Chapter 2

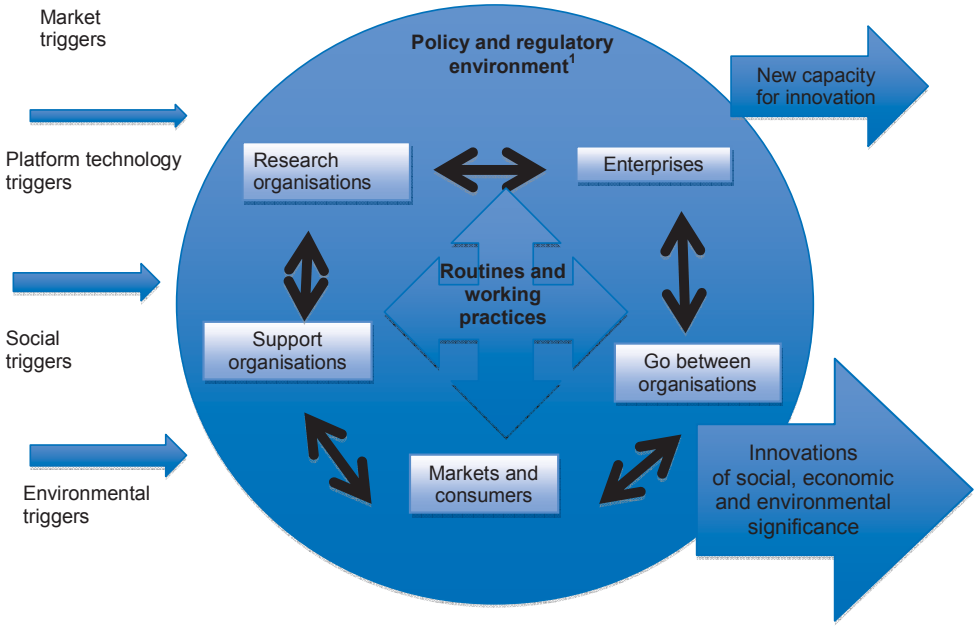
Overview of developments in Agricultural Innovation Systems

This chapter presents an overview of the main trends in Agricultural Innovation Systems (AIS). AIS are diverse, but there are common trends in developed and emerging economies. The scope of innovation has broadened and today AIS include more actors and more diverse institutions. At the international level, a greater number of countries (e.g. Brazil) are active players in agricultural R&D and technology transfers. As such, there is an increased need for interaction not only across components of the AIS, cut also with other innovation sectors and across countries. This is especially the case as budget constraints have been tightened in many countries, while demand for more innovation is growing. This requires stronger governance, planning, priority setting and evaluation mechanisms. This, in turn, has prompted many countries to review their AIS and its performance.

2.1 The diversity of Agricultural Innovation Systems actors and institutions

A number of organisations play various roles in guiding, enabling, funding, creating and diffusing innovation (Figure 2.1). Knowledge is produced and used through their actions and interactions. Hall (2012) describes a number of innovation organisations and actors from the public and private sectors, which respond to market, policy, environmental and social triggers and, together, produce innovation of economic, environmental and social significance. Box 3.1 provides a detailed list of organisations and their main functions. Innovation is produced in a wide variety of organisations. For example, public and private research organisations, higher education establishments and private companies create codified knowledge (or know-what), while enterprise organisations, including farms, are mainly users of this codified knowledge, but sometimes produce tacit knowledge (or know-how). Demand organisations, including consumers, government and international markets, influence research priorities and adoption of innovation, as well as consumers' acceptance. Support organisations facilitate physical and human investment in the creation and adoption of innovation, while go-between organisations help farmers and other enterprises apply innovation. The following paragraphs single out three important organisations — public agricultural R&D, education and extension organisations — and outline their diversity in various OECD countries and emerging economies.

Figure 2.1. Elements of a dynamic working system



1. The government is a major player in innovation. Its roles include setting the policy and regulatory environment, funding and performing research and related activities at central and local level, and providing information, innovation knowledge infrastructure and governance.

Source: Adapted from Hall (2012).

Box 2.1. Organisations in an Agricultural System of Innovation

Support organisations

- Banking and financial system
- Transport and marketing infrastructure
- Professional networks including trade and farmer associations
- Education system

Research organisations

Mainly producing codified knowledge

- National and international, public and private, agricultural research organisations
- Universities and technical colleges (public and private)
- Private research foundations

Sometimes producing codified knowledge

- Private companies
- NGOs

Enterprise organisations

Users of codified knowledge, producers of mainly tacit knowledge

- Farmers
- Commodity traders
- Input supply agents
- Companies and industries related to agriculture, particularly agro-processing
- Transporters

Demand organisations

- Consumers of food and food products in rural and urban areas
- Consumers of industrial raw materials
- International commodity markets
- Policy-making process and government agencies

Go between organisations

- NGOs
- Public extension services
- Consultants
- Private companies and other entrepreneurs
- Farmer and trade associations
- Donors

Source: Hall (2012).

