of Science Europe, which promotes the collective interests of the Research Funding and Research Performing Organisations of Europe (ERC, 2015c).

Estonia has a liaison office of research and development in Brussels. This office is responsible for promotion of Estonian research and development activities, participating in the Informal Group of RTD

Liaison Offices, provides support for Estonian research and development organisations in organising events, and provides opportunities of internships in Brussels (ERC, 2015c).

Estonia is relatively well represented in various EU research co-operation networks by the ERC and the MRA. The limiting factor is the limited and uneven capacity of research organisations and research groups, and ability of scientists to actively participate and benefit from these networks. Therefore, in some disciplines the opportunities are successfully utilised while in other areas the ministry or research council level cooperation has not yet lead to research organisation, research group or scientist level co-operation.

Cooperation outcomes

The extent of international scientific collaboration can be measured by the percentage of documents with collaborating authors from a foreign country (Table 7.6). In Estonia, over 2007-12, 48.1% of all scientific output, and 47.3% of food and agriculture science output were published in collaboration with authors from foreign countries. OECD averages for all scientific output and agricultural science output were 45.6% and 50.8%, respectively. Therefore, the average of all scientific output in Estonia exceeds the OECD average by 2.5 percentage points, while the average of food and agricultural science output is 3.5 percentage points below the OECD average. In Scandinavian countries and the Netherlands, the share of all science and food and agricultural science output with collaborating countries in foreign countries was larger. In Latvia and Canada, this proportion was similar to the Estonian one, in Poland and the Czech Republic, it was markedly lower.

When considering annual data, the share of food and agricultural documents with foreign co-authors in Estonia has increased over the period, from 46% in 2007 to 54% in 2012. But it remains lower than in most Northern European countries at the end of the period.

Table 7.6. Agri-food R&D co-operation, 2007-12

Agri-food outputs with co-authors as a share of total agri-food outputs (%)

	Denmark	**Estonia**	EU15 average	Finland	Germany	Latvia	Nether-lands	Sweden	**OECD average**
Patents	22.1	**13.8**	17.0[1]	5.4	12.0	1.5	16.7	7.8	**12.7**
Publications	64.3	**47.3**	57.7	52.3	55.2	46.9	65.1	62.9	**50.8**

1. EU28.
Source: OECD Patent Database, January 2014; SCImago. (2007). SJR — SCImago Journal & Country Rank, www.scimagojr.com (accessed 19 March 2014).

Fostering international collaboration is one of the priorities of the applied R&D Programme of the MRA for 2015-21, and Estonia's Agriculture, Food and Fisheries Science and Knowledge Transfer Development Plan for the Period 2015-21. Considering that Estonia is a relatively small country with limited research capacity, expansion of co-operation in agricultural research could focus on research organisations in Scandinavian and other Northern European countries. The benefits stem from the culture of cross-border scientific collaboration in these countries, similar climate zones and agricultural production practices, and similarities in institutions and culture.

7.8. Summary

- The Estonian innovation system has many strengths: the conducive business environment; government strategy integrating innovation and economic growth objectives, with investments targeting smart specialisation high-growth areas; a relatively strong public research system, with a high level of public R&D expenditure and strong performance in journal publication and international cooperation; good skills base in the population, in particular young performers in science; and society's positive attitude to science and technology. Shortcomings are mainly related to low R&D and innovation in firms, partly linked to the relatively small size of Estonian companies. The most innovative companies in Estonia are the subsidiaries of foreign companies and foreign-owned companies.

- The strategic framework for innovation policy is clear, but there is an abundance of strategic documents, action plans, policies programmes and projects, which does not facilitate coherence. Innovation priorities have changed between 2004-14, where the focus was on infrastructure, capacity, entrepreneurship, and 2014-20, which emphasises horizontal innovation, risk and acceptance.
- Agricultural innovation strategy, as all sectoral innovation strategies, is fully integrated with the nation-wide strategy.
- Demand side innovation policy is widely discussed but supply side innovation dominates, in particular in agriculture, where the major part of innovation in Estonia and in other countries is facilitated by equipment and material suppliers.
- Public expenditure on agricultural research has increased since 2000, in particular as a share of agricultural value-added.
- The share of project-based research funding, including in food and agricultural areas, is very high at about 80% of total public funding. This share is planned to decrease to ensure more stability for research institutions.
- The Estonian University of life Sciences (EMÜ) carries out most agricultural-related research in Estonia, with two other universities being engaged in environmental sciences and biotechnology and food sciences, and the Estonian Crop Research Institute in crop sciences. The EMÜ research budget is variable, due to the dominance of project-based funding, and the dependence on EU sources, which follow programming cycles.
- Since 2010, research infrastructure roadmaps guide long-term investment decisions, identifying the infrastructure items of national importance that are new or require modernisation. The list is updated every three years. EU structural funds have greatly contributed to the modernisation of the Estonian research infrastructure, which was much needed. Some facilities still need upgrading and further investments from EU structural funds are planned for 2014-20.
- While Estonian agri-food companies are considered as innovative users, they have little capacity to carry out research activities and their contribution to the funding of agricultural research is estimated to be minimal. The most innovative companies in Estonia are foreign-owned companies or their subsidiaries, so research in done abroad.
- Intellectual Property Protection (IPP) is not a problem as an adequate IPR system is now in place in Estonia and the IPP Index increased over time to reach the OECD average level.
- Lack of collaboration between private companies and R&D institutions is a major concern. The most common form of collaboration is participation of representatives in steering committees and networks.
- Incentives are in place to facilitate public-private collaboration. Competence centres are an important source of collaborative innovation, but as private participation is generally from foreign companies, the focus is often on international issues as opposed to topics that can benefit the domestic agriculture sector.
- International cooperation is facilitated through participation in EU research programmes, projects and networks, and incentives for research mobility such as grants and conditions favouring international experience in project allocation and nominations.
- Open access to knowledge, optimal knowledge circulation and transfer through the application of digital European Research Area (ERA) is a priority of the ERA concept that Estonia follows. Farmers are granted free access to the research information on the website of the Estonian Agricultural and Rural Advisory Service.

- The advisory system is also expected to foster knowledge flows. A number of different Estonian organisations provide training and advisory services, including cooperatives, input providers, and education institutions. The Advisory Centre of RDF is currently in charge of the publically-funded advisory system, providing advice to farmers and rural entrepreneurs for a minimal fee.
- Innovation policy and the impact of other policies on innovation are evaluated. The evaluation of EU programmes is based on input and output indicators defined at the EU level, which describe and analyse the dynamics of the Estonian RDI system based on the framework of EU policies and objectives. The current use of indicators has thus been of a monitoring nature.

Notes

1. The term "Agricultural Knowledge and Innovation System (AKIS)" is used in the European Union to describe the features of systems producing agricultural innovation, with the same meaning as the term "Agricultural Innovation System" (AIS) used in the OECD and the World Bank for example.
2. The innovation systems approach highlights the importance of systemic links between scientific research, technological change, learning and innovation. The main focus is on the functioning of the system and the complex relationships that involve a variety of organisations and institutions within the system. At the same time, the focus is shifted away from the activities of individual and isolated parties (companies and consumers) (Chaminade and Edquist, 2005).
3. Innovation wise the **Estonian Entrepreneurship Growth Strategy for 2014-20** is expected to facilitate the achievement of the umbrella objectives within the Estonia 2020, thereby contributing directly to attaining the goal 'Growth of welfare' in the Sustainable Estonia 21 (MEAC, 2013a).
4. Over 2014-20, Estonia is allocated support from five EU structural and investment funds: 1) the European Regional Development Fund (ERDF); 2) the European Social Fund (ESF); 3) the Cohesion Fund (CF); 4) the European Agriculture Rural Development Fund (EAFRD); and 5) The European Maritime and Fisheries Fund (EMFF), which, in line with the Europe 2020 strategy, support economic development in all EU member states.
5. In Estonia, Business Expenditure on R&D (BERD) is concentrated in medium-high to low-technology manufacturing and services, and in a small number of firms (OECD, 2017a, Figure 6).
6. Demand side innovation activities include support for entering to new markets, establishment of quality requirements that initiate creation of new products. Respective policy instruments include regulations, public procurement, and support of private demand. Supply side innovation activities include provision of finances and services. In this case, the policy instruments include capital support, financial instruments, and support to public sector research, training and mobility support, and grants to R&D activities in processing industry (Paltser and Reiljan, 2015).
7. Science Centre AHHAA: www.ahhaa.ee/.
8. See Horizon 2020 web site: https://ec.europa.eu/programmes/horizon2020/.
9. Järvamaa Vocational Education Centre, Olustvere School of Rural Economics and Service, Luua Forestry School, Pärnumaa Vocational Education Centre, Hiiumaa Training Establishment, Räpina School of Horticulture, Väike-Maarja Vocational Education Centre, Viljandi Vocational Education Centre, Tartu Vocational Education Centre.
10. Agricultural Applied Research and Development for 2015-20 is the third programme of this type following the 2004–08 and 2009–14 programmes. However, the MRA has financed agricultural applied research for several decades. The main objective of the first national programme for 2004–08 was to contribute to raising the competitiveness of agricultural production and the processing of agricultural products, analysing the risks to the consumer and the environment arising from agricultural production of agricultural production, and developing solutions for minimising those risks in the whole production and processing chain (MRA, 2004). For the period 2009-14, the main aims were to increase competitiveness of agricultural production

and processing, to ensure its sustainability, analysis of risks associated with agricultural production and produce, and risk management solutions (MRA, 2016a).

11. The present programme is the third programme; previous ones covered 2002–06 and 2007–13.

12. GERD includes expenditure on R&D conducted in the country by Business enterprise; Government; Higher education; and Private non-profit sectors. All sources of funding are included.

13. For example, measures for 2014-20 administered by Enterprise Estonia were not fully implemented in 2015 as they were still in the process of being developed (EE, 2015).

14. Golden Open Access (Gold Open Access) means that the publication is immediately and permanently available free of charge for everyone on the publisher's website. The article publishing charge may be covered by the authors, their institutions or an organisation, such as a university or a professional association or the Academy of Sciences. Most of the scientific journals in Estonia use the latter model, and the authors do not have to pay the article publishing charge to the journals. The specific conditions for the gold open access publications are determined by a specific license. Most of the open-access articles use the so-called Creative Commons licenses. It is allowed to file away such publications oneself and store the copy in the institutional (for example, university digital archive), national (for example, the Estonian Research Information System, ETIS), or an international repository (for example, arXiv, PubMed Central).

15 Laws governing industrial property include: Legal Regulation of Industrial Property Act, Trade Marks Act, Patents Act, Utility Models Act, Geographical Indication Protection Act, Competition Act, Plant Propagation and Plant Variety Rights Act.

16. The PTC provides a unified procedure for filing patent applications to protect inventions in each of its contracting states. The Treaty makes it possible to seek patent protection for an invention simultaneously in each of a large number of countries by filing an "international" patent application. Patents can be then granted by national and regional authorities.

17. OECD seeds schemes web site: www.oecd.org/tad/code/abouttheoecdseedschemes.htm.

18. A 2006 study indicated that the private sector's participation in implementation and assessment of R&D policies was very limited in Estonia. Most common private collaboration is participation through industrial associations in steering committees, boards, and occasionally in networks (Inzelt, 2006).

19. Competence Centre of Food and Fermentation Technologies website: http://tftak.eu/et/.

20. LLC website: http://tptak.ee/.

21. Competence Centre on Health Technologies website: www.ccht.ee/.

22. A EIP-AGRI Regional Workshop on "Establishing Operational Groups under Rural Development Programmes" took place in Tallinn on 2-3 April 2014, https://ec.europa.eu/eip/agriculture/en/content/eip-agri-workshop-regional-workshop-establishing-operational-groups-under-rural-developmen-0.

