OECD Food and Agricultural Reviews

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BETTER POLICIES FOR BETTER LIVES

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Foreword

Innovation, Agricultural Productivity and Sustainability in Canada, is part of the OECD Food and Agricultural Reviews series. It was undertaken at the request of the Canadian authorities, represented by Agriculture and Agri-Food Canada (AAFC). The review examines the conditions surrounding innovation in the food and agriculture sector business and allowing for increased productivity and environmental sustainability. It starts with an overview of the food and agriculture sector and outlines development challenges and opportunities (Chapter 2). A wide range of policies which influence incentives for innovation are then examined: economic stability, governance and trust in institutions (Chapter 3); a favourable and predictable environment for investment (Chapter 4); capacities and public services enabling business development (Chapter 5); agricultural policy (Chapter 6) and the operation of the agricultural innovation system (Chapter 7).

Country policies are analysed following a framework developed by the OECD as part of its work on agricultural innovation and in response to a request from the G20 in 2012 under the Presidency of Mexico. In this first test phase, the framework has also been applied to Australia and Brazil. Additional countries will be studied in subsequent work and the framework is being continuously revised and improved, in particular to reinforce the coverage of sustainability and structural adjustment issues.

This review was prepared by Catherine Moreddu. Lihan Wei and Christine Arriola provided statistical support. Hélène Dernis from the OECD Directorate for Science, Technology and Innovation and Douglas Lippoldt, formerly of the OECD, provided data and expertise on intellectual property protection. Martina Abderrahmane provided editorial assistance and Michèle Patterson editorial and publication support. It benefitted from comments by Ken Ash, Frank Van Tongeren, and Olga Melyukhina.

The review draws heavily on background material co-ordinated by AAFC and originating from several federal and provincial government departments in response to a questionnaire developed as part of the framework. This material has been complemented by a consultant report, prepared by Shelley Thompson, synthesising the views of innovation stakeholders on government action, by information contained in various OECD publications and by cross-country indicators from OECD, and other international databases.

The review owes much to the support and co-operation of Canadian officials, both federal and provincial, in particular Brooke Fridfinnson, who co-ordinated the provision of background information and comments, Colette Kaminsky and Lidija Lebar and all their colleagues from AAFC, who provided information and comments.

This review was declassified by the Working Party on Agricultural Policies and Markets in December 2014.

Acronyms

AAFC	Agriculture and Agri-Food Canada
ACOA	Atlantic Canada Opportunities Agency
AIC	Agri-Innovators Committee
AIF	Atlantic Innovation Fund
AIP	Agricultural Innovation Program
AITC	Atlantic Investment Tax Credit
API	Agri-Processing Initiative
APMA	Agricultural Products Marketing Act
ATA	Admission Temporaire/Temporary Admission
BDP	Business Development Program
BERD	Business Enterprise Expenditure on R&D
BMP	Beneficial Management Practices
BRIICS	Brazil, Russian Federation, India, Indonesia, China, South Africa
BRM	Business Risk Management
CAAP	Canadian Agricultural Adaptation Program
CAGR	Canadian Animal Genetic Resources
CAHRC	Canadian Agricultural Human Resource Council
CALA	Canadian Agricultural Loans Act
CASA	Canadian Agricultural Safety Association
CBIF	Canadian Biodiversity Information Facility
CCA	Council of Canadian Academies
CDC	Canadian Dairy Commission
CDRD	Centre for Drug Research and Development
CETA	Comprehensive Economic and Trade Agreement
CF	Community Futures (organisations)
CFAVM	Canadian Faculties of Agriculture and Veterinary Medicine
CFI	Canadian Foundation for Innovation
CFIA	Canadian Food and Inspection Agency
CGIAR	Consultative Group on International Agricultural Research
CHIR	Canadian Institutes of Health Research
CICP	Canadian Innovation Commercialization Program
CIGI	Canadian International Grains Institute
CIPO	Canadian Intellectual Property Office
COYFP	Canada's Outstanding Young Farmers' Program
CPI	Consumer Price Index

CRA	Canada Revenue Agency
CWB	Canadian Wheat Board
CYFF	Canadian Young Farmers' Forum
DG	Distillers' Grains
DNA	Deoxyribo-Nucleic Acid
EFP	Environmental Farm Plan
FCC	Farm Credit Canada
FDI	Foreign Direct Investment
FMD	Food and Mouth Disease
FPHRC	Food Processing Human Resource Council
FIMCLA	Farm Improvement and Marketing Co-operative Loans Act
FPT	Federal-Provincial-Territorial (governments)
FTC	Food Technology Centres
GBIF	Global Biodiversity Information Facility
GDP	Gross Domestic Product
GF	Growing Forward
GFTC	Guelph Food Technology Centre
GSSE	General Services Support Estimate
GVA	Gross Value-Added
HACCP	Hazard Analysis Critical Control Point
HERD	Higher Education Expenditure on R&D
HQP	Highly Qualified People
HR	Human Resource
ICT	Information and Communications Technology
IDRC	International Development Research Centre
IO	International Organisations
IPR	Intellectual Property Rights
IRAP	Industrial Research Assistance Program
ISF	International Seed Federation
LCGE	Lifetime Capital Gains Exemption
LSVCC	Labour-sponsored Venture Capital Corporations
MFN	Most Favoured Nation
MFP	Multi-Factor Productivity
MIF	Matching Investment Fund
MoU	Memorandum of Understanding
MNE	Multinational Enterprises
MTA	Material Transfer Agreement
NAFTA	North American Free Trade Agreement
NCE	Networks of Centres of Excellence
NGO	Non-Governmental Organisations
NPO	Non-Profit Organisations
NRC	National Research Council

NSERC	National Sciences and Engineering Research Council
OAE	Office of Audit and Evaluation
OPR	Organic Products Regulations
OIPC	Office of Intellectual Property and Commercialization
PBR	Plant Breeders' Rights
PCT	Patent Co-operation Treaty
PGDC	Prairie Grain Development Committee
PGRC	Plant Gene Resources of Canada
PIPRA	International Platform for Coordinating IPR Issues
PISA	Programme for International Student Assessment
PMC	Pest Management Centre
PMR	Product Market Regulations
PMRA	Pest Management Regulatory Agency
PPP	Public-Private Partnerships
P3s	Public-Private Partnerships
P4s	Public-Private-Producers Partnerships
PSE	Producer Support Estimate
R&D	Research and Development
RCC	Regulatory Cooperation Council
RMAF	Results-Based Management Accountability Frameworks
SAWP	Seasonal Agricultural Worker Program
SME	Small and Medium-sized Enterprises
SR&ED	Scientific Research and Experimental Development
SSHRC	Social Sciences and Humanities Research Council
STIC	Science, Technology and Innovation Council
STE	State Trading Enterprises
S&T	Science and Technology
TFP	Total Factor Productivity
TPP	Trans-Pacific Partnership
TSE	Total Support Estimate
TFWP	Temporary Foreign Worker Program
UPOV	International Union for the Protection of New Varieties of Plants
VC	Venture Capital
VCAP	Venture Capital Action Plan
VCRT	Value Chain Round Tables
WB	World Bank
WDI	World Development Indicators
WEF	World Economic Forum
WGRF	Western Grains Research Foundation
WTO	World Trade Organization

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Executive summary

The Canadian food and agriculture sector is for the most part competitive and export-oriented. Although the challenges and opportunities faced by the Canadian agriculture sector can vary significantly between regions, primary agriculture benefits from an abundance of natural resources and faces limited environmental constraints. Canada differs from many other agricultural net exporting countries in that agriculture accounts for a much smaller share of land and water use, reflecting its climate and geography. The negative environmental impacts of agriculture relate mainly to local water pollution by agricultural nutrients. Productivity growth, resulting from innovation and structural change, has driven production and income growth without significantly increasing pressure on resource use. The capacity to innovate is crucial for the export-oriented Canadian sector to take advantage of the growing and changing demand for food and agricultural products at the global level.