Public **R&D** mainly takes place in research institutes under the ministry in charge of agriculture or in charge of science, technology and innovation, and in universities. Some agriculture-related research is also carried out in agencies attached to other fields, such as environment or health. The role of the ministry in charge of agriculture varies by countries. In some countries, like Canada, France, Denmark and Japan, it defines, co-ordinates, evaluates and funds the agricultural innovation strategy, while in others it executes a strategy defined and managed by the agency in charge of innovation, such as the National Innovation Council in Chile, the National Council of Science and Technology in Mexico, or the Ministry of Science and Innovation in New Zealand, in collaboration with relevant ministries. In other countries, specific agencies under the ministry in charge of agriculture supervise agricultural research and innovation (e.g. the Council of Agricultural Sciences at the Ministry of Agriculture in Estonia). In Brazil, the System of Agricultural Research and Innovation organises, co-ordinates and implements research. A semi-autonomous federal agency (public

corporation) under the Ministry of Agricultural and Food Supply, Embrapa dominates agricultural R&D (Lopes, 2012). In Indonesia, the Agricultural Research Committee takes care of strategic planning, while the Indonesian Agency for Agricultural R&D is in charge of research (Subagyono, 2012).

Higher education is dominated by public, often regional, universities, which may receive some private funding. In some countries, there are both agricultural universities and agricultural departments in general universities. Public universities are generally under the umbrella of the ministry of education. In France and the Netherlands, higher education agricultural colleges are funded by the ministry in charge of agriculture. In many countries, more applied agricultural education is taking place in public and private, technical schools.

Extension systems display a wide diversity across countries or regions. They generally operate at sub-national level, and include very diverse actors: government agencies, education institutions, upstream and downstream industries, NGOs, consultants and farmers' organisations. They provide an increasing number of services ranging from technical and financial advice to implementation of policy. For example, Produce Foundations in Mexico were established to implement the *Allianza* programme. In the European Union, the Farm Advisory Service was originally introduced to help farmers implement cross-compliance, and covers now broader issues. It is co-funded at EU and national levels.

Table 2.1 identifies four main types of institutions and funding systems, which can co-exist in some countries. Some extension systems are totally financed by public funds and managed by the state, often through regional organisations. There are totally private systems (e.g. in the Netherlands or New Zealand) where farmers pay for a service and choose the service provider on a commercial basis. There are mixed systems where services are provided by state institutions and private consultant firms and farmers pay part or the whole cost. Finally, there are systems co-managed by farmers' organisations (e.g. France and Finland), with funding from the government, farmers' organisations and individual farmers (Laurent et al., 2006).

Table 2.1. Advisory services in OECD countries

	Main institutions	Source of funds	Countries
State-run	Public organisations at regional and national level	Wholly financed from public funds	Belgium, Italy, Greece, Slovenia, Sweden, Germany's southern regions, Spain, Portugal, Luxembourg, Japan, United States
Public private service	Increasingly provided by private consultant firms	Farmers partly or wholly pay for services; centralised and decentralised	Canada, Ireland, Czech Republic, Poland, Slovak Republic, Hungary, Estonia, Australia, Chile
Farmer organisations	Farmers' organisations	Membership fees and payments by farmers	Austria, France[1], Denmark, Finland, north-west regions of Germany, Norway
Commercial	Commercial firms or private individuals	Payment through project implementation or grants	England, Netherlands, north-east regions of Germany, New Zealand

1. In France, extension (farm advisory) services are provided primarily by the Chamber of agriculture, which are consular chambers (public institution that represents the interests of private actors) managed by representatives from the sector and funded by an additional tax on undeveloped land (50%), by contracts with different levels of governments and by clients.

Source: Adapted from Laurent et al. (2006), using responses to OECD questionnaire (www.oecd.org/agriculture/policies/innovation).

2.2 General trends in Agricultural Innovation Systems institutions

In recent years, many countries have reviewed their agricultural knowledge systems and moved away from supply-driven innovation towards a more interactive, demand-driven AIS approach, in response to concerns about: lack of adoption of innovation by farmers; the ability of AIS to meet emerging and pressing challenges; budget pressures; and issues related to the acceptance of innovation by consumer and civil society.