23. Measure 1.7.1, Processing of agricultural products, was the predecessor of the current innovation cooperation support measure (M 16.2).

24. It replaces the project Mobilitas in place during the period 2008-15.

References

AB (Agricultural Board) (2016), www.pma.agri.ee/index.php?id=104&sub=128&sub2=296&sub3=297 (accessed 9 April 2016).

AB (2015), Põllumajandusameti tegevusülevaade 2014 [Agriculture Agency for review], www.pma.agri.ee/docs/pics/PMA_tegevusulevaade_2014_1(1).pdf (accessed 11 January 2016).

ARIB (2017), http://www.pria.ee/et/toetused/valdkond/taimekasvatus/innovatsiooniklastri_toetus_2015/; http://www.pria.ee/et/toetused/valdkond/taimekasvatus/innovatsiooniklaster/.

ARIB (2016) Innovatsiooniklastri toetus (MAK 2014-2020 meede 16) 2015 [Innovation support (RDP 2014-2020 Measure 16) 2015], www.pria.ee/et/toetused/valdkond/taimekasvatus/innovatsiooniklastri_toetus_2015/#maar (accessed 17 February 2016).

ARIB (2015), Estonian Agricultural Registers and Information Board (ARIB), www.pria.ee.

Ajujaht (2016), www.ajujaht.ee/ajujahist/ (accessed 15 March 2016).

Arnold, E., K. Männik, R. Rannala, A. Reid, B. Bayer, and S. Ljungström (2008), Mid-Term Evaluation of the Competence Centre Programme, Final report, Innovation Studies No. 12, www.mkm.ee/sites/default/files/is12_competence_center_programme_2008.pdf (accessed 16 February 2016).

ASTI (2016), database, http://asti.cgiar.org/.

BioCC (2016), Bio-Competence Centre of Healthy Dairy Products LLC (BioCC) webpage, http://tptak.ee/en (accessed 8 February 2016).

Campi, M. and A. 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.

CDCIS (County Development Centres Information System) (2016), Maakondlikud arenduskeskused. http://old.arenduskeskused.ee/Maakondlikud-arenduskeskused.html (accessed 3 February 2016).

Chaminade, C., and C. Edquist (2005), "From theory to practice: the use of systems of innovation approach in innovation policy", CIRCLE, Lund University, *Electronic Working Paper Series*, Paper No. 2005/2.

Christensen, T.A., S. Freireich, J. Kolar, and P. Nyberg (2012), "Peer-Review of the Estonian Research and Innovation System. Steady Progress Towards Knowledge Society", *Innovation Studies*, No. 19, www.hm.ee/index.php?popup=download&id=11652 (accessed 7 February 2016).

Competence Centre for Knowledge-Based Health Goods and Natural Products (2016), Polli Horticultural Research Centre, http://pk.emu.ee/en/structure/polli/competence-centre-for-knowledge-based-health-goods-and-natural-products/ (accessed 4 April 2016).

EC (2016), Projects & Results, CORDIS, European Commission, http://cordis.europa.eu/project/rcn/106468_en.html (accessed 15 March 2016).

EC (European Commission) (2014), Summary of the Partnership Agreement for Estonia, 2014-2020. https://ec.europa.eu/info/sites/info/files/partnership-agreement-estonia-summary-jun2014_en.pdf (accessed 5 December 2017).

EC (2012), Elements of the Common Strategic Framework for the period 2014-2020, http://ec.europa.eu/esf/BlobServlet?docId=386&langId=en (accessed 11 February 2016).

ECRI (2017), Annual Financing of ECRI 2007-2017, Data provided by the Estonian Crop Research Institute.

ECRI (2015), Estonian Crop Research Institute, www.etki.ee/index.php/eng/ (accessed 12 February 2015).

EDF (2013), Nutikas spetsialiseerumine – kvalitatiivne analüüs, [Smart specialisation - Qualitative analysis], Eesti Arengufond [Estonian Development Fund], February, www.arengufond.ee/upload/Editor/Publikatsioonid/Nutikas%20spetsialiseerumine%2020_02_2013.pdf (accessed 15 March 2016).

EE (Enterprise Estonia) (2016a), Tehnoloogia Arenduskeskused [Technology Development Centres], www.eas.ee/teenus/tehnoloogia-arenduskeskused/ (accessed 31 January 2016).

EE (2016b), Development voucher, www.eas.ee/service/development-voucher/?lang=en (accessed 9 March 2016).

EE (2016c), Tark hankimine [Getting smart], www.eas.ee/teenus/tark-hankimine/ (accessed 6 April 2016).

EE (2016d), Toetatud projektide andmebaas [Supported project database], EAS, http://workestonia.eu/et/eas/sihtasutusest/toetatud-projektid/toetatud-projektid-alates-2004a-aprill (accessed 15 March 2016)

EE (2015), Ettevõtluse Arendamise Sihtasutuse 2015, aasta koondtegevuskava (Annual Activity Plan for the Entrepreneurship Development Foundation, 2015], www.eas.ee/wp-content/uploads/2015/11/koondtegevuskava_2015.pdf (accessed 19 February 2016).

EERC (Estonian Environmental Research Centre) (2016), Biomajandus [Bioeconomy], www.klab.ee/kohanemine/valdkonnad/biomajandus/ (accessed 9 April 2016).

EIC (2016), Environmental Investment Centre, www.kik.ee/et/kik/pohikiri (accessed 17 March 2016).

EIPTTC (2016), Intellectual Property, The Estonian Intellectual Property and Technology Transfer Centre, http://eitk.ee/intellektuaalomand/ (accessed 11 January 2016).

Eljas-Taal, K. (2014), Riik kui tark tellija ehk kuidas saab riik toetada turunõudlust innovatsiooni järele [Wise country if the customer or the state can support market demand for innovation], www.mkm.ee/sites/default/files/ds_uuringu_tutvustus_121114.pdf (accessed 4 April 2016).

EMÜ (2017), Background report for the OECD review on Estonian innovation policy and agricultural innovation system, January.

EMÜ (2016a), Kuratoorium [Board of Governors], www.emu.ee/ylikoolist/yldinfo/juhtimine/kuratoorium/ (accessed 3 February 2016).

EMÜ (2016b), Eesti maaelu arengukava 2007-2013 1., 3. ja 4. telje püsihindamise aruanne [Estonian Rural Development Plan 2007-2013, the first, third and fourth axis permanent evaluation report], 2015 year.

EMÜ (2016c), Development plan of Estonian University of Life Sciences until 2025, www.emu.ee/ylikoolist/yldinfo/arengukavad-ja-strateegiad/ (accessed 18 October 2016).

EMÜ (2015a), Eesti maaelu arengukava 2007-2013 1., 3. ja 4. telje püsihindamise aruanne [Estonian Rural Development Plan 2007-2013, the first, third and fourth axis permanent evaluation report], 2014.

EMÜ (2015b), Majandusaasta aruanded 2007-2015 [Annual Reports], www.emu.ee/ylikoolist/yldinfo/eelarve/ (accessed 5 December 2016).

EMÜ (2015c), Innovatsioonimõõdikud põllumajandussektori ja toiduainetööstuse ettevõtjate investeeringute ja konkurentsivõime analüüsimiseks [Indicators of innovation in the agricultural sector and the food industry and the competitiveness of enterprises to analyse investments], www.agri.ee/sites/default/files/content/uuringud/2015/uuring-2015-innovatsioonimoodikud.docx (accessed 11 February 2016).

EMÜ (2013a), Eesti Maaülikooli rakendusteaduse auhinna statuut [Estonian University of Life Science Award application statute], www.emu.ee/userfiles/Teadus/Oigusaktid/Rakendusteaduse%20auhinna%20statuut.pdf (accessed 29 January 2016).

EMÜ (2013b), Eesti maaelu arengukava 2007−2013 meetme 1.1 “Koolitus- ja teavitustegevused” rakendamistulemuste analüüs [Estonian Rural Development Plan 2007-2013, measure 1.1 “Training and Information Activities” Analysis of the implementation results], pp. 19.

EMÜ (2012), Koolitus- ja teavitustegevuste mõju põllumajandus-, toidu- ja metsandussektoris hõivatute konkurentsivõimele [Training and information activities impact on agriculture, food and forestry sector, the competitiveness of the employed].

EMÜ (2010), EMÜ tehnoloogiasiirde ja koostööpartnerite uuring: Lõpparuanne. B. I. A. [Technology transfer and cooperation partners in the study: final report].

EPO (2016), Patendiamet, The Estonian Patent Office, www.epa.ee/et/ametist/patendiamet (accessed 11 January 2016).

ERC (2016a), Keskkonnakaitse ja -tehnoloogia teadus- ja arendustegevuse programm KESTA [Environmental protection and technology R&D programme KESTA], www.etag.ee/rahastamine/programmid/loppenud-programmid/kesta/ (accessed 31 January 2016).

ERC (2016b), Teadus- ja arendustegevuse rahastamine Eestis [R&D funding in Estonia], www.etag.ee/tegevused/uuringud-ja-statistika/statistika/teadus-ja-arendustegevuse-rahastamine-eestis/ (accessed 30 January 2016).

ERC (2016c), Infrastructure Funding, www.etag.ee/en/funding/infrastructure-funding/ (accessed 15 February 2016).

ERC (2016d), Applied research in smart specialisation growth areas: NUTIKAS.

ERC (2016e), Valdkondliku TA tegevuse toetamine – RITA [TA support to sectoral activities], www.etag.ee/rahastamine/rakendusuuringute-toetused/rita-rakendusuuringud/ (accessed 7 April 2016).

ERC (2015a), Teaduse populariseerimine [Science popularisation], Estonian Research Council, www.etag.ee/tegevused/teadpop/ (accessed 29 January 2016).

ERC (2015b), TeaMe+ tegevused, www.etag.ee/tegevused/teadpop/teamepluss/ (accessed 29 January 2016).

ERC (2015c), Avatud teadus Eestis. Tööversioon [Open Science working draft], www.etag.ee/wp-content/uploads/2016/03/AT_soovitused_20160229.pdf (accessed 23 March 2016).

ERC (2013), Estonian R&D funding system (since 1 March 2012), www.etag.ee/wp.../SEV2013_ENERG_RD-system/ (accessed 13 December 2015).

Etis (2016), Eesti Teadusinfosüsteem: Projektid [Estonian Research: Projects], www.etis.ee/Portal/Projects/Index (accessed 30 January 2016).

Eurobarometer Qualitative Study (2015), Public Opinion On Future Innovations, Science and Technology Aggregate Report June, http://ec.europa.eu/public_opinion/archives/quali/ql_futureofscience_en.pdf (accessed 17 March 2016).

EUSAE (European Union Structural Assistance to Estonia) (2015), Webpage www.struktuurifondid.ee/en/ (accessed 29 January 2016).

FACCE-JPI (2016), What is FACCE-JPI? www.faccejpi.com/About-Us/What-is-FACCE-JPI (accessed 4 April 2016).

Government (Republic of Estonia Government) (2016), Objectives and activities, https://valitsus.ee/en (accessed 10 February 2016).

Government Office (2016), Research and Development Council, https://riigikantselei.ee/et/valitsuse-toetamine/teadus-ja-arendusnoukogu, 15 November.

Government Office (2014), National Reform Programme "ESTONIA 2020", (accessed 28 January 2016).