The economic conditions and general policy environment are conducive to investment needed to improve productivity growth. The food and agriculture system benefits from stable macroeconomic fundamentals and good governance, well-developed regulations that ensure competition, and largely open trade in goods and capital that facilitates access to factors and participation in the international trading system. Tax rates for corporate profits are relatively low, there is good infrastructure and services, including in rural areas, and a well-educated population.

The overall policy environment for innovation to increase productivity and sustainability could be further improved, however, in a number of areas. The federal and provincial governments are currently in the process of simplifying and modernising regulations to better respond to future needs, including through trade facilitation measures. While there continues to be a certain mismatch between labour supply and demand, this is being tackled through improvements to education, skills development, retraining, and immigration systems. The sector has access to credit but little access to venture capital, which is particularly important for innovative firms; as such, the government has taken steps to support the development of venture capital markets. The corporate tax rate is relatively low at the OECD median, but lower rates for small firms may act as a disincentive to firm growth. Research and Development (R&D) tax rebates benefit primarily large, innovative firms and better targeting could improve the effectiveness of this incentive. Public services are widely available in rural areas, although the use of information and communication technology could be further developed.

Direct incentives to innovation have increased in recent agricultural policy frameworks. These incentives focus on promoting cooperation between the public and private sectors and fostering adoption of innovation by the food and agricultural sector. The general approach to agricultural policy remains highly focused on risk management and investment support. Other aspects of agricultural policies, such as price pooling arrangements that do not reward innovative farmers and supply management schemes that control production and prices, can act as disincentives to adjustment and innovation. This in turn may limit productivity growth and a greater focus on new product and export market opportunities. Removing these impediments to structural adjustment could potentially facilitate growth in these sectors.

The agricultural innovation system performs relatively well. Canada is a strong contributor to agricultural innovation at the world level, and to international co-operation, as measured by the number of patents and scientific publications. Innovations are widely adopted at the farm level, the availability

of training and extension is diverse, and services are widely accessible. Specific programmes focus on facilitating adoption, including business management advice. And although the agricultural innovation system includes a wide range of actors, with differences across regions, there are various coordination mechanisms in place to improve the collective understanding of how federal, provincial and territorial governments use different methods to fund, support and encourage innovation. In addition, stakeholders are widely consulted. Public investment in agricultural R&D has declined, but R&D intensity remains high by international comparison. The knowledge infrastructure, including institutions, networks and databases, is well developed but will require stable funding in order to maintain current capacity. Intellectual Property Rights are strong in general, but intellectual property protection for plant breeding is currently lower than in partner countries; this could potentially restrict the availability of new, high-yielding varieties. Legislation is being discussed to reinforce plant breeders' rights. Collaboration and partnerships in research and innovation between public and private actors are increasingly encouraged, but there remains room for improvement in the level of private investment.

Policy recommendations encompass the following four key areas:

- **Further improve incentives for private investment** including by: continued efforts to ensure macroeconomic stability; an increased focus on reducing unnecessary costs associated with regulatory frameworks, both between provinces and internationally; further development of venture capital markets; review the impact of corporate tax incentives for small firms; and reform of the SR&ED tax credit.

- **Improve capacities and services for innovation,** including through better integrating education, skills, on-the-job training, and job search systems, and by further opening key service sectors, such as telecommunications, both across provinces and at the national level.

- **Remove unintended impediments to innovation** through reform to agriculture policy support instruments that impede structural adjustments or investments and can reduce the incentive to innovate.

- **Strengthen direct incentives to innovation in food and agriculture,** for example by: increasingly incorporating innovation as a core element of future agriculture policy frameworks and evaluating current and new policy proposals through the lens of the expected impact on productivity growth and sustainable resource use; simplifying the plethora of existing incentive measures, including by establishing a single window for industry to identify available assistance measures; examining alternative public and private sources of funding and possible public-private partnership arrangements in order to not just maintain but to enlarge innovation infrastructure; strengthening plant breeders' rights and continually examine the balance between intellectual property rights, and widespread and timely knowledge diffusion.

Chapter 1

Overall assessment and recommendations

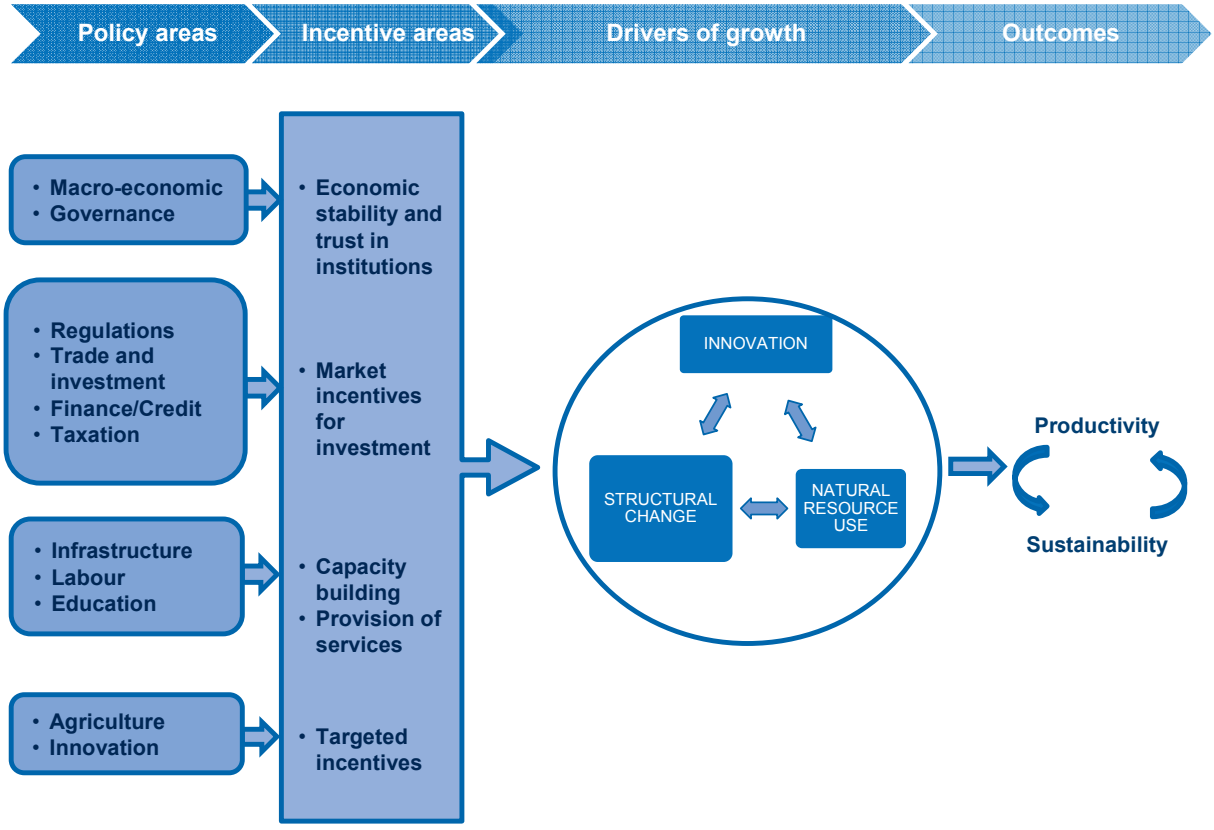
This chapter presents the framework applied in the review to analyse the extent to which Canadian policies are supportive of innovation for productivity and sustainability and the findings of the review of a wide range of policies in Canada. In each policy area, it develops specific policy recommendations.