Mechanisms to develop a **strategy**, set priorities and co-ordinate agricultural research have been strengthened, and sometimes made more inclusive. In Australia, for example, a National Primary Industries R&D and Extension Framework was defined in 2009 with all stakeholders (National and State governments, CSIRO, Research and Development Corporations, Council of Deans), under the auspices of the Primary Industries Ministerial Council (Grant, 2012). The Indian Council of Agricultural Research plans, co-ordinates and promote agricultural innovation. It has established a Directorate of Knowledge Management in Agriculture within the ministry in charge of agriculture to ensure agricultural knowledge access for all (Venkatasubramanian and Mahalakshmi, 2012). In South Africa, the Agricultural Research Council (ARC) was created in 1990 through the amalgamation of 15 government specialised institutes and in 1992, it was formally separated from the Department of Agriculture (DoA) and established as a publicly owned and funded agency charged with basic research, technology development and technology transfer (OECD, 2006a).

Mechanisms to **monitor and evaluate** national AIS are being developed and implemented. In Australia and Brazil, net returns of R&D agencies are published annually. Independent reviews and evaluation of impacts are being carried out regularly for Embrapa activities in Brazil and on an *ad hoc* basis in Chile and Mexico. In Indonesia, the Assessment Institute for Agricultural Technology (AIAT) assesses research results, monitors implementation and reports feed-back from users. In Japan, the ten-year programme plan includes targets to facilitate assessment (Subagyono, 2012). The Collaborative Working Group on Agricultural Innovation and Knowledge Systems (CWG-AKIS) of the Standing Committee on Agricultural Research (SCAR) has carried out a preliminary analysis of Agricultural Knowledge Systems in a number of European countries (EU-SCAR, 2012). However, lack of data, targets and systematic evaluation of national AIS makes it difficult to compare performances across countries (Annex A). Research agencies, services and researchers are generally evaluated on a regular basis and discussion is on-going on the criteria used to evaluate them. They are often based on academic merits (e.g. number of publication in top journals) and this does not encourage more applied research and development activities, or non-core activities such as information dissemination and networking. The development of project- or output-based research, which is more prone to evaluation, has spread the culture of evaluation in the system.

Institutional changes have generally aimed at increasing **co-ordination** at national level both within the AIS and between the AIS, other related domains and the general innovation system. Some countries have merged or strengthened links between agricultural R&D and higher education institutions. Examples are: Denmark around the Universities; France with mixed technological units at the local level, mixed technological networks at national level, and the Agreenium research consortium which groups agricultural research agencies and agricultural colleges (schools) (Bergeret, 2012); the Netherlands which merged applied research and university into Wageningen UR; Flanders with the Platform for Agricultural Research founded in 2004; and Turkey with the Agricultural Research Advisory Board which brings together parts of the agricultural ministry, relevant science departments of universities, farmers' organisations, and Chamber of professional organisation (EU SCAR, 2012).

In most countries, agricultural R&D remains mainly funded by public expenditure (Figure 2.2). Public funding for agricultural research institutes is often national (federal), while research carried out in universities may be partly or totally funded by regional governments (e.g. United States). Public funds generally cover operational costs and basic research, as well as part or all costs of project-based research. Increasingly, public research institutes also receive funding from other sources, including charitable foundations, user fees, industry contracts, or producer levies. In many countries, public funds are increasingly granted for projects or programmes conducted in various types of government and non-government organisation, often with matching funds from other stakeholders, whether through competitive processes or not. Public-Private Partnerships (PPP) often fund projects with relatively short-terms prospects for marketable results. While in most countries, there are funds earmarked for agricultural projects, agriculture competes with general innovation projects for public funding in Chile and New Zealand (Falloon, 2012). The public research mandate has been broadened to include environmental, food and other issues, in particular in developed countries, reducing funds available for productivity-oriented research. While primary agriculture used to be the main focus of traditional agricultural knowledge systems, more attention is now given to innovation along the food chain and to non-technological innovations, e.g. institutional or marketing innovations.

The private sector is increasingly involved in R&D activities that have high potential market returns, such as biotechnology. Agricultural input industries account for about 45% of total agricultural R&D and are the major source of new crop varieties, crop protection chemicals, and livestock and animal breeds. Private R&D is concentrated in a relatively small number of large multinational firms with global R&D and marketing networks (Fuglie et al., 2011).