Hanson, M. Kuningas, T. Muuk-Adrat, R. Pohlak, and A. Urmet (2015), Intellektuaalomandi õppematerjal, Eesti Intellektuaalomandi ja Tehnoloogiasiirde Keskus [Intellectual property teaching material. Estonian Intellectual Property and Technology Transfer Centre, EIPTTC], pp 8.

Health promotion research programme TerVE (2016), www.etag.ee/en/funding/programmes/closed-programmes/health-promotion-research-programme-terve/ (accessed 18 March 2016).

Huisman, J., P. Santiago, P. Högselius, M.J. Lemaitre, and W. Thorn (2007), OECD reviews of tertiary education: Estonia, http://www.oecd.org/estonia/39261460.pdf (accessed 31 March 2016).

Inzelt, A. (2006), Private Sector Interaction in the Decision Making Processes of Public Research Policies. Country Profile: Estonia, http://ec.europa.eu/invest-in-research/pdf/download_en/psi_countryprofile_estonia.pdf (accessed 28 January 2016).

Jaaksoo, K., M. Kitsing, K. Lember, and T. Rebane (2012), "Ettevõtlus- ja innovatsioonipoliitika vahehindamine" [Interim evaluation of enterprise and innovation policy], *Innovation Studies*, No. 21, www.mkm.ee/sites/default/files/inno_21.pdf (accessed 31 January 2016).

Kaarna, K., K. Ojamäe, E. Welch, B. Fisher, and K. Lember (2015), Eesti ettevõtete uuendusmeelsus ja innovatsiooni toetamise võimalused [Estonia's support for innovation and innovation in business opportunities], *Innovation Studies*, No. 24, www.mkm.ee/sites/default/files/inno_24.pdf (accessed 28 January 2016).

Kaeramaa, M. (2014), Tõuaretus on tõstnud Eesti põllumajanduse konkurentsivõimet [Animal breeding has increased the competitiveness of Estonian agriculture], https://maablogi.wordpress.com/2014/09/18/touaretus-on-tostnud-eesti-pollumajanduse-konkurentsivoimet/ (accessed 11 February 2016).

Kalvet, T., E. Karo, and R. Kattel (2010), Eesti ettevõtete uued võimalused – ärimudelid, avatud innovatsioon ja riigi valikud [Estonian companies, new opportunities - business models for open innovation and public choices], *Innovation Studies* No. 14, www.arengufond.ee/upload/Editor/ettevotlus/Eesti%20ettev%C3%B5tete%20uued%20v%C3%B5imalused%20%E2%80%93%20%C3%A4rimudelid,%20avatud%20innovatsioni%20ja%20riigi%20valikud_2010.pdf (accessed 28 January 2016).

Karo, E., R. Kattel, V. Lember, K. Ukrainski, H. Kanep, nad U. Varblane (2014a), Nutika spetsialiseerumise võimalused ja väljakutsed Eestis teadus-, arendus- ja innovatsioonipoliitika kujundamisel ja juhtimisel 2014-2020, TIPS poliitikaanalüüs [Smart specialisation opportunities and challenges in the research, development and innovation in policy-making and leadership from 2014 to 2020, TIPS policy analysis], http://dspace.ut.ee/bitstream/handle/10062/40970/TIPS_NS_pol.analyys.pdf (accessed 11 February 2016).

Karo, E., R. Kattel, P. Tõnurist, K. Valdmaa, L. Looga, M. Kirs, P. Lumi, and M. Käger (2014b), Eesti teadusfinantseerimise instrumendid ja teaduse rakendatavus majanduses: poliitikaanalüüs tänase TAI süsteemi väljakutsetest ja võimalustest, TIPS uuringu 5.1 lõppraport [Estonian research funding instruments and scientific applicability in the economy: a policy analysis today TAI system challenges and opportunities, TIPS 5.1, Final report of the study], http://tips.ut.ee/index.php?module=32&op=1&id=3637 (accessed 11 February 2016).

Kirss, L., H.-S. Haaristo, M. Nestor, and E. Mikko (2013), Teadust ja tehnoloogiat populariseerivad tegevused Eestis. Uuringuaruanne. Praxis, [Popularising science and technology activities in Estonia: Study report], www.etag.ee/wp-content/uploads/2012/05/Praxis-2013-web.pdf (accessed 29 January 2016).

Koppel, A. (2016), Kulutused teadus- ja arendustegevusele: investeering tulevikku [Spending on research and development: investing in the future], Eesti teadus 2016, Tartu: Eesti Teadusagentuur, pp. 11-18, www.etag.ee/wp-content/uploads/2014/01/TA_teaduskogumik-2016-veeb.pdf (accessed 5 December 2016).

Lember, V., E. Karo, M. Kirs, P. Tõnurist, K. Valdmaa, R. Mäekivi, and R., Hanson (2015), Eesti teadussüsteemi ja majanduse seosed: juhtumianalüüsid avaliku ja erasektori nõudlusele vastamisest, TIPS uuringu 5.2 raport [Estonia's research system and economic relationships: the case studies of public and private sectors to meet demand, 5.2 TIPS study report], TTÜ Ragnar Nurkse innovatsiooni ja valitsemise instituut [University Nurkse Innovation and Governance Institute], Tallinn, pp. 29-30.

Lember, V. and T. Kalvet (2014), "Estonia: Public procurement, innovation and 'no policy' policy", in Lember, V., R. Kattel, and T. Kalvet (Ed.), *Public Procurement, Innovation and Policy: International Perspectives*, Heidelberg, Springer, pp. 127−149.

Lember, V. and T. Kalvet (2012), Riigihanked ja innovatsioon Eestis: milleks kulutada 11 miljonit päevas? [Public procurement and innovation in: Why spend 11 million a day?], Riigikogu Toimetised [Proceedings], Vol. 26, pp. 110−126.

Linnas, R. (2007), "Innovatsioonipoliitika kavandamisest Eesti [Innovation policy design Estonia]", *Riigikogu Toimetised* [Riigikogu Papers], No. 15, www.riigikogu.ee/rito/index.php?id=11572&op=archive2 (accessed 28 January 2016).

Masso, J., M. Liik, and K. Ukrainski (2013), Teaduse-arendustegevuse ja innovatsiooni indikaatorid Eesti innovatsiooni- ja teaduspoliitikas: senine praktika ja poliitikasoovitused, Uuringu 7.1, raport [R&D and innovation indicators of the Estonian innovation and research policy: current practice and policy recommendations, Study 7.1, Report], http://dspace.ut.ee/bitstream/handle/10062/40969/Indikaatorid_raport_Eesti.pdf (accessed 30 January 2016).

Masso, J. and K. Ukrainski (2008), Public Research Funding in Central and Eastern European Countries. Estonian Country Report, www.enid-europe.org/papers/research_funding_Estonia.pdf (accessed 15 March 2016).

MEAC (2013a), Estonian Entrepreneurship Growth Strategy 2014-2020, http://kasvustrateegia.mkm.ee/pdf/Estonian%20Entrepreneurship%20Growth%20Strategy%202014-2020.pdf (last accessed 28 January 2016).

MEAC (2013b), Digital Agenda 2020 for Estonia. www.mkm.ee/sites/default/files/digital_agenda_2020_estonia_engf.pdf (accessed 30 March 2016).

MEAC (2006), Eesti infoühiskonna arengukava 2013 [Estonian Information Society Strategy], www.riigikantselei.ee/valitsus/valitsus/et/valitsus/arengukavad/majandus-ja-kommunikatsiooniministeerium/T_iendatud_info_hiskonna_arengukava.pdf (accessed 23 March 2016).

MER (2016a), Teadusraha [Research funds], www.hm.ee/et/tegevused/teadus/teadusraha (accessed 4 April 2016).

MER (2016b), Financing of the infrastructure, https://hm.ee/en/activities/research-and-development/financing-infrastructure (accessed 17 February 2016).

MER (2015a), Infokiri teaduse rahastamisest 2016 Aastal [Newsletter science funding in 2016], www.etag.ee/wp-content/uploads/2016/01/HTM-infokiri-teaduse-rahastamine-2016-22.12.2016.pdf (accessed 22 October 2016)

MER (2015b), Research and Development, https://hm.ee/en/activities/research-and-development (accessed 14 December 2015).

MER (2014a), Eesti teadus- ja arendustegevuse ning innovatsiooni strateegia 2014–2020 "Teadmistepõhine Eesti" [Estonian Research and Development and Innovation Strategy 2014-2020 "Knowledge-based Estonia"], www.hm.ee/sites/default/files/59705_teadmistepohine_eesti_est.pdf (accessed 28 January 2016).

MER (2014b), Eesti elukestva õppe strateegia 2020 [Estonian Lifelong Learning Strategy 2020], www.hm.ee/index.php?popup=download&id=12568 (accessed 31 January 2016).

MER (2013), Eesti teadus- ja arendustegevuse ning innovatsiooni strateegia 2007-2013 "Teadmistepõhine Eesti": Aruanne strateegia eesmärkide ja rakendusplaani täitmisest 2012, aastal [Estonian Research and Development and Innovation Strategy 2007-2013 "Knowledge-based Estonia": Report on the objectives of the strategy and implementation plan of 2012, www.riigikantselei.ee/valitsus/valitsus/et/valitsus/arengukavad/haridus-ja-teadusministeerium/TAI%20aruanne%202012.pdf (accessed 30 January 2016).

MER (2007), Knowledge-Based Estonia: Estonian Research and Development and Innovation Strategy 2007-2013, http://cs.ioc.ee/excs/policy/teadm-pohine-eesti2-en.pdf (accessed 23 February 2016).

MER-ERC (2014), Haridus- ja Teadusministeerium, Eesti Teadusagentuur. Baasfinantseerimise kasutamise analüüs 2005-2013 [Ministry of Education and Research, Estonian Science Agency: Analysis of the use of basic financing 2005-2013], www.etag.ee/wp-content/uploads/2014/02/Baasfinantseerimise-kasutamise-analyys.pdf (accessed 30 January 2016).

Mihkelson, P., T. Rebane, M. Kitsing, and K. Lember (2014), Ettevõtlus- ja innovatsioonipoliitika vahehindamine [Interim evaluation of enterprise and innovation policy], www.eas.ee/images/doc/sihtasutusest/uuringud/ettevotlus/ettevotlustoetuste-vahehindamine-2014.pdf (accessed 11 February 2016).

Mihkelson, P., T. Rebane, E. Peters, and K. Lember (2013), Klastriprogrammi vahehindamine [Interim evaluation of the cluster], Tallinn, http://workestonia.eu/images/doc/sihtasutusest/uuringud/ettevotlus/klastriprogrammi-vahehindamine-2013.pdf (accessed 21 March 2016).

MoE (2016a), Kliimapoliitika põhialused aastani 2050, Põllumajanduse valdkonna mõjude hindamine [Climate Policy Fundamentals for 2050, agricultural impact assessment], http://envir.ee/sites/default/files/kpp_pillumajanduse_mijude_hindamise_seletuskiri_18.03.pdf (accessed 9 April 2016).

MoE (2016b), Studies and reports, www.envir.ee/et/eesmargid-tegevused/vesi/uuringud-ja-aruanded (accessed 3 October 2016).

MoF (2016), Välistoetused [Foreign Grants], www.fin.ee/valistoetused (accessed 11 February 2016).

MoF (2015), Riigi eelarvestrateegia 2016-2019 [State Budget Strategy], www.fin.ee/riigi-eelarvestrateegia (accessed 31 January 2016).

MoF (Ministry of Finance) (2014a), Ühtekuuluvuspoliitika fondide rakenduskava 2014-2020 [Cohesion Policy Funds Implementation], www.struktuurifondid.ee/public/Rakenduskava.pdf (accessed 29 January 2016).