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

Improvements in agriculture productivity growth are required to meet the growing demand for food, feed, fuel and fibre, and must be achieved sustainably through the more efficient use of natural and human resources. A common finding is that a wide range of economy-wide policies affect the performance of the food and agriculture sectors, and thus need to be considered alongside agriculture-specific policies. Recognising that innovation is essential to improving productivity growth sustainably along the whole agri-food chain, OECD work has focused on the performance of agricultural innovation systems.

The framework used in this report to review Canadian policies considers policy incentives and disincentives to innovation, structural change and access to natural resources, which are key drivers of productivity growth and sustainable use of resources (Figure 1.1). The current focus is mainly on agricultural innovation systems. The Oslo Manual defines innovation as the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations (OECD and Eurostat, 2005).

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



Source: OECD (2014), "Analysing Policies to improve agricultural productivity growth, sustainably: Revised framework", www.oecd.org/agriculture/policies/innovation.

This review begins with an overview of the characteristics and performance of the food and agriculture sector, and outlines the challenges and opportunities (Chapter 2). A wide range of policies is then considered according to the four main channels or incentive areas through which they affect drivers of productivity growth and sustainable use of resources.

- Economic stability and trust in institutions (justice, security, property rights), both of which are essential to attract long-term investment in the economy (Chapter 3).
- Private investment, which in turn requires a transparent and predictable environment that balances the interests of investors and society (Chapter 4).
- Capacity building, including provision of essential public services (Chapter 5).
- Targeted incentives to food and agriculture, which ensure agricultural policies and agriculture innovation systems align the supply of innovation with sector demand and facilitate the adoption of innovation at farm and firm levels (Chapters 6 and 7).

A policy area can affect innovation through more than one channel. Policies can affect innovation positively or negatively depending on the type and intensity of measures. This review reports country-specific information when readily available.

This report aims to review the extent to which the Canadian policy environment contributes to improving productivity growth and sustainable use of resources in the food and agriculture sector by fostering the creation and adoption of innovation. Throughout the report, the likely impacts of each policy area on innovation are first discussed in general terms. Specific country measures are then analysed in this regard. Overall assessment and recommendations are drawn from this review on a large range of policy areas.

Overview of the Canadian food and agriculture sector

The Canadian food and agriculture sector, similar to other countries worldwide, faces a changing environment that is characterised by a stronger and more diversified demand for food, feed, fuel and fibre, more stringent consumer requirements on products and practices, more variable commodity prices, and stronger competition from emerging economies that have higher agricultural productivity growth rates. Despite facing challenges that can vary substantially between regions, the Canadian food and agriculture sector is, however, well placed to seize opportunities both at home and in the international market. It has abundant natural resources, competitive and generally open markets, an educated labour force, a sound banking system, and good governance. Canadian agriculture offers a variety of crop and livestock products and most commodity sectors are competitive and export-oriented. A few sectors, however, continue to be highly protected and regulated by domestic market measures. Structural adjustment and the wide adoption of innovation in competitive sectors have led to a steady increase in productivity, albeit at a slower pace since 2004. Canadian agriculture faces limited environmental constraints which relate mainly to local water pollution by agricultural nutrients. The adoption of innovative production practices, such as precision agriculture, has permitted production growth while limiting increased pressure on natural resources.

The Canadian food and agricultural system operates within a framework that is generally favourable to investment and innovation. Canada enjoys stable and reliable institutions, with effective property rights and justice systems. Macroeconomic policies have helped maintain modest growth despite the world economic crisis; fiscal consolidation should continue as planned at both the federal and provincial levels of government (OECD, 2014a). Business development is facilitated by a well-developed banking sector and regulations, as well as by relatively low corporate tax rates. The largely open trade and investment environment also facilitates access to agricultural factors of production, including capital, and participation in the international trading system. Canada ranks relatively high in terms of coverage and quality of infrastructure and public services are widely available in rural areas. There is, nevertheless, a shortage of required skills in the economy, particularly in the food and agricultural system, and this occurs despite flexible employment legislation, a well-performing education system, and a well educated population.

Canada's agricultural policy framework has recently placed more emphasis on strategic initiatives that focus on innovation, competitiveness and market profitability, while, risk management remains a

key area of focus. The dairy, poultry and eggs sectors are highly protected and domestic markets are regulated by supply management schemes. Canada's agricultural innovation system is diverse and contributes strongly to agricultural innovation at the regional, national and world levels. The public sector plays an important role as a coordinator, funder and provider of research and development (R&D). Private investments in R&D in Canada are growing, but there is scope for improvement. The Canadian food and agricultural sector benefits, however, from international innovations, in part due to its open trading system, and innovations are widely adopted at the farm level.

This review of Canadian policies that affect drivers of productivity growth and sustainable use of resources offers the following policy recommendations for consideration, recognising that significant differences exist in how federal, provincial and territories fund, support and encourage innovation.

Improve incentives for private investment

The Canadian **regulatory framework** is well-developed and generally facilitates investment. Product Market Regulations (PMR) promote competition and low barriers to entrepreneurship facilitate the creation of innovative businesses in the agri-food sector. The competitive business environment also gives farmers access to world class inputs. In contrast, supply-managed sectors are largely isolated from international competition and while R&D and innovation occurs within the supply managed sectors, the system is focused on domestic considerations rather than bolstering productivity and responding to new product and export market opportunities.

Natural resources are regulated at both the federal and provincial levels, while many environmental regulations are under provincial or local jurisdiction. Water governance varies widely across provinces, as do agri-environmental policy approaches. These differences may reflect specific circumstances in terms of availability, quality and demand, and it would be useful to compare experiences. Significant farmland consolidation has occurred in Canada, suggesting that current regulations enable land markets to function smoothly.