Among mechanisms to fund research, partnerships between public research and the private sector are being developed, including with local industries. To avoid crowding-out, mobilise extra funding and better understand users' demands, governments have encouraged public research to engage in **Public-Private Partnerships (PPP)** for specific projects. The cost of research infrastructure (e.g. gene sequencing) is increasing and collaboration is attractive to overcome investment constraints. These partnerships have been favoured by a strengthening of Intellectual Property Rights (IPRs), but also by the increasing share of public funds dedicated to "output-driven" projects replacing, to a still limited extent in most cases, funding granted on a permanent basis to research institutions. For example, most public expenditures on agricultural R&D in New Zealand now goes to Primary Growth Partnerships schemes, with 50-50 matching funds from the industry (Falloon, 2012). Government expenditure for these partnerships has tripled between 2010 and 2011.[1] In Australia, a significant proportion of government expenditure on rural R&D is conducted through research and development corporations (Grant, 2012). They were established in 1989 as a co-investment model under which an agricultural industry, and in particular individual farm business, agrees to contribute to R&D for the long term benefits of the sector. From 2008 to 2009, these R&D corporations spent a total of AUD 470 million on R&D, of which around 45% was matched by public funds. Australian Co-operative Research Centres (CRC) are also partnerships, with particular emphasis on applied research. They account for 6% of government expenditures on agricultural R&D accounted for in the PSE/CSE database. Chile also places a large emphasis on PPP and competitive funding for agricultural R&D. In the Netherlands, InnovationNetwork aims to develop new ideas and ground-breaking innovations by working on projects with an extensive network of parties (EU SCAR, 2012, Box 5.15).

International and cross-country co-operation is also being strengthened. The reform of the CGIAR, in particular the creation of a consortium, aims to strengthen its ability to co-ordinate activities within the 15 member centres and other partners within the framework of the GCIAR Research Programmes (CRPs). In addition, partnerships have become broader,

funding has increased, and research agendas are now more results-oriented (CGIAR Consortium, 2012). A number of networks have recently been created to improve international co-operation, e.g. Global Research Alliance on Agricultural Greenhouse Gases and the Knowledge-Based Bio Economy (KBBE) Forum in 2009 (Fallon, 2012); and regional co-operation, e.g. INNOVAGRO for Latin America in 2011 (Deschamps, 2012). G20 Ministers have supported existing international initiatives to improve agricultural innovation, in particular in developing countries, and launched new ones (Chapter 5).

Developments in **extension services** include a decentralisation of public services and the emergence of private actors (Laurent and Labarthe, 2011). Lesser government involvement in the delivery of extension services has permitted the emergence of other intermediaries in this area. Innovation brokers have emerged in some countries. They articulate the demands of farmers for research and help them to access technology, or are associated with creating linkages in value chains (Hall, 2012; Klerkx, 2012). In addition, efforts have been made to improve the **sharing of information and knowledge**, using Information and Communication Technology (ICT), e.g. the Knowledge Platform for Rural and Marine Affairs in Spain (Garcia-Fernandez, 2012) and Agricultural Technology Information Centres in India (Venkatasubramanian and Mahalakshmi, 2012).

At the same time, **agricultural education** has been neglected in many countries and is less attractive to young people, although there have been exceptions such as France. Insufficient human capital in the sector, and growing disconnection between farmer knowledge and research and extension, often result in lack of adoption of innovation by farmers. Some countries like New Zealand or India have reformed their agricultural curricula to adapt them better to market demand.

2.3. Trends in agricultural R&D and extension funding

In most countries for which data are available (Box 2.2), the public sector plays a major role in agricultural R&D, and R&D performed by government and higher education institutions accounts for 45% to 95% of total expenditures on agricultural sciences (Figure 2.2). This share is higher for agricultural sciences and agriculture R&D than for total R&D (Annex Table B.1). The share of agricultural R&D performed in government and higher education institutions remained stable over the last two decades in the United States, at 45%, the Czech Republic at close to 70%, and Argentina, Iceland and Poland at around 90%. It decreased in some countries over the last decade, reflecting the stronger involvement of the private sector, but also the decrease in public R&D in Australia and Portugal (Annex Table B.4). This share increased in some transition economies, where public effort had decreased in the 1990s during the transition period, as well as in China, where the decline in business R&D is over compensated by the increase in public R&D, and in Korea where R&D performed by business and higher education organisations both increase.

Public expenditures on agricultural R&D (in constant terms as measured government budget appropriations or outlays for R&D, GBAORD, in constant 2005 USD-PPP) increased between the mid-1980s and the mid-2000s in more than two-thirds of countries, for which data are available in the OECD R&D database (Table 2.2). However, they decreased in the late 2000s in half of OECD countries covered. In some countries (e.g. Finland and Slovak Republic) where public expenditure declined, however, expenditures on agricultural sciences R&D performed by government and higher education increases, probably because they receive more funds from the private sector (Annex Table B.4). Moreover, the decline in public expenditures can also be accompanied by an increase in private expenditures, as in Australia and Portugal, although not large enough to prevent total expenditures from decreasing. Changes in the number of full-time equivalent staff working in government and higher education institutions on agricultural sciences do not reflect exactly changes in

expenditures, probably because staff resources take longer to adjust than financial resources (Table 2.3).

Box 2.2. Main databases on R&D effort

Trends in R&D funding and staff mainly come from the OECD database on R&D statistics,[1] which are comparable across countries, and with Eurostat data.[2] R&D expenditures include Gross domestic expenditure on R&D by sector of performance (Higher education, Government, business and private non-profit), by field of science and socio-economic objective, as well as Government budget appropriations or outlays for research and development (GBAORD) by socio-economic objective. The definition of agriculture as a field of science and as a socioeconomic objective is given in Box 1.2.