MoF (2014b), Euroopa Liidu struktuuritoetus: Hindamine. [European Union's structural support: evaluation], www.struktuurifondid.ee/hindamine (accessed 30 January 2016).

MRA (2016a), Rakendusuuringud ja arendustegevus [Applied Research and Development], www.agri.ee/et/eesmargid-tegevused/teadus-arendus-ja-nouanne/teadus-ja-arendustegevus#rakendusuuringud-arendustegevus (accessed 31 January 2016).

MRA (2016b), Eesti põllumajandus-, toidu- ja kalamajandusteaduse ning teadmussiirde arengukava aastateks 2015–2021 [Estonian agriculture, food and fisheries economics of knowledge transfer Development Plan for 2015-2021], http://agri.ee/sites/default/files/content/arengukavad/arengukava-teadmussiire-2015-2021.pdf (accessed 10 February 2016).

MRA (2016c), Majandusaasta aruanded. Majandusteave [Annual budgets of MRA governance area, Economic Information], www.agri.ee/et/ministeerium-kontakt/majandusteave (accessed 30 March 2016).

MRA (2016d), Estonian Rural Development Plan 2014-2020, www.agri.ee/et/eesmargid-tegevused/eesti-maaelu-arengukava-mak-2014-2020 (accessed 29 January 2016).

MRA (2016e), Toiduainetööstus [food], www.agri.ee/et/eesmargid-tegevused/pollumajandus-ja-toiduturg/ulevaated/toiduainetoostus (accessed 30 January 2016).

MRA (2016f), Põllumajandusministeeriumi valitsemisala arengukava 2016-2019 [The Ministry of Agriculture Development Plan 2016-2019], www.agri.ee/sites/default/files/content/arengukavad/pollumajandusministeerium-vau-2016-2019.pdf (accessed 18 October 2016).

MRA (2016g), Applied Research and Development Programme of Ministry of Rural Affairs for 2015-2021, http://agri.ee/et/pollumajanduslikud-rakendusuuringud-ja-arendustegevus-aastatel-2015-2021 (accessed 11 February 2016).

MRA (2015a), Agricultural Applied Research and Development Activities 2015-2021, www.agri.ee/sites/default/files/content/.../arengukava-arendustegevus-2015-2021.odt (accessed 18 October 2016).

MRA (2015b), Eesti maaelu arengukava 2014-2020 kommunikatsioonistrateegia [Estonian Rural Development Plan 2014-2020 Communication Strategy], www.agri.ee/sites/default/files/content/arengukavad/mak-2014/mak-2014-kommunikatsioonistrateegia.pdf (accessed 31 January 2016).

MRA (2015c), International R&D Co-operation of MRA, http://agri.ee/et/ministeerium-kontakt/rahvusvaheline-koostoo/pollumajandusministeeriumi-rahvusvaheline-teadus-ja (accessed 11 February 2016).

MRA (2013a), Collection and Conservation of Plant Genetic Resources for Food and Agriculture in 2014-2020, www.agri.ee/sites/default/files/content/arengukavad/program-genetic-resources-2014-2020.pdf (accessed 5 February 2016).

MRA (2013b), Evaluation of the Rural Development Plan for the period 2007-2013, www.agri.ee/en/evaluation (accessed 30 January 2016).

MRA (2008), Riiklik programm "Sordiaretusprogramm aastatel 2009−2019". Põllumajandusministri 03.07.2008. käskkirja nr 152 lisa [The National Program "Plant breeding period 2009-2019" Minister of Agriculture 03.07.2008. Decree No. 152, www.agri.ee/sites/default/files/public/juurkataloog/TEADUS-ARENDUS/Ministri_kk_152_2008_2_sordiaretusprogramm.pdf (accessed 31 January 2016).

MRA (2005), Põllumajandus- ja maaelu areng. Ülevaated aastatest 1998-2005 [Agricultural and Rural Development. Overviews from 1998-2005], www.digar.ee/arhiiv/et/raamatud?id=7291 (accessed 4 April 2016).

MRA (2004), Põllumajanduslikud rakendusuuringud ja arendustegevus aastatel 2004–2008. [Agricultural Applied Research and Development 2004- 2008], www.agri.ee/sites/default/files/public/pllumajanduslikud_rakendusuuringud_ja_arendustegevus_aastatel_20042008.doc (accessed 27 April 2017).

MRA (1999), Põllumajandus ja maaelu areng, Ülevaade 1998. [Agricultural and Rural Development] Infotükk. Tallinn, 142 p.

Mürk, I., and T. Kalvet (2015), Teaduspõhiste ettevõtete roll Eesti T&A- ja innovatsioonisüsteemis – TIPS uuringu 4.3 lõppraport. Tallinn: TTÜ Ragnar Nurkse innovatsiooni ja valitsemise instituut [The role of science-based businesses in Estonian R&D and innovation system - 4.3 TIPS study final report. Tallinn: Tallinn University of Technology, Institute of Governance and Innovation Nurkse], https://energiatalgud.ee/img_auth.php/4/4a/Teadus-_ja_Innovatsioonipoliitika_Seire_Programm._Teadusp%C3%B5histe_ettev%C3%B5tete_roll_Eesti_T%26A-_ja_innovatsioonis%C3%BCsteemis._2015.pdf (accessed 28 November 2016).

Must, Ü., O. Otsus, A. Soon, M. Habicht, Ü. Napa, T. Tuisk, S. Lätt, R. Uus, and M. Lust (2014), Eesti Euroopa Liidu teadus- ja arendustegevuse 7. Raamprogrammis. Horizon 2020 [Estonia and the European Union research FP7 and Horizon 2020], www.horisont2020.ee/wp-content/uploads/2014/01/Eesti-EL-7.-raamprogrammis.pdf (accessed 5 February 2016).

NAO (National Audit Office) (2014), The Impact of innovation support measures on the Competitiveness of Companies. Report to the Estonian Parliament (Riigikogu), Tallinn, 1 December, www.riigikontroll.ee/DesktopModules/DigiDetail/FileDownloader.aspx?FileId=13243&AuditId=2340 (accessed 11 February 2016).

NRN (Estonian National Rural Network) (2013), Take notice of innovative agriculture, Publication, www.maainfo.ee/data/trykis/Notice_the_Innovative_Agriculture_eng_2013_WEB.pdf.

OECD (2017a), "Estonia", in *OECD Science, Technology and Innovation Outlook 2016*, OECD Publishing, Paris, http://dx.doi.org/10.1787/sti_in_outlook-2016-58-en.

OECD (2017b), *Main Science and Technology Indicators, Volume 2016 Issue 2*, OECD Publishing, Paris, http://dx.doi.org/10.1787/msti-v2016-2-en (last accessed in June 2017).

OECD (2017c), OECD statistics [Research and Development, OECD National Accounts], http://stats.oecd.org/ (last accessed in June 2017).

OECD (2015), "Analysing Policies to improve agricultural productivity growth, sustainably: Revised framework", www.oecd.org/tad/agricultural-policies/Analysing-policies-improve-agricultural-productivity-growth-sustainably-december-2014.pdf.

OECD (2014b), *OECD Science, Technology and Industry Outlook 2014*, OECD Publishing, Paris, http://dx.doi.org/10.1787/sti_outlook-2014-en.

OECD (2013), A*gricultural Innovation Systems: A Framework for Analysing the Role of the Government*, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264200593-en.

Pakkas, E. (2014), TAK programm täna ja homme : Mis hästi, mis halvasti? [TAK program today and tomorrow: As good as bad?] http://biopark.ee/wp-content/uploads/2014/12/28.11.2014_Eve-Pakkas.pdf (accessed 23 February 2016).

Paltser, I., and J. Reiljan (2015), Eesti rahvusvaheline positsioon innovatsioonipoliitika eri valdkondades [Estonia's international position in innovation policy in different areas], Riigikogu Toimetised [Proceedings of Riigikogu], Vol. 32, www.riigikogu.ee/rito/index.php?id=16015 (accessed 29 January 2016).

Parliament of Estonia (2016), Majanduskomisjon otsustas Arengufondi tegevuse lõpetada. Pressiteade. Majanduskomisjon [The Economic Development Fund has decided to terminate its activities, Press Release], www.riigikogu.ee/pressiteated/majanduskomisjon-et-et/majanduskomisjon-otsustas-arengufondi-tegevuse-lopetada/ (accessed 18 March 2016).

PlantValor (2016), Competence Centre for Knowledge-Based Health Goods and Natural Products, http://plantvalor.ee/index.php/home (accessed 4 April 2016).

Rand, L., and P. Ardel (2010), Seeme on saagi algus: Sertifitseeritud seemne eelistest ja sordikaitsest Eestis [The seed is the beginning of the harvest: Certified seed of the benefits and variety protection in Estonia], Põllumajandusministeerium [Ministry of Agriculture], www.agri.ee/sites/default/files/public/juurkataloog/TRUKISED/2010/trykis_seemesaagialus_2010.pdf (accessed 11 January 2016).

RDF (Rural Development Foundation) (2016), Nõuandekeskus [Advisory], www.mes.ee/nouandekeskus (accessed 31 January 2016).

RERC (Rural Economy Research Centre) (2016), Maaeluvõrgustik. Innovatsioonivõrgustik [Innovation Network], www.maainfo.ee/index.php?page=4& (accessed 1 February 2016).

Rietzke, D. (2015), "Push or Pull? Grants, Prizes and Information", Lancaster University Management School, *Economics Working Paper Series* 2015/011, www.lancaster.ac.uk/media/lancaster-university/content-assets/documents/lums/economics/working-papers/LancasterWP2015_011.pdf (accessed 4 April 2016).

Romanainen, J., K. Eljas-Taal, J. Rigby, J. Edler, P. Cunningham, K. Izsak, K. Männik, J. Angelis, K. Kosk, and J. Vallistu (2014a), "Teostatavusuuring innovatsioonipoliitika nõudluspoole meetmete väljatöötamiseks ja rakendamiseks Eestis. Uuringu II osa – poliitikasoovitused" [Feasibility study of innovation policy: Demand side measures for the development and implementation of Estonia. Part II of the study - the policy recommendations], *Innovation Studies* No. 23, www.mkm.ee/sites/default/files/inno_23_final.pdf (accessed 28 January 2016).

Romanainen, J., K. Eljas-Taal, J. Rigby, J. Edler, P. Cunningham, K. Izsak, K. Männik, J. Angelis, K. Kosk, and J. Vallistu (2014b), Feasibility Study for the Design and Implementation of Demand-side Innovation Policy Instruments in Estonia. Final report part 1 – Market Potential and International Experiences, Technopolis Group, www.mkm.ee/sites/default/files/final_report_part_1.pdf (accessed 1 March 2016).

Roolaht, T. (2012), "The problems of Estonian R&D and innovation strategy and the demand-side innovation policies", *Discussions on Estonian Economic Policy*, Vol. 1, pp. 186−203.

Ruttas-Küttim, R. (2014), ERAWATCH Country Reports 2013: Estonia, JRC Science and Policy Reports, https://rio.jrc.ec.europa.eu/en/library/erawatch-country-report-estonia-2013 (accessed 15 February 2016).

SCImago. (2007), SJR — SCImago Journal & Country Rank, Retrieved March 2014, from www.scimagojr.com.

Sepp, J., and R. Wrobel (2011), "The Double Challenge of Transformation and Integration: European Experiences and Consequences for Korea". Sepp, J.; Frear, D. (eds), *The Economy and Economics after Crisis,* Berliner Wissenschafts-Verlag, pp. 211−233.