The regulatory process related to farm inputs and outputs is responsive to industry demand and decisions are based on scientific evidence. This approach provides a predictable regulatory environment that is key to promoting innovation and increased competitiveness. Canada's efforts to respond to producer and consumer demand, and to consult and communicate standards and science-based information facilitate the introduction of new products on markets, while protecting consumers and the environment. However, according to a panel of industry representatives, approval procedures can be lengthy and costly, the regulatory process is sometimes more reactive rather than forward looking, and there remain areas where regulations are not clear, such as for bio-chemical plants. In response, efforts are being made at the federal and provincial levels to reduce regulatory burden without compromising health and environmental safety outcomes. Outcome-based regulations, which enable more latitude in the processes that are used as long as the end result meets the required outcome, for example, help lessen regulatory burden on small businesses. Regulations are being streamlined and updated. Efforts are being made to increase regulatory-related transparency and predictability to improve services to business. This includes reducing time for the registration of new products, anticipating new regulatory needs, reducing duplication, minimising burden on small business and communicating more clearly.

When developing and reviewing standards, Canada endeavours to make national standards compatible with international rules. Efforts to update and align regulations with the United States are made in response to industry concerns about compliance costs and excessive constraints on their business decisions, and aim to foster the competitiveness of the Canadian industry. The extent to which differences in regulations across provinces add to the cost of marketing products at the national level is not covered in the survey of stakeholders undertaken for this review.

The **trade and investment** environment facilitates access to agricultural production factors (including capital) and participation in the international trading system, which foster innovation and productivity growth. Very low tariffs for capital and most intermediate goods mean that the food and

agriculture sector can obtain advanced foreign technologies and equipment at a competitive cost. Export-oriented agricultural sectors receive little protection and are competitive on world markets. However, some agricultural commodity sectors remain highly protected, imposing costs on consumers and potentially impeding adjustment and innovation. Lowering protection, while implementing appropriate adjustment measures, could improve the competitiveness of those sectors.

Reflecting its good governance and regulatory framework, Canada performs well in terms of trade facilitation (i.e. customs and other border procedures), allowing both inputs and outputs to flow without imposing unnecessary costs on traders. Further effort in this area could focus on improving external border agency cooperation. Barriers to Foreign Direct Investment (FDI) are mainly in the form of ownership restrictions or regulatory discretion over mergers and acquisitions and are generally not considered to create major disincentives in practice. There are few specific restrictions to FDI in food processing and FDI stocks in this sector have significantly increased in recent years, with most investment originating from the United-States and European countries. The main restrictions in primary agriculture concern access to land and this differs by province.

Farmers have access to credit thanks to a well-developed **financial and banking sector**. The agricultural and food sector also benefits from specialised and personalised services, including from Farm Credit Canada which provides loans to farmers. In addition, it benefits from specific agricultural credit programmes which lower the cost of credit for farmers, cooperatives and the agri-food industry. Access to finance has helped the sector invest and innovate to improve productivity, but the extent to which investment support is still justified by market failure in the current economic environment and domestic financial system is not clear.

As in many countries, venture capital, which is particularly important for innovative firms, is in short supply and the government has taken steps to support the development of venture capital markets. Government support to venture capital access will focus on areas where risks are higher, although there is the risk that venture capital will remain dependant on public support over the long term. Care should be taken that these markets do not become dependent on government support in the long-run. OECD 2012 recommendations for boosting business innovation (Box 1.1) suggest to that effect to:

> "Carefully design support to venture capital by means of strictly temporary co-financing arrangements, giving private partners full management control and possibly capping government returns in order to leverage private returns. Eliminate tax credits to retail investors in Labour-sponsored Venture Capital Corporations (LSVCC) funds. Provide institutional support to angel funds." (OECD, 2012a).

It also recommends to "Promote efficient and deep financial markets by: improved accounting for intellectual assets, more vigorous competition in financial services, and consistent and high standards in provincial securities market regulation." (OECD, 2012a).

So far venture capital benefits mainly Information and Communications Technology (ICT) companies, and only a few agri-food companies have been successful at accessing it.

The Canadian average corporate **tax** rate is relatively low. It is close to the OECD median rate and lower than that of the United States. Small businesses benefit from even lower corporate tax rates. This may have unintended consequences on business practices, including discouraging some small farms and agri-food firms from investing in activities that would increase the size of the business above the lower tax threshold. Applying the same rate to all firms would remove this distortion and might encourage increased investment and innovation.

Special tax provisions for farmers aim to facilitate transfer to the next generation of farmers and to encourage income risk management. The taxation system also allows for faster depreciation of machinery and equipment in farms and food processing industries, and thus supports investment.

Both federal and provincial governments provide tax incentives to support private investment in R&D. The tax subsidy rate is one of the highest among OECD countries, and is particularly high for

small firms. One federal programme (SR&ED) represents one of the most expensive R&D tax expenditures in Canada. The OECD has recommended simplifying and better targeting fiscal credit to R&D to ensure support benefits firms which would not have otherwise invested in innovation (Box 1.1). The OECD has also recommended strengthening cooperation with provinces to align their grants and tax credits to R&D and venture capital with those of the federal government (OECD, 2012a).

Recommendations to improve incentives for private investment

- To improve macroeconomic stability, fiscal consolidation should continue as planned at both the federal and provincial levels of government.
- Efforts to modernise regulations should continue. This involves improving clarity, consistency and responsiveness to industry and consumer needs, using more outcome-based regulations, and adopting a forward-looking approach to developing regulations for new products and services. Regulatory services to businesses should be strengthened. To reduce compliance costs, information relevant to companies could be included in a single platform. Further efforts could focus on regulatory collaboration between provinces and with main trade partners.
- The extent to which agriculture credit programmes are well targeted and respond to the current credit market situation should be reassessed.
- Access to capital is crucial for innovation. Efficient and deep financial markets should continue to be promoted, as recommended by OECD (2012a) (Box 1.1). In addition, placing information on market and programme opportunities on a single platform would improve access to capital.
- Lower rates of corporate tax for small firms may act as a disincentive to firm innovation and growth. Applying the same rate to all firms would remove this disincentive (see Box 1.1 on OECD 2012 recommendations for overall business innovation).

Improve capacities and services for innovation

Given the size of the country, providing strategic **infrastructure** for the development of rural areas and good access to public services is a challenge which is met through a diversity of federal and provincial policy interventions. Public services are widely available in rural areas. Regarding health services, proactive policies encourage medical staff to settle in rural areas through conditional education grants. According to the World Economic Forum (WEF) Global Competitiveness Index, Canada ranks relatively high in terms of coverage and quality of transport, electricity and telephone infrastructure, in absolute terms and relative to its large geographical size. Infrastructure development has benefited from efforts by "PPP Canada" to fund Public-Private Partnerships. However, with respect to information and communication technology, Canada's cellular telephone services are less developed than in other OECD countries and Internet usage in rural areas is less developed than in urban areas.