OECD data are complemented by information from Eurostat for some EU member states and from the Agricultural Science and Technology Indicators (ASTI) database for some emerging economies.[3] Government expenditures on extension and advisory services are drawn from the OECD database on support to agriculture.[4]

1. Available on OECD.stat, available at www.oecd.org/statistics, under theme Science, Technology and Patent, sub-theme Research and Development Statistics.

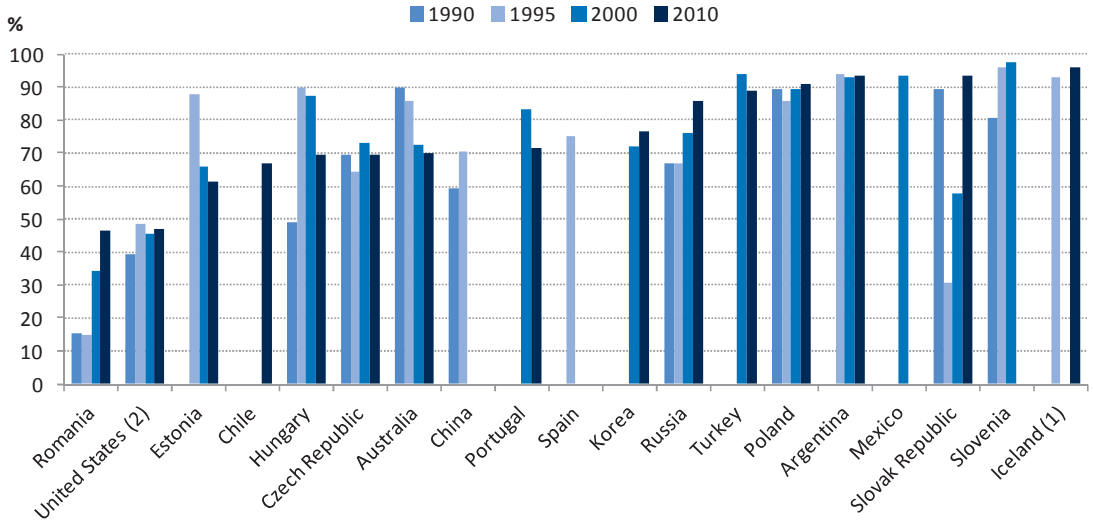
2. Available at epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database, under Theme Science and Technology, sub-theme Research and Development.

3. Available at www.asti.cgiar.org.

4. PSE/CSE database available at: www.oecd.org/tad/agriculturalpoliciesandsupport/producerandconsumersupportestimatesdatabase.htm.

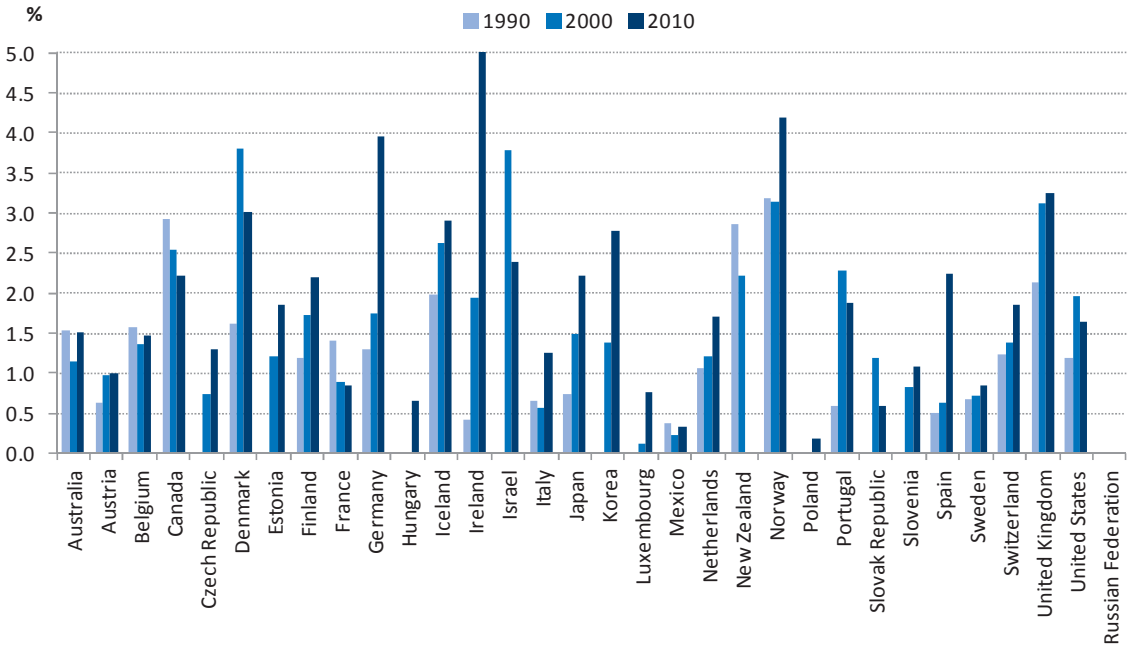
Figure 2.2. Share of expenditures on agricultural sciences R&D performed by government and higher education institutions