State Journal (2005), Eesti säästva arengu riikliku strateegia "Säästev Eesti 21" heakskiitmine [Estonian national sustainable development strategy "Sustainable Estonia 21" approval], www.riigiteataja.ee/akt/940717 (accessed 30 January 2016).

Staehr, K. (2010), "An analysis of tax incentives to promote research and development in Estonia", KPMG Baltics AS, Praxis Center for Policy Studies, www.mkm.ee/public/TA-Maksuuuring-2010-01.pdf (accessed 3 March 2016).

Statistics Estonia (2017), Online statistical database, www.stat.ee (last accesssed 13 June 2017).

Statistics Estonia (2015a), Technologically innovative enterprises by type of innovation activity engaged during 2012-2014 and economic activity, 2014, www.stat.ee.

Statistics Estonia (2015b), Statistical Yearbook of Estonia, Statistics Estonia, Tallinn, www.stat.ee/en.

TBP (Tartu Biotechnology Park) (2015a), Toiduainetööstus muudab tooteid teadusega tervisele kasulikumaks [The food industry makes products more useful to health science], http://biopark.ee/uudised/toiduainetoostus-muudab-tooteid-teadusega-tervisele-kasulikumaks (accessed 29 January 2016).

TBP (2015b), Tallinna Teaduspargi Tehnopol ja Tartu Biotehnoloogia Pargi poolt juhitav tervisetehnoloogia klaster sai EAS-ilt 600 000 eurose toetuse [Tallinn Science Park Technopol and Tartu Biotechnology Park, operated by the Health Technology Cluster, received a EE 600 000 euro grant], http://biopark.ee/uudised/tallinna-teaduspargi-tehnopol-ja-tartu-biotehnoloogia-pargi-poolt-juhitav-tervisetehnoloogia-klaster-sai-eas-ilt-600-000-eurose-toetuse (accessed 29 January 2016).

TU (2016), Eelarved [Budget], www.ut.ee/et/ulikoolist/avalik-teave-ja-statistika/finantsstatistika/eelarved (accessed 23 February 2016).

TU (2015), Teaduse populariseerimine [Science popularisation], University of Tartu, www.ut.ee/et/teadus/populariseerimine (accessed 29 January 2016).

Ukrainski, K., T. Tänav, E. Karo, M. Kirs, V. Lember, T. Kalvet, A. Kelli, J. Vallistu, and U. Varblane (2015a), Eesti teadus- ja arendustegevuse ning innovatsiooni strateegia 2007-2013 täitmise analüüs, Lõpparuanne [Estonian Research and Development and Innovation Strategy 2007-2013 Analysis of performance, final report], https://dspace.ut.ee/bitstream/handle/10062/50390/TAI%20strateegia%202007_2013anal%C3%BC%C3%BCs.pdf?sequence=1&isAllowed=y (accessed 30 January 2016).

Ukrainski, K., H. Kanep, K. Timpmann, T. Tänav, T. Hirv, H. Kanep, and E.-L. Otsus (2015b), Eesti teaduse rahastamise seire, Uuring 2.2, lõppraport [Estonian research funding for monitoring, Study 2.2, Final report], http://tips.ut.ee/index.php?module=32&op=1&id=3697 (accessed 10 February 2016).

UPOV (2016), List of UPOV Members, International Union for the Protection of New Varieties of Plants, www.upov.int/members/en/ (accessed 29 January 2016).

Varblane, U., and K. Ukrainski (2016), Teadus- ja arendustegevus ja tootlikkus rahvusvahelises võrdluses, Tartu: Eesti Teadusagentuur, 31-42 [Research, development and productivity in international comparison, Tartu: Estonian Research Agency, pp. 31-42], www.etag.ee/wp-content/uploads/2014/01/TA_teaduskogumik-2016-veeb.pdf (accessed 5 December 2016).

Varblane, U. (2014), Euroopa raha võlu ja valu [The magic of money and pain], Riigikogu Toimetised [Proceedings], Vol. 29, pp. 25−39.

Vooremäe, A. (2011), Teadus- ja arendusstegevuse mõju põllumajandus- ja toidusektori arengule [Research and breeding impact on the agriculture and food sector], Põllumajandus ja maaelu 2011. Koosatnud: M. Aamissepp, E. Matveev, Maamajanduse Infokeskus, Jäneda.

World Economic Forum (2016), *The Global Competitiveness Report 2016-2017: Full data E*dition, Geneva 2015.

Annex 7.A1

Agricultural Innovation System governance mechanisms

Priority setting

Establishment and communication of priorities

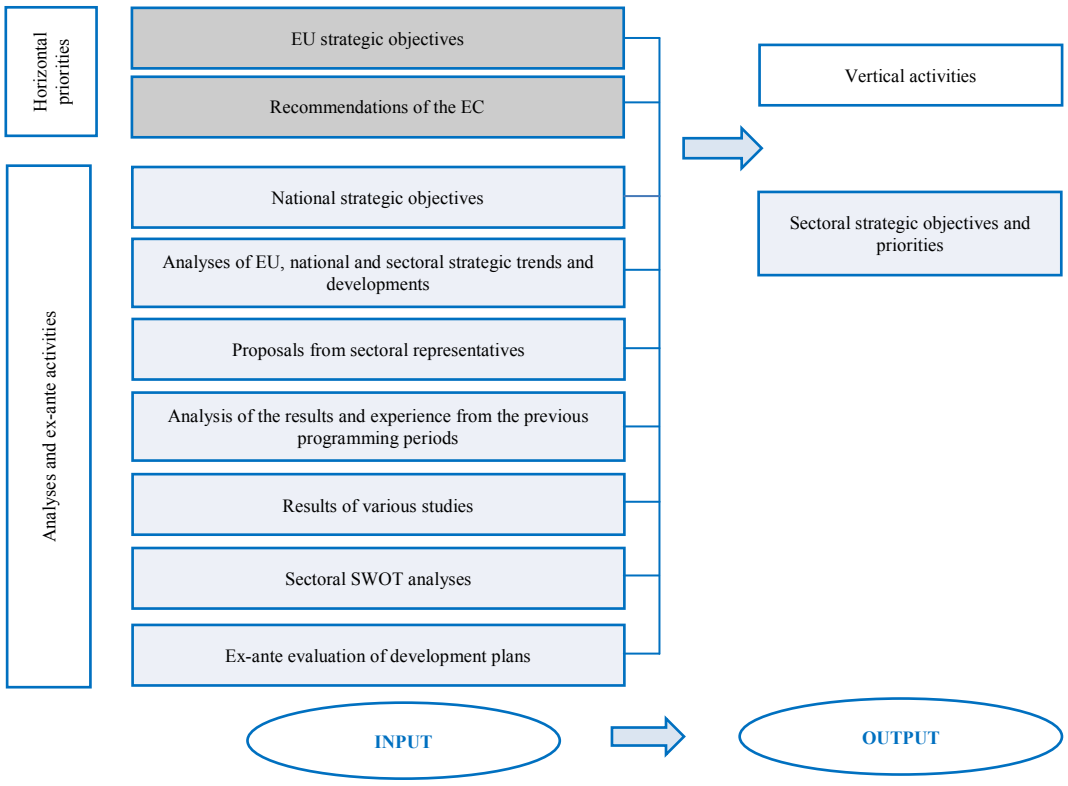
Setting priorities in development strategies in Estonia is based on the goals of the Europe 2020 strategy. Achieving the objectives of innovation strategies — ensuring the sustainable development of society through RDI — is supported by Sustainable Estonia 21 and Estonia 2020.

To implement Estonia 2020, MEAC devises an annual roadmap, which is approved by the Government. The roadmap includes the list of planned activities together with the indicators, budgets and responsible parties. With each new action plan, the report for the previous period is submitted to the Government. The bodies involved in the development and implementation of innovation and entrepreneurship policies have the following roles (MEAC, 2013a):

- MEAC sets the strategic directions and formulates the application principles and distributes the roles between the implementing authorities.
- Innovation and Enterprise Policy Committee advises the Minister of Economic Affairs and Communications on key policy issues and assesses policy implementation.
- EDF organised the foresight activities necessary for long-term policy-making and made direct venture capital investments till the launch of the state venture capital fund, monitored and analysed international economic indexes and made policy suggestions on the basis thereof.
- KredEx supports business development through various financial instruments. KredEx portfolio includes loans, credit insurance and government-guaranteed securities. As a new direction KredEx will start to manage the venture capital fund.
- Enterprise Estonia (EE) helps to implement the innovation and entrepreneurship policy through various support schemes, advising and training. In 2014-20, the foundation puts more emphasis on the development of long-term partnerships with enterprises, and providing support through comprehensive development plans.

Figure 7.A1.1 describes the mechanism for the development of priority areas in agriculture.

Figure 7.A1.1. Mechanism for the development of priority areas



Source: EMÜ (2017).

The development plans are based on SWOT analyses, the analysis of the strategic documents of the EU, other countries and sectors, as well as the results and experience from previous development plans. According to the Regulation of the European Parliament and of the Council of the European Agricultural Fund for Rural Development (EAFRD) *ex ante* evaluation and SWOT analysis form a mandatory part of the development plan (Official Journal, 2014). The *ex ante* evaluation of the Estonian RDP is carried out by the procured enterprises, whereas the MRA and the permanent evaluators (from the EMÜ and the ARC) provide their input (MRA, 2016c).

During the *ex ante* evaluation, the evaluators conduct interviews with the representatives of the organisations responsible for the implementation and consult with the representatives of the Government Office and ministries, in order to take into account the developments in national policies. For example, when providing *ex ante* evaluation on the RDP 2014-20, the experts suggested that a greater emphasis should be placed on the dissemination of information in the field of RDI, as well as on enhancing cooperation between the different parties, including farmers, entrepreneurs and advisory services. A significant threat to the sustainability of agriculture is the insufficient spread of RDI information, and the lack of cooperation between different stakeholders in promoting innovation. The evaluators also state that offering multi-disciplinary solutions to agricultural producers and processors has taken a secondary place, as a result of which the actors have not received sufficient information on the entire production chain (MRA, 2016c).

Measurement and evaluation of performance

Framework for performance evaluation

Until March 2016 the Estonian Development Fund (EDF) was responsible for the monitoring and analysis of the growth areas, engaging entrepreneurs, researchers, and sectoral ministries, and, if necessary, other institutions or partners in the discussions on specific growth areas. Smart specialisation areas were controlled by a Steering Committee comprising the representatives from the MER, MEAC, Government Office, MoF and, if necessary, the representatives of other ministries and enterprises. The Steering Committee monitored the movement towards achieving the goals and fulfilment of the objectives and, when necessary, made proposals for changes in policies and activities, or initiated changes to the strategies (MEAC, 2013a). To continue the monitoring activities performed by the EDF, an independent unit with its own budget and competence for decisions will be set up under the Estonian Parliament, whereas the responsibility for EDF investment activities will be transferred to KredEx (Parliament of Estonia, 2016).

The priority of the Cohesion Policy Funds Operational Programme 2014-20 "Stimulating business growth supported by R&D" is related to economic growth and RDI. Performance indicators include the share of private spending on R&D activities in the public sector, Estonia's success rate in Horizon 2020, the scope of agreement of the obtained funding per capita, the share of R&D expenditure in the private sector (% of GDP), the share of enterprises cooperating for innovation with universities and other institutions of higher education as a percentage of total surveyed enterprises, and resource productivity attained through innovative solutions (MoF, 2014b).