Canadian **employment** legislation facilitates labour mobility and the use of temporary, often foreign, workers, including seasonal labour in agriculture. Despite this flexibility, there is a continuing mismatch between skills supply and demand, which is more pronounced in certain sectors and in some regions, but which also affects the food and agricultural sector. Government policy aims to match labour supply and demand across regions, sectors and skills though education, skills development, retraining, and immigration systems, including temporary work visas. The government also works upstream to promote careers in agriculture and to develop business skills, a determining factor in the adoption of innovation.

The **education** system has an important role to play in maintaining the supply of skilled labour needed for the development of a knowledge-based economy that rapidly evolves. To that effect, the participation rate in higher education needs to continue expanding. According to a recent OECD review, this could be achieved by encouraging access to higher education for disadvantaged socio-economic groups, while enhancing the flexibility of the system to allow students with diverse needs to move between institutions more easily to meet their learning objectives. Skills for innovation can also be improved by increasing the integration of technical, business and communications skills training with practical industry experience within tertiary education programmes to meet the demands of the labour market. In an environment of government spending restraint, the quality of tertiary education could be

strengthened by increasing the distinction between institutions that target research and those that emphasise teaching, and by re-evaluating tuition policies in provinces where public finances are stretched (also see OECD, 2012a, Chapter 2).

Earlier OECD recommendations to reduce the skills shortage would also contribute to reduce the mismatch between supply and demand of labour for agriculture. In particular, OECD (2014) recommends to "provide better information on expected returns to post-secondary education to improve students' study choices. …. continue to work with provinces and territories to harmonise training and certification requirements of all apprenticeship programmes across the country to increase completion rates and inter provincial mobility of apprentices. … and enhance opportunities for seasonal workers to retrain." It also suggests to "Reduce the incidence of weak numeracy or literacy skills being a barrier to post-secondary education (PSE) completion, perhaps by requiring students to study mathematics and English/French until the end of secondary school or by investing in remedial education in PSE institutions. Increase experiential-learning components of university programmes to develop the soft skills sought by employers. Sustain programmes for immigrants to complement their foreign credentials and become qualified to local standards."

Specific programmes may be also warranted to upgrade or adapt skills in the agricultural labour force as the sector evolves rapidly to adopt new technologies, marketing and management practices. Agricultural education supply does not seem to be the problem as the Canadian system attracts a significant number of foreign students in this area. For the food and agricultural sector, competition in the education and labour market with dynamic sectors with higher wages is a challenge which cannot be met by the education system alone. The industry itself has a role to play to make agricultural and agri-food careers more attractive and better known.

Recommendations to improve capacities and services for innovation

- Skills for innovation could be reinforced by increasing integration between education, formal training and practical experience within tertiary education, increasing the distinction between institutions that target research and those that emphasise teaching, and re-evaluating tuition policies.
- Increased efforts should be made, in particular by the private sector, to better communicate evolving needs to educators and to promote further opportunities, such as internships, which are responsive to evolving business needs.
- Further efforts could be made to enhance the public's perception of agriculture and its role in the economy, including by improving information on job market opportunities in the sector.

Remove unintended impediments to innovation from agricultural policy

Canadian agricultural policy traditionally provides farmers with tools and support to manage risk and facilitate investment. Innovation has received more attention in the most recent Growing Forward 2 policy framework, with the implementation of specific programmes that provide funding for innovation, and promote cooperation between the public and private sectors as well as the adoption of innovation by the food and agricultural sector. The impacts of risk management programming on innovation likely depend on an individual producers' risk tolerance. While long-term risk management support may have reduced the incentive to invest in innovation and contributed to maintaining more farmers in the sector, it may also have encouraged some risk-averse farmers to invest when they may otherwise have not done so in the absence of this support. In any case, it would be more efficient to continue to develop programmes that target innovation directly, like the AgriInnovation programme under Growing Forward 2, and to provide incentives for private investment in the creation and adoption of innovation. To be effective, this emphasis needs to be pursued and reinforced over the long-term, in the light of evaluation of current programmes.

The dairy, poultry and egg sectors operate under a supply management system, with production levels established to meet domestic demand at a regulated pricing level, and high tariffs limiting the

importation of foreign products. OECD analysis shows that such market price support mechanisms affect production decisions and affect structural adjustment as they reduce incentives to use production factors more efficiently. While Canadian milk yields are high (IFCN, 2013), evidence suggests that structural adjustment in dairy farms has been slower in Canada than in the United States and New Zealand (Barichello, Castellanos and McArthur, 2012; Informa Inc., 2010). Domestic competition is restricted as the high cost of production quota raises the cost of entry as producers need to buy quota in order to produce supply managed commodities (OECD, 2008). These factors discourage structural adjustment, which is an important driver of productivity growth, together with innovation.[1] Removing impediments to structural adjustment could facilitate the adoption of larger-scale innovations, lower costs of production, and facilitate increased overall total factor productivity growth in these sectors.

Transforming the Canadian Wheat Board monopoly into a voluntary marketing organisation implies changes in the way the western Canadian wheat and barley sector operate. However, whether and how these changes impact on innovation and sector productivity remains to be seen.

Recommendations to remove impediments to innovation from agricultural policy

- High levels of support through domestic and border measures like those in place for supply-managed commodities distort markets and can impose a high cost on intermediate and final consumers. Lowering support and minimising distortions could help the industry adapt to market opportunities, including through enhanced innovation.
- Removing impediments and/or disincentives to structural adjustment could facilitate the adoption of innovation and increase productivity growth.
- Programmes that target innovation directly and provide incentives for private investment in the creation and adoption of innovation should be further developed.

Strengthen direct incentives to innovation in food and agriculture

Public research and public supply of knowledge are strong in Canada, as measured by the number of scientific articles per capita and spending on higher education R&D as a proportion of GDP. However, business investment in R&D is limited compared to some sectors and efforts are being made to better link public and private initiatives. Earlier OECD recommendations to improve general innovation systems would also benefit the Canadian agricultural innovation system, as agricultural innovation increasingly depends on knowledge infrastructure (including general purpose technologies such as information and communication technology, biotechnology, and nanotechnology), education, and skills development.

The Canadian agricultural innovation system has been performing relatively well. It is a major contributor to world innovation and has delivered innovations that have been widely adopted at farm level. As a result, total factor productivity has continued to grow at a relatively good pace and the efficiency with which natural resources are being used has increased.

Agricultural innovation includes a large diversity of actors, which calls for strong cooperation and governance systems. Various mechanisms help coordinate innovation priorities and actions between the federal and provincial levels, and stakeholders are widely consulted. Innovation has recently received increased emphasis in agricultural policy, but it is important to ensure even stronger coherence between economy-wide, agriculture and innovation policy so that they work together to achieve the long-term objective of improving the profitability, competitiveness and sustainability of the food and agriculture sector.

The public sector is the main supplier and funder of agricultural R&D through various institutions and programmes. Private investment in agricultural R&D is increasing, mainly in the food processing area, but in general, there appears to be scope for an expanded private sector role. While public expenditure on agriculture R&D is decreasing in real terms, agricultural R&D intensity – expenditure

as a proportion of value added – remains high compared to other countries at a similar level of development and relative to the contribution of the sector to GDP.