As a percentage of all R&D expenditures on agricultural sciences



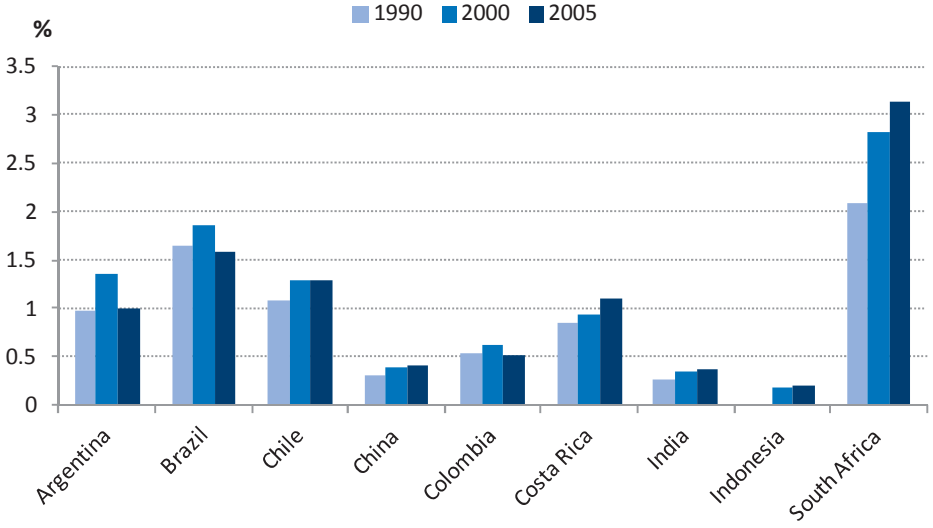
Note: * Irrespective of the origin of funds. See definitions of agricultural R&D in Box 1.2.
1. Eurostat. 2. USDA, R&D expenditures on agriculture as a socio-economic objective.
Source: OECD R&D database in OECD.stat. (Annex Table B.1).

Figure 2.3. Government budget appropriations or outlays for R&D (GBAORD) on agriculture as a % of agricultural gross value added



Note: See definitions of agricultural R&D in Box 1.2.
Source: OECD R&D database in OECD.stat. (Annex Table B.2).

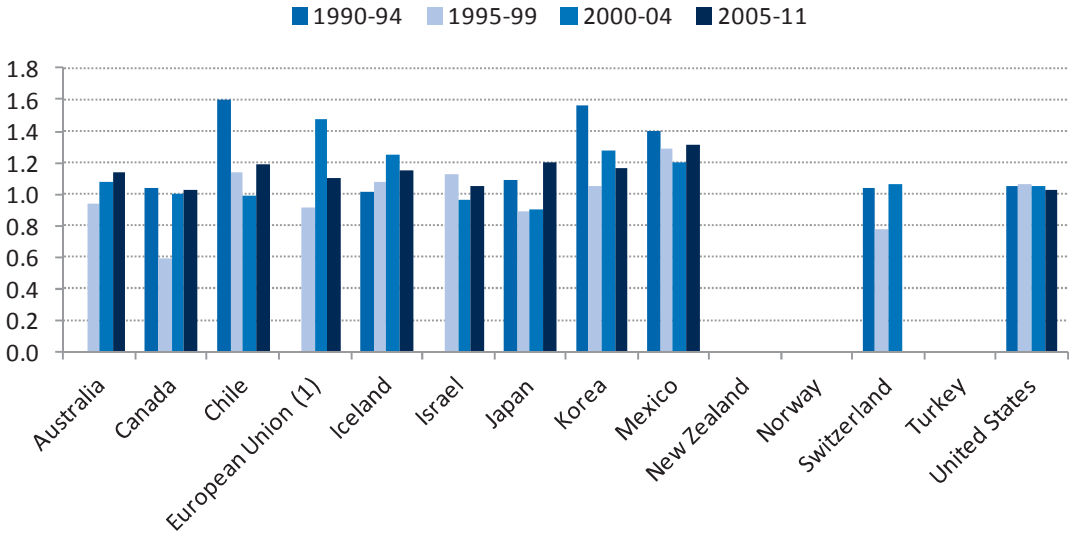
Figure 2.4. Public agricultural R&D expenditures as a percentage of agricultural GDP



Note: See definitions of agricultural R&D in Box 1.2.
Source: ASTI database.