Programmes are evaluated to find out how effective an action has been. To do this, data on the results and impact of the programmes, including the environment, agriculture and rural development as a whole, is collected and consistency with the set targets is assessed. As to the nature of their content, the evaluations are divided into evaluations of an operational nature, focusing on the functioning of the system, and evaluations of a strategic nature, focusing on the achievement of the objectives. Evaluation is carried out in three stages (MoF, 2014b):

1. *Ex ante* evaluation (including the *ex ante* evaluation of the EU and the European Cohesion Policy Funds operational programmes, as well as *ex ante* evaluation of sectoral development plans).
2. Evaluations undertaken during the programme period (typically carried out in two-year cycles, with the aim to assess the efficiency, effectiveness and impact of priority axes).
3. *Ex post* evaluations (evaluations carried out after the end of the period. These evaluations are performed by the EC in cooperation with the member states. Member states, including Estonia, can arrange additional needs based evaluations to identify the effects of subsidies).

The evaluation of the RDI system in Estonia as a whole was carried out over the period 2011-15 in the framework of a special monitoring programme "TIPS" for research and innovation policies, launched specially by the MER, where evaluations were carried out by researchers and scientists from the TU and TUT.

Since 2002, a series of studies and surveys "Innovation Studies", commissioned by the MEAC has been published. The series brings together studies, evaluations and analyses on the Estonian innovation system and innovation policy. The action is an attempt to raise awareness for innovation and promote knowledge-based innovation policy in Estonia.

Permanent evaluators participate in the evaluations, policy studies are conducted by Estonian and international bodies and the National Audit Office of Estonia also passes its judgement through audits.

Levels (project, programme, system) and frequency of performance evaluation

Estonia 2020 is reviewed annually and updated, if necessary. The upgrading process takes into account the statistics related to achieving the set objectives, the country-specific recommendations obtained during the European semester, discussions between ministries, strategy documentation on the use of support/investments

for the EU budget period 2014-20, as well as the priorities of the new government coalition and the challenges specified in the talks between the prime minister and ministers (Government Office, 2014).

Statistics Estonia, acting under the leadership of the MOF, monitors the implementation of Sustainable Estonia 21. Statistics Estonia collects and analyses the statistics on sustainable development and every two years publishes the results of the statistics in the publication "Sustainable Development Indicators" (Statistics Estonia, 2015a).

The implementation of the RDI policy is monitored on an annual basis. MER is responsible for the implementation of the programme and reports the monitoring results to the Government every year. The evaluation of the strategic objectives is based mainly on official and internationally comparable statistics (Eurostat, Statistics Estonia, European Innovation Union Scoreboard, Europe 2020 implementation surveys, OECD databases, the Estonian Education Information System EHIS; Scopus/Science Metrics, Thompson Reuters Web of Science, the Horizon 2020 database). All these sources are used to check whether the target levels of the indicators have been reached. For some indicators, where drawing comparisons is not possible, a methodology for benchmarking is developed. The monitored indicators include the share of private investment (% of GDP), productivity per worker as of the EU27 average (%), Estonia's place in the Innovation Union Scoreboard, number of PhD defences in an academic year, the proportion of high-level Estonian scientific papers among the 10% of the world's most cited articles, the number of high-level Estonian scientific articles per one million inhabitants, the share of private sector investments into the R&D expenditure of the public sector, the share of expenditure earmarked for socio-economic applications (except academic studies) from the state budget R&D allocations, the share of high-tech products and services in exports (%), the share of high and medium-high-tech sector employment as of total employment (%), Estonia's success rate in obtaining funding from the Horizon 2020, including the volume of contracts per capita (% of the EU average), and the proportion of internationally coordinated research in state-funded R&D (MER, 2014a).

In the middle of the programme period, an interim report on the implementation of the R&D strategy will be compiled under the leadership of MER. Interim evaluations are carried out by the respective specialised research institutions. Both quantitative (databases, statistics, reports, etc.) and qualitative (interviews, panel of experts, etc.) methods are used in the evaluation. At the end of the programming period, the success of the strategy as a whole, as well as the effectiveness of the measures and the capabilities of the participants are analysed, and recommendations for the next period are made.

The current RDI programming period (2014-20) is the third one. At the end of the first period (2004-06), the evaluators assessing the implementation of the strategy pointed out that the RDI system in Estonia was more public sector (financing) centred than in the EU countries on average, whereas the final report for the second period (2007-13) stated that Estonia was moving towards a model dominated by enterprise and higher education institutions, characteristic of the Nordic countries. A problematic aspect highlighted at the beginning of the third programming period was high dependence on the R&D activities of enterprises and higher education institutions on public funding, and the non-compliance of some indicators to peculiarities of Estonia (e.g. patents as too narrow an indicator, or Estonia's place in the Innovation Union Scoreboard, which is measuring the R&D-based innovation, rather than the import of knowledge and its application for the benefit of the society, which is important from Estonia's point of view (Ukrainski et al., 2015a).

In the framework of Estonia 2020, MEAC is responsible for the implementation and monitoring of the entrepreneurship and innovation policy in Estonia. The entrepreneurship and innovation policy evaluation is designed to assess the impact, effectiveness and feasibility of the implemented measures. To implement the strategy, every year MEAC prepares an action plan (with the report on the previous action plan), which is approved by the government. The action plan lists the planned activities together with the indicators, budgets and responsible parties. Mid-term evaluations take place every two years and assess the impact of business supports and loans on enterprises. Enterprises that have used the respective services are compared to companies that have not used such services. The evaluators use both the corporate economic performance data, and interviews and surveys. Quantitative and qualitative combined research methods are used. Interim

evaluations are commissioned and organised by the MEAC and conducted by MEAC in cooperation with EE and KredEx (Jaaksoo et al., 2012).

In addition, Estonia participates in the Community Innovation Survey (CIS) carried out by the European Union every two years. Establishments answer questions about product, processes, marketing and organisational innovation, as well as about the sources of innovation and cooperation and the distribution and volume of investments. Information on new products and non-domestic revenues is also collected. The aim of the CIS data analysis is to identify the barriers to the innovation process and find the biggest obstacles affecting the innovation system (Kaarna et al., 2015).

As to Smart Specialisation, monitoring activities were carried out by EDF. The intermediate and *ex post* evaluations are arranged by RDC. These reports compare the obtained results against the set objectives as well as to the world-class achievements (MER, 2014a).

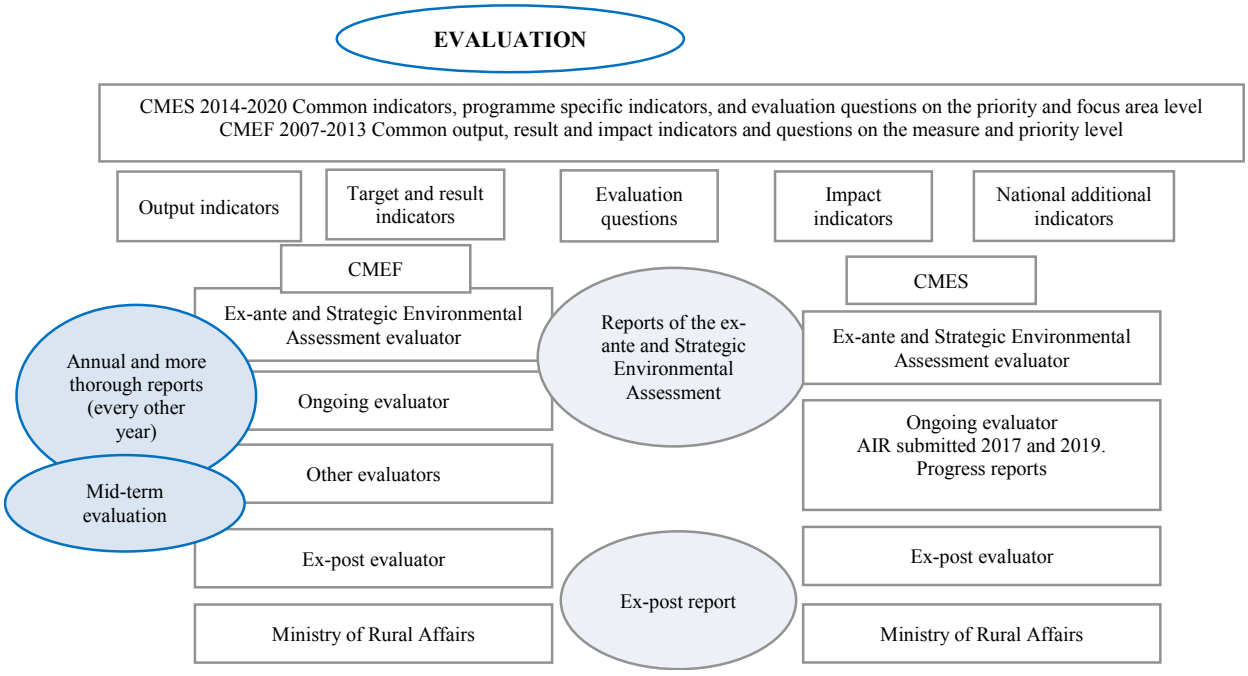
Criteria of performance measurement

Since 2006, a common pan-EU evaluation process, the Common Monitoring and Evaluation Framework (CMEF), is used to assess Estonian RDP. The CMEF establishes agreed indicators for assessing the achievement of established results and impacts. In addition, the CMEF includes evaluation questions, which can be approached through additional national indicator analysis. In 2014, the common monitoring and evaluation system (CMES), which is a part of the CMEF was introduced.

The aim of the ongoing evaluation system is to monitor the results and impact of the Estonian RDP. In the course of the ongoing evaluation, the assessors, among other things, perform sectoral studies and analyses necessary for elaborating on the evaluation. ARC (agri-environmental measures) and the Department of Rural Economy Research of the Institute of Economic and Social Sciences of EMÜ (other rural development measures) are responsible for the ongoing evaluations. The aim is to identify and monitor the results and impacts across the RDP, including the impact of CAP Pillar 1 measures on the Estonian RDP, and vice versa, as well as to assess the impact of other horizontal issues (sustainable development, climate change and innovation) in the context of the Estonian RDP and the contribution of the Estonian RDP into the common strategic framework. The evaluators measure the output indicators once a year.

The evaluation (2014-20) is predominantly conducted along the priorities, measures, target areas and priorities of the projects. According to the CMEF, output indicators are set on the measures level, result indicators on the target area level and impact indicators on the priorities level. For the period 2007-13, the indicators were set at the measure level. The impact of the implementation of the Estonian RDP is assessed in four sections (Figure 7.A1.2).

Figure 7.A1.2. Monitoring and evaluation system of the Estonian RDP

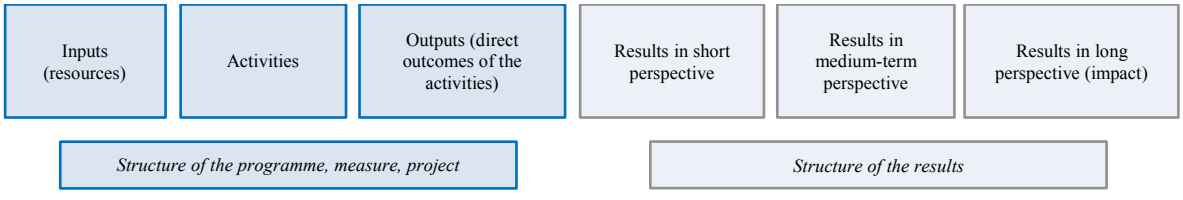


Source: Based on MRA (2016a).