An increasing share of public funds to agricultural R&D at the federal level is of a targeted or time-limited nature. Small and large private sector firms use both agricultural specific and general innovation programmes to reduce risk, leverage funds, and identify innovation with potential. The most frequent complaints from industry are about administrative burdens, differences in rules depending on the source of funding, delays in obtaining funds, and the lack of policy predictability.

Knowledge infrastructures, such as research centres and universities, are well-spread across Canada and tend to specialise into regional systems. However, these infrastructures are ageing, and funding should continue to cover maintenance and upgrading costs where possible. Information on genetic resources and research results is widely shared and communicated to diverse audiences.

Intellectual property protection, which is essential to attracting private investment in innovation, is generally high by international standards. Plant variety protection, however, is lower than in many developed countries, as Canada did not sign the more protective 1991 UPOV convention. This may have prevented foreign breeders from introducing new varieties in Canada and put Canadian farmers at a competitive disadvantage. Increasing plant variety protection would place Canadian farmers at a level playing field with their major competitors on world markets. Legislation is currently being discussed to reinforce plant breeders' rights. There are various mechanisms and facilitators in Canada which provide information and advice on how to use Intellectual Property.

Recent programmes clearly encourage public-private cooperation through funding mechanisms. At the same time, a wealth of institutional arrangements such as research centres, centres of excellence, Agri-science clusters, and value-chain round tables aim to foster collaboration within the national agricultural innovation system and with the general innovation system. Researchers, however, mention problems of culture between public and private actors, short-term length of public programmes and related funding cycles, and inconsistency of budget procedures to apply for funding as obstacles to cooperation. As innovation success is largely determined by the integration of efforts, these obstacles need to be addressed.

Canadian researchers are active in cross-country cooperation, with a large share of patents and publication involving foreign researchers. International cooperation is encouraged through measures that facilitate staff and student exchanges, as well as through participation in international science-based organisations and networks. Maintaining a high quality education and research system, with stable funding, is essential to pursue effective collaboration at the international level.

Training and advisory services play an important role in facilitating the adoption of innovation at the farm level. The supply in Canada is diverse and accessible. As extension services vary by province, it is difficult to evaluate and compare the different systems, or to provide an overall picture of what is available. But there is survey evidence that Canadian farmers adopt new high yield varieties and production practices, such as no-till, on a wide scale. Government programmes to improve business management skills are very effective in facilitating the adoption of innovation. The current agricultural policy framework includes specific measures to facilitate the commercialisation and adoption of innovation at the farm and firm levels, which would need to be evaluated over time. Finally, government and private actors are playing an important role in providing strategic market information, as well as information on programmes and innovative technologies and practices. Independent brokers, such as consultancy firms, can facilitate access to this information and help decision-making related to investments or a change in practices.

Innovation policies are regularly evaluated according to the common framework used to evaluate all government policies, and which is mainly based on trends in economic performance. There is too little evidence to evaluate the cost-effectiveness of the agricultural innovation system, in particular regarding non-government activities and the adoption of innovation. To improve the effectiveness of government actions, it would be important to strengthen monitoring and evaluation tools. Indicators

on innovation outcome and performance should be developed to monitor the enabling environment, investment in R&D (including by the private sector) and higher education, and the adoption of innovative practices at the farm and firm levels. These indicators could be used for economic evaluation of policy impacts, which would then feed the policy-making process. A challenge would be to take account of time lags in the innovation process as this calls for continuity in programmes and evaluation processes.

Recommendations to strengthen direct incentives to innovation

- Establish a common strategy for agriculture and broader, government-wide innovation objectives to strengthen policy coherence. This will ensure that agricultural policy facilitates the adoption of innovation and that broader innovation policy contributes to long-term objectives to improve the profitability, competitiveness and sustainability of the food and agriculture sector to the extent possible.
- All agricultural programmes should be evaluated in terms of their impact on innovation, as the results would help to strengthen the focus on innovation of future frameworks. The development of outcome and performance indicators needs to be built into the policy-making process and used to evaluate policy impacts to allow for future improvements.
- Simplifying programming, such as initiatives related to financial support and business management advice, that aim to facilitate the adoption of innovation in farms and firms, would improve access to support and information, and thus to innovation.
- There should be a single platform which can identify all sources of available government funding. Streamlining fragmented federal granting programmes would encourage businesses to collaborate with researchers in the public sector. It would also help if provinces aligned their grants with those of the federal government.
- To maintain research capacity, it is also important to ensure stable funding for knowledge infrastructure, including general knowledge technologies, institutions, networks and databanks, as well as funding for long-term projects. It is also important to explore funding models that can help attract private sector investment, as well as public private partnerships that can support agricultural knowledge infrastructure and further innovation.
- Further investigate the demand and supply for venture capital for agricultural businesses and identify constraints and possible government role to ease these constraints.
- It is important to review the effectiveness of coordination and the responsiveness of the system to stakeholder demands. To increase collaboration and partnerships between public and private actors it is important to explore and tackle difficulties such as differences in culture, constraining requirements for using public funds, and frictions over the handling of IPR. .
- Strengthening Plant Breeders' Rights would attract private investment and place Canadian farmers at a level playing field with their major competitors on world markets.
- An important role for the government is to facilitate flow and access to information. It must also contribute to improving public understanding of the importance of innovation in the agricultural sector, as well as to society at large.

Box 1.1. OECD 2102 recommendations for boosting business innovation

Provide a stronger culture of competition, risk taking and customer orientation

- Increase competitive intensity in network sectors and professional services, in line with Going for Growth (OECD, 2012b) and Compete to Win (CPRP, 2008) recommendations. Fully implement the Agreement on Internal Trade to dismantle provincial barriers. Clarify the net benefit test for Foreign Direct Investment and apply it narrowly.
- Promote efficient and deep financial markets by: improved accounting for intellectual assets, more vigorous competition in financial services, and consistent and high standards in provincial securities market regulation.
- Examine how institutions can better develop cognitive and social skills for entrepreneurship and risk-taking. Support and encourage risk-takers across the board, from high-tech avant-garde to skilled trades.

Better target fiscal supports to R&D

- Scale down SR&ED tax subsidies, reducing the small firm subsidy rate towards that of large firms while keeping the base broad (inclusive of capital) to avoid distortions in technology choice. Restore the 20% general SR&ED rate.
- Streamline fragmented federal granting programmes to boost business interest in collaborations with academics. As IRAP[1] is expanded, consider partial cost recovery of pre-commercial business advice.
- Carefully design support to venture capital by means of strictly temporary co-financing arrangements, giving private partners full management control and possibly capping government returns in order to leverage private returns. Eliminate tax credits to retail investors in Labour-sponsored Venture Capital Corporations (LSVCC) funds. Provide institutional support to angel funds.
- Co-operate with provinces to align their grants and tax credits to R&D and venture capital with federal government.
- Design low-budget-cost policies to foster market demand for innovations, including "green" technologies, e.g. consumer policies and getting prices right via carbon taxes. Public procurement is relevant here, though it needs to be carefully designed to focus on technology neutrality and performance to stimulate innovation.
- As the policy mix shifts towards more granting and procurement, design safeguards against the risks of: lack of capacity in the public sector to wisely choose projects; inefficient policies and market distortions (including at the international level) due to Canada-only provisions; and capture by vested interests.