Figure 2.5. Government expenditures on extension services

Annual % growth rate, by period, based on USD-PPP 2005



Note:

1. EU15 from 1995 to 2003; EU25 from 2004 to 2006; and EU27 from 2007 to 2011. For the European Union, 2000-03 instead of 2000-04; and 2007-11 instead of 2005-11.

Source: OECD, PSE/CSE database, 2012.

The share of public expenditures on agricultural R&D as a percentage of agricultural gross value added (GVA) [2] varies greatly among OECD countries, from less than 0.5% in Mexico to over 7% in Norway (Figures 2.3 and 2.4, Annex Tables B.2 and B.3). It generally increased since the 1990 in most OECD countries, with the exception of Canada, France, Israel, Mexico, New Zealand, and the Slovak Republic. With the exception of Brazil, Costa Rica and South Africa, it is below 1% in emerging economies, and even below 0.5% in China, India and Indonesia. In the food industry, R&D intensity, i.e. R&D as a percentage of net sales, is 1.7%, half that of all sectors (Table 2.4). It is higher in Japan and the European Union than in the United States. Biotechnology is the industry with the highest R&D intensity (over 20%). Annex Box C.1 contains more detailed information on innovation in agri-food enterprises in selected EU member states.

Government expenditures on **extension services** in OECD countries, where they exist, continued to increase at an annual growth rate of 1% or more (USD-PPP 2005). This rate slowed down in the European Union, Iceland, Korea and the United States in the second part of the 2000s compared to the first part, but increased in Australia, Chile, Israel, Japan and Mexico (Figure 2.5).

Table 2.2. Changes in government budget appropriations or outlays for R&D on agriculture

	1984-86	1989-91	1994-96	1999-2001	2004-06	2009-11	2009-11/ 1984-86	1994-96/ 1984-86	2004-06/ 1994-96	2004-05/ 1984-86	2009-11/ 2004-06
	2005 USD Million - Constant prices and PPPs						Annual growth rate in percentage				
Australia	240	209	256	253	327	312	1.2	0.6	2.8	1.8	-1.0
Austria	36	41	46	45	37	40	0.4	2.7	-2.1	0.1	1.9
Belgium	85	75	59	52	30	33	-2.4	-3.1	-4.9	-3.2	2.1
Canada[1]	675	584	544	543	501	429	-1.5	-1.9	-0.8	-1.3	-2.9
Czech Republic	n.a.	n.a.	n.a.	n.a.	58	69	n.a.	n.a.	n.a.	n.a.	3.8
Denmark	52	74	67	121	74	58	0.5	2.9	1.1	2.2	-4.3
Estonia	n.a.	n.a.	n.a.	n.a.	12	14	n.a.	n.a.	n.a.	n.a.	3.8
Finland	61	79	78	78	97	92	2.0	2.7	2.5	3.0	-1.0
France	633	755	609	404	334	319	-2.0	-0.4	-4.5	-2.4	-0.9
Germany	348	470	520	471	400	777	4.9	5.0	-2.3	0.8	18.8
Greece	77	61	48	44	48	36	-2.1	-3.9	0.1	-1.9	-5.0
Hungary	n.a.	n.a.	n.a.	n.a.	100	39	n.a.	n.a.	n.a.	n.a.	-12.2
Iceland	9	13	13	17	17	21	5.2	4.2	3.3	4.5	4.3
Ireland	35	24	54	69	73	106	8.1	5.5	3.5	5.5	8.9
Israel	n.a.	n.a.	87	88	85	87	n.a.	n.a.	-0.3	n.a.	0.4
Italy	320	270	197	202	395	338	0.2	-3.9	10.1	1.2	-2.9
Japan	n.a.	514	614	828	924	1 020	n.a.	n.a.	5.0	n.a.	2.1
Korea	n.a.	n.a.	n.a.	488	663	860	n.a.	n.a.	n.a.	n.a.	5.9
Mexico	n.a.	255	81	107	165	165	n.a.	n.a.	10.4	n.a.	0.1
Netherlands	144	164	160	148	236	175	0.8	1.1	4.8	3.2	-5.2
New Zealand[1]	n.a.	111	114	125	116	120	n.a.	n.a.	0.2	n.a.	0.7
Norway	83	111	107	108	134	143	3.0	2.9	2.6	3.1	1.4
Poland[2]	n.a.	n.a.	n.a.	n.a.	13	37	n.a.	n.a.	n.a.	n.a.	36.1
Portugal	41	76	81	154	139	98	5.6	9.7	7.1	11.9	-5.8
Slovak Republic	n.a.	n.a.	41	33	25	24	n.a.	n.a.	-3.8	n.a.	-1.3
Slovenia	n.a.	n.a.	5	9	7	13	n.a.	n.a.	3.6	n.a.	16.9
Spain	129	209	172	219	604	708	17.9	3.3	25.1	18.4	3.4
Sweden	48	46	36	40	61	43	-0.4	-2.4	6.7	1.3	-5.8
Switzerland[3]	78	59	26	45	48	43	-1.8	-6.7	8.7	-1.9	-2.4
United Kingdom	643	480	528	463	437	428	-1.3	-1.8	-1.7	-1.6	-0.4
United States	1 688	1 807	2 098	2 436	2 593	2 240	1.3	2.4	2.4	2.7	-2.7
Argentina[1]	n.a.	n.a.	212	190	266	503	n.a.	n.a.	2.6	n.a.	17.8
Russian Federation[4]	n.a.	n.a.	920	451	n.a.	229	n.a.	n.a.	n.a.	n.a.	n.a.