Availability of input and output indicators

Different evaluations are carried out to identify the efficiency of the systems, programmes, measures, activities and projects. Indicators have been developed to measure the results, the changes as a result of the intervention and the performance of the participants. So far, the RDI indicators applied in Estonia have primarily been focused on the use of input and output indicators comparable to the EU that describe and analyse the dynamics of the RDI system based on the framework of EU policies and objectives. The current use of indicators has thus been of a monitoring nature. The development of more detailed indicators with intervention logic is carried out in the preparation phase of the specific operational plans and programmes (Karo et al., 2014b). The criteria used for the evaluation of indicators are in this case divided into three groups: validity (the indicator measures what needs to be measured) and reliability (replicability of results), efficiency (source data availability and processing costs), and quality (simplicity of use and impact). The indicators are assessed and the relevant recommendations are made by the expert analysts during the *ex ante* evaluation of the new strategy. Indicators are divided into input, output and performance indicators (Figure 7.A1.3) (Masso et al., 2013). Similar indicators are used in the field of agriculture and in the Monitoring and Evaluation System of the Estonian RDP.

Figure 7.A1.3. Types of indicators



Source: Based on Masso et al. (2013).

At the measure level, monitoring data collection and reporting is carried out through ARIB and other relevant institutions, including the Foundation Private Forest Centre (PFC), LEADER local action groups and the RERC. Once a year ARIB prepares and submits an annual report to MRA on the basis of relevant information.

The innovation indicators for evaluating measures that support innovation in the Estonian RDPs for 2007-13 and 2014-20 are presented in Table 7.A1.1. In addition to indicators, the European Commission has developed common evaluation questions. Evaluation questions in the field of innovation in 2014-20 are quite similar to those used in 2007-13, although they are priority target areas based, rather than measure-based (Table 7.A1.2).

In addition to the evaluation of RDP implementation, the respective results achieved by agriculture-related companies/organisations are assessed in the course of the evaluation of all strategies listed in Table 7.A1.3, including RDI policy, Sectoral R&D activities and Entrepreneurship and innovation policy.

Table 7.A1.1. Indicators for the measures supporting innovation in RDPs 2007-13 and 2014-20

2007-13				2014-20			
Measures	Output indicator	Result indicator	Impact indicator	Focal sectors/measures	Target indicator	Output indicator	Result indicator
Priority: Improving the competitiveness of the agricultural and forestry sector				**Priority: Fostering knowledge transfer and innovation in agriculture, forestry, and rural areas**			
Training and information activities	Number of participants in training and information sessions; Number of training and information sessions a year	Number of successful completions	GVA changes per unit labour costs per year; Additional indicators: proportion of managers of agricultural holdings with basic and full education; proportion of adult population participating in life-long learning	Fostering innovation, cooperation, and the development of the knowledge base in rural areas Measures: - Knowledge transfer and information, - Advisory services, - Farm management and farm relief services, - Cooperation	Share of expenditure from the total Estonian RDP expenditure	Total public expenditure; total public expenditure on training and mobility and promotion schemes of agricultural enterprises	% of innovative projects out of all RDP supported projects; Number and types of partners involved in cooperation projects; Number of supported innovative actions implemented and disseminated by EIP operational groups
Support for advisory system and services	Number of agricultural producers and private forest owners supported Number of centres reformed	Increase in GVA of agricultural producers and private forest owners supported	GVA changes per unit labour costs per year	Strengthening the links between agriculture, food production and forestry and research and innovation, including for the purpose of improved environmental management and performance Measures: -Cooperation	Total number of cooperation projects (groups, networks/clusters, pilot projects, etc.) supported	Number of EIP working groups supported (creation and activity); Number of other cooperation projects (groups networks/clusters, pilot projects, etc.) supported	% of cooperation operations continuing after the RDP support including for the purpose of improved environmental management and performance Number and types of partners involved in cooperation projects

Table 7.A1.1. Indicators for the measures supporting innovation in RDPs 2007-13 and 2014-20 (cont.)

2007-13				2014-20			
Measures	Output indicator	Result indicator	Impact indicator	Focal sectors/measures	Target indicator	Output indicator	Result indicator
				Priority: Enhancing farm viability and competitiveness of all types of agriculture in all regions and promoting innovative farm technologies and the sustainable management of forests			
Modernisation of agricultural holdings	Number of agricultural entrepreneurs and producers supported; the volume of investments per programming period	Number of agricultural entrepreneurs and producers making innovative products or use innovative technologies per programming period; Increase in NVA by the end of the programming period	Growth in NVA and change in GVA per unit labour costs by the end of the programme	Improving the economic performance of all farms and facilitating farm restructuring and modernisation, notably with a view to increasing market participation and orientation as well as agricultural diversification Measures: -Knowledge transfer and information; -.Advisory services; - Farm management and farm relief services; - Investments into real property; - Development of agricultural; holdings and entrepreneurship; - Cooperation	The share of agricultural holdings receiving support for investments in the re-organisation and modernisation from the Estonian RDP	Number of participants in training; total public expenditure on education and skills acquisition actions, mobility and promotion in agricultural holdings; Number of beneficiaries receiving advice; Number of agricultural holdings receiving support for investing in agricultural holdings; total public expenditure on investments in infrastructure; Number of agricultural holdings receiving business start-up aid for setting up small-scale agricultural enterprises	% of agriculture holdings with RDP support for investments in restructuring or modernisation Complementary result indicator: Change in agricultural output on supported farms/AWU (Annual Work Units)

Table 7.A1.1. Indicators for the measures supporting innovation in RDPs 2007-13 and 2014-20 (cont.)

2007-13				2014-20			
Measures	Output indicator	Result indicator	Impact indicator	Focal sectors/measures	Target indicator	Output indicator	Result indicator
				Priority: Promoting food chain organisation, including processing and marketing of agricultural products, animal welfare and risk management in agriculture			
Improving the economic value of forests and adding value to forestry products	Number of properties supported; Total volume of investments Number of prevention and restoration actions	Boosting the production potential and value of forests; Number of micro-enterprises applying new products and innovative technologies		Improving competitiveness of primary producers by better integrating them into the agri-food chain through quality schemes, adding value to agricultural products, promotion in local markets and short supply circuits, producer groups and organisations and inter-branch organisations Measures: - Knowledge transfer and information; -.Advisory services; - Farm management and farm relief services; - Quality assurance schemes for agricultural and food products - Investments into real property; - Creation of producer groups and organisations -Cooperation	Share of agricultural holdings receiving support through quality assurance schemes, local markets and short supply chains, producer groups and organisations	Number of participants in training; total public expenditure on education and skills acquisition actions, mobility and promotion schemes in agricultural holdings; Number of beneficiaries receiving advice; Number of activities receiving support for investments; Number of activities receiving support for producer group creation; Number of agricultural holdings participating in activities of the supported producer groups; Number of agricultural holdings involved in the cooperation within the supply chain or promote cooperation on the local level	% of agricultural holdings receiving support for participating in quality schemes, local markets and short supply circuits, and producer groups/ organisations

Table 7.A1.1. Indicators for the measures supporting innovation in RDPs 2007-13 and 2014-20 (cont.)

2007-13				2014-20			
Measures	Output indicator	Result indicator	Impact indicator	Focal sectors/measures	Target indicator	Output indicator	Result indicator
Adding value to agricultural and non-wood forestry products	Number of enterprises and cooperative societies supported; total volume of investments	Number of enterprises and cooperative societies introducing new products and innovative technologies	Net value added expressed in purchasing power standard (PPS), (% of EU average); change in GVA per unit labour costs per year	Supporting farm risk prevention and management Measures: - Advisory services; - Farm management and farm relief services.	Number of agricultural enterprises participating in risk management schemes	Number of beneficiaries receiving advice; total public expenditure	% of farms participating in risk management schemes
Development of new products, processes and technologies in the sectors of agriculture, food and forestry	Number of cooperation projects supported	Number of entrepreneurs introducing new products and innovative technologies	Net value added expressed in purchasing power standard (PPS), (% of EU average); change in GVA per unit labour costs per year				

Sources: based on Estonian Rural development Plans for programming periods 2007-13 and 2014-20 and Common evaluation questions for rural development programmes 2014-20

Table 7.A1.2. Evaluation questions concerning innovation about the implementation and impact of the Estonian RDP 2007-13 and 2014-20

2007-13		2014-20		
Measure	Evaluation question	Priority	Focal sector	Evaluation questions
Training and information activities	To what extent have the training, information, knowledge and innovative practices dissemination activities improved labour productivity and/or other elements related to competitiveness in the agricultural, food and forestry sector? To what extent have the training activities contributed to improving sustainable land management, including sustainable use of natural resources? To what extent are the supported training courses in accordance with the actual needs and coherent with other measures of the programme?	Fostering knowledge transfer and innovation in agriculture, forestry, and rural areas	Fostering innovation, cooperation, and the development of the knowledge base in rural areas	To what extent have RDP interventions supported innovation, cooperation and the development of the knowledge base in rural areas? RDP projects have been innovative and based on developed knowledge • Operational groups have been created • Variety of partners involved in EIP operational groups • Innovative actions have been implemented and disseminated by the EIP operational groups
Support for advisory system and services	To what extent has the measure improved the management and economic performance of agricultural and forestry enterprises? Specify the following aspects: production techniques; quality standards: occupational safety; management of natural resources. To what extent has the measure contributed to improving the human potential in the agricultural sector? To what extent has the scheme contributed to improving the competitiveness of the agricultural sector?		Strengthening the links between agriculture, food production and forestry and research and innovation, including for the purpose of improved environmental management and performance	To what extent have RDP interventions supported the strengthening of links between agriculture, food production and forestry and research and innovation, including for the purpose of improved environmental management and performance? Long term collaboration between agriculture, food production and forestry entities and institutions for research and innovation has been established • Cooperation operations between agriculture, food production and forestry and research and innovation for the purpose of improved environmental management and performance have been implemented
Modernisation of agricultural holdings	To what extent have investment grants contributed to a better use of production factors in agricultural enterprises? Specifically, to what extent have investment grants facilitated the introduction of new technologies and innovation? To what extent have investment grants enhanced the market access and market share of agricultural enterprises? To what extent have investment grants contributed to long-term and sustainable activity of agricultural enterprises? To what extent have investment grants contributed to improving the competitiveness of the agricultural sector?	Enhancing farm viability and competitiveness of all types of agriculture in all regions and promoting innovative farm technologies and the sustainable management of forests	Improving the economic performance of all farms and facilitating farm restructuring and modernisation, notably with a view to increasing market participation and orientation as well as agricultural diversification	To what extent have RDP interventions contributed to improving the economic performance, restructuring and modernisation of supported farms in particular through increasing their market participation and agricultural diversification? Agricultural output per annual working unit of supported agricultural holdings has increased • Farms have been modernised • Farms have been restructured

Table 7.A1.2. Evaluation questions concerning innovation about the implementation and impact of the Estonian RDP 2007-13 and 2014-20 (cont.)