Update institutional foundations of the "knowledge economy"

- Motivate technology transfer from academia by means of improved incentives for academics, e.g. by adopting a more open and inclusive research-granting process, and business vouchers for academic collaborations. Consider rationalisation of currently widespread distribution of research resources in order to promote Canadian "star" universities better able to command market interest for their research.
- Strengthen the IP system: i) modernise the relevant legislation/public agencies to enhance transparency and guidance to inventors; ii) establish national protocols for sharing/transfer of IP in academic-business collaborations; iii) provide IP management services to small and medium enterprises (SMEs), e.g. within regional centres of excellence; iv) establish a specialised Patent Court or section of a court; and v) promote international IP collaboration.
- Build capacity to undertake comparative evaluations of fiscal supports to better guide funding allocations and programme design. This could be done by an arms-length Innovation Council as recommended by the Jenkins panel.
- Tailor privacy protections to minimise trade-offs with knowledge diffusion and network benefits from the Internet and integrated electronic medical records.

1. The Industrial Research Assistance Program (IRAP) is the major grant programme targeting SMEs.

Source: OECD (2012a), *OECD Economic Surveys: Canada*, OECD publishing. http://dx.doi.org/10.1787/eco_surveys-can-2012-en .

Note

1. Evidence suggests that expansion of farm size and exit of smaller farmers is an important driver of productivity growth (OECD, 2011 and 2012c; Kimura and Sauer, 2015). Recent analysis shows that dairy productivity has increased with the gradual phasing out of milk quotas in selected EU member states (Kimura and Sauer, 2015).

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Chapter 2

Overview of food and agriculture challenges and performance in Canada

This chapter outlines the main challenges and opportunities for the food and agriculture sector of Canada, which will require innovation. It describes the overall economic, social and environmental context in which the sector operates, and the natural resource base upon which it relies. It provides an overview of the general geographical and economic characteristics of the country; and outlines the contribution of the agri-food system to the economy. It identifies the main structural characteristics of primary agricultural and upstream and downstream industries; describes the main food and agriculture outputs and markets; and reviews trends in agricultural productivity and sustainability.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

Challenges and opportunities: The need for innovation in food and agriculture

Canada is highly dependent on trade in many sectors, including agriculture. Canadian primary producers and processors face world prices for most products and rely on being able to access markets for their long-term profitability. With a significant share of agricultural production currently being exported, the future competitiveness and sustainability of the industry will be influenced by the rapidly evolving global environment. For many sectors, prospects for agricultural world prices remain positive for the medium term, as demand for food and agricultural products is rising in response to an ever-growing world population, increased urbanisation, rising incomes, and increased demand for biofuels and non-food uses of agricultural products. Another expected feature of global markets is higher price variability reflecting tight market conditions and the additional uncertainty of food supplies from higher frequency of extreme natural events related to climate change. In addition, the trading environment has changed with the rise of regional and bilateral trade agreements.

The growing and changing demand for food and agricultural products will create opportunities for the Canadian food and agriculture sector. Yet, new competitors are emerging in South America, Asia, and the former Soviet Union countries, which are ramping up production of agricultural products to meet rising national and global demands. To remain competitive, Canadian exporters will likely need to compete on costs as well as product attributes. It will be necessary for players in Canada's agricultural innovation system be as adaptable and efficient as possible to ensure that Canada continues to be a major exporter and marketer of food and agricultural products that meet the demands of the world's food importers and emerging economies.

Rising incomes and population growth in developing and emerging economies along with discerning consumers in Canada and many other developed countries are leading to changing food consumption patterns. Food consumers are increasingly attaching value to attributes such as food safety and quality, enhanced nutrition, environmental stewardship in production and processing practices, animal welfare, and fair trade and development-related outcomes. Stronger consumer demand for such attributes to be embedded in food products has prompted retailers to translate these consumer expectations back up the value chain to suppliers. As a consequence, new business models are being adapted to respond to this demand, where global supply chains and private standards play a dominant role. Not only do such new business models and the attendant governance structure influence Canada's opportunities both at home and abroad, these are also influencing how the Canadian food and agriculture sector is evolving as it adapts to its environment.

The sector's capacity to produce, process and distribute safe, healthy, and high-quality agriculture, agri-food and agri-based products is dependent on its ability to increase productivity and sustainable use of resources to expand domestic and global markets by meeting and exceeding consumer expectations. Risk management is critical for ensuring food safety and market development. Improved regulatory processes contribute directly to the economic stability and prosperity of Canadian farmers and for the safety and overall well-being of the Canadian public at large. Improving the resource efficiency also contributes to the preservation of natural resources for farmers, society and future generations.

Innovation, which encompasses investments in R&D and the adoption of new products, processes and production practices, technologies and business strategies, will be key to helping the sector respond to these changing global forces by producing consumer-oriented products in a sustainable way, while remaining competitive at home and abroad. Science and technology, in particular, has a critical role to play in helping the food and agriculture sector achieve greater competitiveness, improve environmental performance, and contribute to the health and well-being of Canadians.

General context: Economic situation and natural environment

Canada is a large country in terms of land mass with a relatively small population (Table 2.1). It is well endowed with an abundance of agricultural and arable land, water and natural resources such as forests, oil and gas. On a per capita basis, it ranks third in the world for arable land behind Australia and Kazakhstan, and first for freshwater resources. The vast majority of the population and most arable land are in the southern regions of Canada, which display a variety of temperate, cold climatic conditions. Cool summers, mild winters and abundant rain prevail along the Pacific coast. The Prairies are characterised by extreme temperatures, long and cold winters and short and dry summers. In Southern Ontario and Quebec, the climate is less severe and precipitation is abundant and highly uniform throughout the year. The growing season is short, even in the most southern regions.

Canada is a small, wealthy and open economy. GDP per capita is above the OECD average (Table 1.1) and by this indicator, Canada is ranked 7th among OECD countries. The economy is dominated by services, which account for 71% of total activity. Primary agriculture, forestry and fishing account for 1.5% of total activity; and industry, including construction, for 27% (OECD, 2014a).

The Canadian economy is more exposed to trade than that of major OECD regions and emerging economies (Figure 2.1). This exposure reflects Canadian export orientation, but also the importance of imports.

Table 2.1. Contextual indicators, 2012*

	GDP	GDP per capita	Population	Land area	Agricultural land	Arable land per capita	Freshwater resources[2]	Freshwater resources per capita[2]
	Billion USD	PPP USD	Million inhabitants	'000 km^2	'000 ha	Ha	Billion m^3	m^3
Australia	1 519	44 407	23	7 682	409 673	2.14	492	22 039
Brazil[1]	2 207	11 239	202	8 459	275 030	0.40	5 418	27 512
Canada	1 775	41 150	35	9 094	62 597	1.20	2 850	82 647
European Union	17 293	34 091	501	4 182	187 882	0.21	1 505	2 963
United States	16 765	51 689	316	9 147	411 263	0.51	2 818	9 044
China [1]	9 167	9 058	1 347	9 327	519 148	0.08	2 813	2 093
Russia[1]	2 122	22 502	147	16 377	121 750	0.83	4 313	30 169
South Africa[1]	384	11 028	52	1 214	14 350	0.23	45	886
OECD	45 777	37 010	1 250	34 219	403 496	0.37	..	..