Note: n.a.: Not available. See definitions of agricultural R&D in Box 1.2. Agriculture as a socio-economic objective includes R&D expenditures directed at the food industry.
1. 2009-10 instead of 2009-11; 2. 2008 instead of 2009-11; 3. Average of 2009 and 2011 instead of 2009-11; 4; 2009 instead of 2009-11.

Source: OECD R&D database in OECD.stat. (Annex Table B.4).

Table 2.3. Changes in agricultural R&D staff

Annual growth rate of full-time equivalent person on agricultural sciences R&D performed in government and higher education institutions

	1995 to 2000	2000 to 2005	1995 to 2005	2005 to 2010	Notes
Australia	2.0	-3.3	-1.3	n.a.	1996, 2006
Austria	3.7	3.5	3.1	2.6	1998, 2002, 2006, 2009
Belgium	0.0	-2.5	n.a.	2.0	2009 instead of 2010
Czech Republic	-4.1	11.8	2.7	1.9	
Denmark	-2.1	-2.9	-2.0	2.8	1997, 2000, 2005, 2009
Estonia	n.a.	n.a.	n.a.	5.1	
Finland	1.8	1.4	1.7	-2.0	2009 instead of 2010
Germany	-1.7	-2.6	-2.0	0.8	2009 instead of 2010
Hungary	8.2	-3.2	1.8	1.3	2009 instead of 2010
Iceland	1.4	-1.9	n.a.	n.a.	
Ireland	n.a.	-5.1	n.a.	6.2	2002, 2005, 2009
Italy	n.a.	n.a.	n.a.	3.4	2009 instead of 2010
Japan	n.a.	24.5	n.a.	0.1	2001, 2005, 2007
Netherlands	n.a.	n.a.	n.a.	-8.4	2007, 2009
Norway	n.a.	1.4	n.a.	-2.8	2001, 2005, 2009
Poland	-2.1	-3.7	-2.7	-7.5	2009 instead of 2010
Portugal	1.0	-3.7	-1.4	-5.5	2009 instead of 2010
Slovak Republic	-17.4	12.0	-5.1	10.2	1996 instead of 1995
Slovenia	1.6	4.0	2.6	-11.8	1997, 2000, 2005, 2009
Spain	10.1	3.1	7.3	4.2	2009 instead of 2010
Romania	-16.0	16.4	-3.5	-6.8	1996, 2000, 2005, 2009

Note: n.a.: Not available. See definitions of agricultural R&D in Box 1.2.
Source: OECD R&D database in OECD.stat.

Table 2.4. Industry R&D as a percentage of net sales, by sector

Sector	Overall sector R&D intensity	EU sector R&D intensity	US sector R&D intensity	Japan sector R&D intensity
Beverages	1.1	0.5	0.8	0.8
Biotechnology	20.9	15.8	22.8	0.0
Food & drug retailers	0.4	0.3	0.4	0.4
Food producers	1.7	1.9	1.4	2.3
Total above	**2.3**	**1.2**	**3.7**	**1.5**
Software and computer services	0.6	10.6	10.5	5.8
Leisure goods	6.2	6.4	8.4	5.9
Chemicals	3.1	2.7	2.8	4.3
Total all sectors	**3.3**	**2.5**	**4.7**	**3.8**

Note: The survey includes the 1 400 largest R&D performers worldwide.
Source: The 2011 EU industrial R&D Investment scoreboard. European Commission, JRC/DG RTD (iri.jrc.ec.europa.eu/research/scoreboard_2011.htm).

Notes

1. See New Zealand PSE/CSE database at: www.oecd.org/tad/agriculturalpoliciesandsupport/producerandconsumersupportestimatesdatabase.htm.
2. Public R&D expenditures on agriculture may include some funding that is directed at food processing, which is not included in agricultural gross value added.