2007-13		2014-20		
Measure	Evaluation question	Priority	Focal sector	Evaluation questions
Improving the economic value of forests	To what extent have investment grants contributed to the diversification of the production of forest enterprises? To what extent have investment grants contributed to increasing the market share of forest enterprises, and improving market access in such sectors as renewable energy? To what extent have investment grants contributed maintaining or improving the sustainable management of forests? To what extent have investment grants contributed to increasing the competitiveness of forest holdings?	Promoting food chain organisation, including processing and marketing of agricultural products, animal welfare and risk management in agriculture	Improving competitiveness of primary producers by better integrating them into the agri-food chain through quality schemes, adding value to agricultural products, promotion in local markets and short supply circuits, producer groups and organisations and inter-branch organisations	To what extent have RDP interventions contributed to improving the competitiveness of supported primary producers by better integrating them into the agri-food chain through quality schemes, adding value to the agricultural products, promoting local markets and short supply circuits, producer groups and inter-branch organisation? Competitiveness of supported primary producers has improved • The share of the final price of agriculture products retained with primary producers has increased • The added value of agricultural products of primary producers has increased Implementation of quality schemes by primary producers has increased • Participation of primary producers in short circuit schemes, quality-oriented producer group and/or inter branch organisation has increased
Adding value to agricultural and forestry products	To what extent have investment grants contributed to introducing new technologies and innovation? To what extent have investment grants contributed to improving the quality of agricultural and forestry products? To what extent have investment grants contributed to improving the efficiency of agricultural and forestry product processing and marketing? To what extent have investment grants contributed to enhancing the market access and market share of agricultural enterprises and forest holdings, including in such sectors as renewable energy? To what extent have investment grants contributed to improving the competitiveness of the agricultural and forestry sector?		Supporting farm risk prevention and management	To what extent have RDP interventions supported farm risk prevention and management? Participation of farms in risk prevention and management schemes has increased
Cooperation in the sectors of agriculture, food and forestry to develop new products, processes and technologies	To what extent has the support enhanced the market access of primary agricultural and forestry products and the market share of innovative products, processes and technologies developed in cooperation between the participants in the production chain? To what extent has the support contributed to improving the competitiveness of agricultural, forestry and food sector?			

Sources: based on Guidelines for ongoing assessment, rural development programmes in 2007-13 and Common evaluation questions for rural development programmes 2014-20.

Table 7.A1.3. Innovation policy indicators in national strategies

Policy	Responsible institution	Evaluation frequency	Data sources	Submitted to:	Innovation indicators
RDI policy	Ministry of Education and Research *(sectoral RDI indicators are presented to MER by sectoral ministries, including MRA)*	Once a year	Eurostat; Statistics Estonia; Innovation Union Scoreboard; Surveys on Strategy "Europe 2020" implementation; OECD; Estonian Education Information System EHIS; Scopus/Science Metrics; Thompson Reuters Web of Science; Horizon 2020 database	National government	Proportion of RDI, including private investments, % GDP; *productivity per employee, % of the EU average, Place of Estonia in the European Innovation Scoreboard; Number of defended PhD theses in a study-year; Number of high-level articles belonging to the 10% of the most cited articles in the world; Number of high-level articles per one million inhabitant; Share of private investments in the RDI of the public sector; Share of financing earmarked for socio-economic activities (except academic research) in the RDI allocations in the state budget; Share of high-tech products and services in export, %; Employment in high-tech sector from total employment, %, Estonia's success in Horizon 2020, including the volume of financing received per inhabitant, % of EU average; Share of internationally coordinated research from the state supported R&D activities; Number of joint publications of public and private sector (Innovation Union Scoreboard)
Sectoral R&D activities	Sectoral ministries, including MRA	Once a year	Statistics Estonia	MER	Number of employees engaged in research and development; Internal and external expenditures on R&D of enterprises in entrepreneurship sector; Number of employees engaged in R&D activities in non-profit sectors Number of employees engaged in R&D activities in non-profit sectors by field of action; Expenditure on R&D by institutional sector and types of expenditure; Expenditure on R&D and their financing from the state and municipal budget
Entrepreneurship and innovation policy	MEAC	Once a year or every other year	Business register, Enterprise Estonia	National government	Number of enterprises cooperating in the field of innovation; R&D expenditures in enterprises; Added value per employee; Number of enterprises launching innovative products; Number of innovative ideas entering the market; Revenues from sales, including revenues from innovative products; Export income and net income of an enterprise.

Table 7.A1.3. Innovation policy indicators in national strategies (cont.)

Policy	Responsible institution	Evaluation frequency	Data sources	Submitted to:	Innovation indicators
Agricultural innovation policy (as expressed in the RDP)	MRA	Once a year	Statistics Estonia, ongoing evaluator, World Economic Forum	EC	Planned output indicators in 2014-20: Public sector expenditure on knowledge transfer and dissemination (including training, demonstration and dissemination activities, visits to enterprises, workshops); Number of participants in training; Public sector expenditure on advisory services (including individual advice and training of advisors) and agricultural enterprise management and replacement activities; Public sector expenditure on enhancing cooperation (including the development of innovation clusters, new products, practices, processes and technologies); Number of EIP working groups supported (launch and activity); Number of other cooperation projects (groups, networks, clusters, test projects, etc.): Additional indicator that were measured in 2007-13: Economic growth (measured through the net added value earned by the beneficiary (% of EU27 average); Productivity of labour; Competitiveness (better economic results, more efficient use of resources, etc. as compared to other enterprises); Labour efficiency and wages; Efficiency of production and marketing; Economic sustainability (expressed through financial ratios of beneficiaries).

Source: Based on MRA (2016a), MER (2014a), EMÜ (2015c), Mihkelson et al. (2014).

Benchmarking tools

In the course of the ongoing evaluation, the assessors analyse the implementation of the planned measures, as well as the fulfilment of the objectives set. The EMÜ and the ARC analyse the impact of the implementation of the agricultural innovation policy. ARIB registers, records of other pertaining institutions, research data on a sector basis, and various databases (Agricultural Board, Statistics Estonia, FADN, etc.) are used during the analysis.

In the assessment of the achievements in RDI, mainly official and internationally comparable statistics are used (Eurostat, Statistics Estonia; Innovation Union Scoreboard, Europe 2020 implementation surveys, the OECD, the Estonian Education Information System EHIS; Scopus/Science Metrics; Thompson Reuters Web of Science, the Horizon 2020 database), which the attained target objectives or levels are checked against.

The development of measures for the achievement of the objectives of the sector-specific development plans is preceded by an *ex ante* evaluation and a feasibility analysis, which include a comparative analysis of the objectives, the current situation and the context (necessary preconditions for the implementation of the instruments). The feasibility study also analyses similar experiences of other countries in implementing the measures (for example the development of demand-side measures for the innovation policy).

In the course of mid-term and *ex post* evaluations, experts compare the implementation results to the objectives set. Comparisons between the various sectors and performance within the sector are also carried out. The impact of support for entrepreneurship and innovation and loans on enterprises is also evaluated through comparative analysis. The enterprises granted the support are compared to businesses that have not used the support. The economic indicators of the company and surveys are used as data sources.

The effectiveness analysis comparing the implementation of innovation policy between the EU countries is conducted by the European Commission, which annually collects the necessary input data for the analysis from the member states.

Evaluation of economic, environmental and social impacts of innovation

For both the RDP 2007-13 and the RDP 2014-20, the impact of the innovation measures and innovation measures from other focal sectors on the economy, environment and the social sphere is assessed. These questions are reflected in the EC common evaluation questions for rural development. The results of the economic, environmental and social aspects are nationally assessed in the course of mid-term and *ex post* evaluations (in the new period during the compilation of the strategy report). Compared to the 2007-13 period, in the new period the above-mentioned aspects are evaluated horizontally, whereas in 2007-13 the results were assessed based both on the measure and through general evaluation questions horizontally. In both periods, assessing the outcome of the support interventions and the impact of innovation on economy has received the most attention. The impact of innovation on the environment and social aspects has been evaluated indirectly through the implementation of agricultural policy and support schemes earmarked for development. Tables 7.A1.2 and 7.A1.3 present the indicators reflecting the innovation performance on the economy, as well as the evaluation questions. Indirect effects of the innovation performance on the environment are assessed through the impact of investment grants on forest area management, preservation and improvement of biodiversity, ensuring animal welfare, developing farming systems, maintaining and improving water and soil quality, and mitigating the effect of climate change. The impact of innovation activities on the social aspects are assessed through the overall improvement in the quality of life in rural areas, an increase in employment growth and the promotion of entrepreneurship.

Evaluation methods and frequency

The impact of the RDI strategy on enterprises has been inclusively estimated in a number of studies (mainly in the framework of research and innovation monitoring programmes). Several measures have been studied in the 'analytical matching framework', where a control group was created. The control group was similar in all other characteristics, but did not receive the support. The performance of different groups was compared to identify the impact of the support. For example, in 2012, the Estonian Audit Office, which is also

authorised to study the country-wide innovation impact on enterprise competitiveness, in collaboration with Statistics Estonia, carried out an 'analytical matching framework' study and survey into the impact of innovation support measures. To assess the impact of the innovation support measures, enterprises receiving subsidies for the years 2004-12 from EE were interviewed in 2012 and compared to enterprises not supported. The enterprises supported were asked how the received support affected the company's economic indicators (revenue, exports, value added), whether new products or services had been developed, etc. Enterprises not supported were asked to explain why they had not applied for support. Both groups of the enterprises were asked which kind of support companies should offer (NAO, 2014). TUT's researchers studying the same issue with a slightly different methodology than the Estonian Audit Office came to practically the same conclusions. Both studies showed that there were positive correlations with the company's turnover and number of employees, but the correlation with performance (productivity) could not be found, or a statistically significant negative correlation was detected. The general problem of the studies performed was that the time between receiving the grant and measuring the results was too short, which is the reason the results reflect the corporate profile of the companies receiving support rather than the effectiveness of the support (Ukrainski et al., 2015a).

The problem in assessing the success of the implementation of the programmes is a time-lag between the programme outcomes and their effects, which may take years. Usually the immediate control over the programme ends with the outputs. The changes induced by the outputs are affected by all sorts of external factors. The longer the delay between the output of the programme and the impact of the achieved output, the more uncontrollable factors intervene in the chain. However, this delayed impact is of real importance and should be evaluated (Masso et al., 2013).

Compared to the input and output indicators of the programmes, projects and activities, the use of result indicators has been limited despite the fact that performance indicators should make it clear what the actual impact of the intervention has been. The use of impact indicators in RDI fields, however, is difficult because the effects can be very versatile by nature (therefore, in recent assessments more and more attention is being paid to the so-called behavioural added value, where, for example the beneficiary of the supported R&D projects or research cooperation continues the use and expansion of the RDI network to meet the challenges facing them), and/or the impact of the specific intervention may manifest itself only after a longer period (Karo et al., 2014).

Use of evaluation results in priority setting and decision making

Thematic objectives and key actions have been agreed upon in the pan-European strategic coherence framework (EC, 2012). During the period 2014-20, the rural development policy is included in the common pan-European strategic frameworks of the ERDF, the European Social Fund, the Cohesion Fund and the European Maritime and Fisheries Fund. As part of the joint planning, a partnership agreement is negotiated and signed with the EC at the national level.

In setting long-term objectives, member states comply with the sectoral and cross-sectoral (including innovation) Europe-wide objectives, thereby contributing, through the implementation of the objectives, to the improved competitiveness on the European level. The member states also base their choice of measures for achieving the objectives on the key actions of the EU, taking into account national/regional specificities. The adoption of every new sectoral strategic plan is preceded by an *ex ante* evaluation, for which input includes results of the performance and impacts assessment of the previous programming period, as well as the analysis of economic trends and the international and national economic environment. Inputs are the basis for the formulation and development of the new economic and innovation policy. *Ex ante* evaluations usually take place in parallel with the elaboration of the development plans for the new period, which is why the inputs are up to date. *Ex ante*, mid-term and *ex post* evaluations are carried out by experts who give expert opinions and recommendations related to the goals and measures of the new period.

The Research and Development Council (RDC) advises the government in matters relating to the development of the national research, development and innovation system. The RDC advises the Government on the preparation of the draft state budget in respect to the amounts prescribed for research and development,

on the establishment and reorganisation of research and development institutions and the termination of their activities and on establishing the conditions and procedures for the evaluation of research and development. The RDC also presents its opinion to the government on the national research and development programmes presented by the ministries and on the objectives of research and development policy for the forthcoming period (Government Office, 2016).