* Or latest available year.
PPP: Purchasing Power Parity.

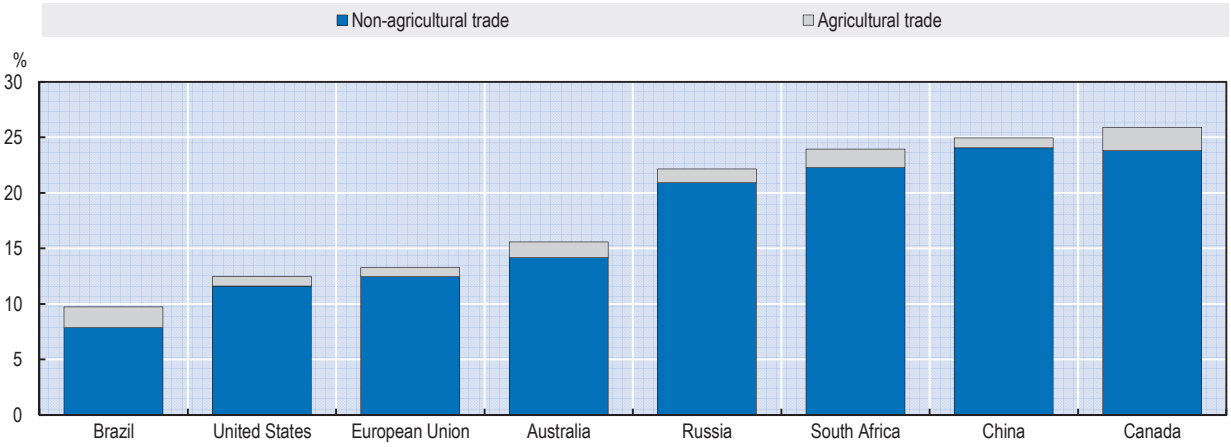
1. Updated from OECD (2013a), *Agricultural Policy Monitoring and Evaluation 2013: OECD Countries and Emerging Economies*, OECD Publishing. http://dx.doi.org/10.1787/agr_pol-2013-en.

2. World Bank's World Development Indicators, 2014. http://data.worldbank.org/products/wdi.

Source: OECD (2014b) *Agricultural Policy Monitoring and Evaluation 2014: OECD Countries*, DOI: http://dx.doi.org/10.1787/agr_pol-2014-en.

Figure 2.1. Exposure to trade, selected economies, 2012

Trade (average of exports and imports) as a percentage of GDP

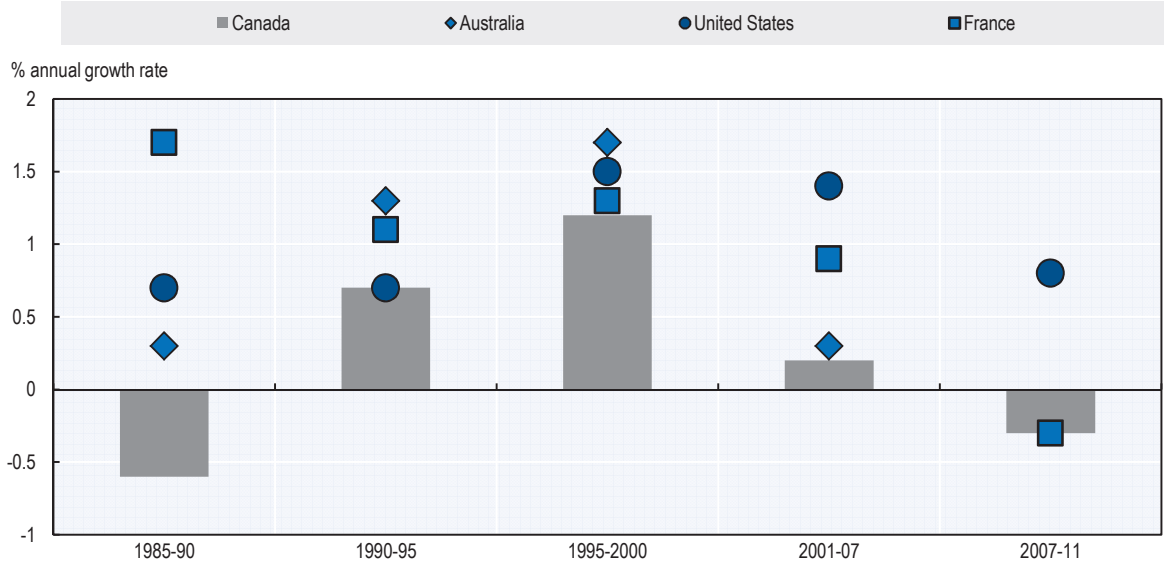


Source: OECD System of National Accounts; UN COMTRADE, 2015.

StatLink http://dx.doi.org/10.1787/888933250173

The Canadian economy has performed relatively better than the OECD average since the beginning of the global economic crisis (Chapter 3). Canada benefits from a highly-educated population and from the diversity of its population, which is drawn from immigrants from all countries around the world. Canada is also equipped with efficient production systems and well-established markets. Its enabling environment for innovation ranks highly in terms of its framework policies, fiscal stability, rule of law, ease of starting a new business, efficient markets, attractiveness for foreign investment, trust in government policy making, quality of infrastructure, social safety net and health system. Its financial services sector came in first among G7 countries for the soundness of its banking system for the fifth consecutive year. Canada also has relatively low corporate tax rates, contributing to its attractiveness as an investment destination and cost competitiveness.

Figure 2.2. Multi-Factor Productivity of the economy, selected countries, 1985-2011



Source: OECD Productivity Database, 2015.

StatLink http://dx.doi.org/10.1787/888933250189

Despite these assets and sound policies, multi-factor productivity growth in the overall economy has been low in the last decade compared to the United States (US) and some other countries of similar level of development (Figure 2.2). It was negative on average in 2007-11 despite some recovery in 2010 and 2011. Investigating this paradox, a recent OECD economic review (OECD, 2012) suggests that it is partly due to the structural composition of the economy, including the poor performance of a relatively important mining sector (4.5% of GDP). Differences could be also influenced by the relative sizes of the industries being studied, as well as the firm size distribution within those industries. The investigation also points to lower R&D intensity, lower investment in Information and Communication Technologies (ICT), possible labour rigidities, and small firms failing to grow, possibly because of the small domestic market, and a tax system that discourages growth (Chapter 4). However, in contrast with the overall economy, primary agriculture is one of the sectors with the highest Multi-Factor Productivity (MFP) growth rate in Canada. Food processing industries also show productivity near or above US levels (OECD, 2012).

Importance of the food and agriculture system in the economy

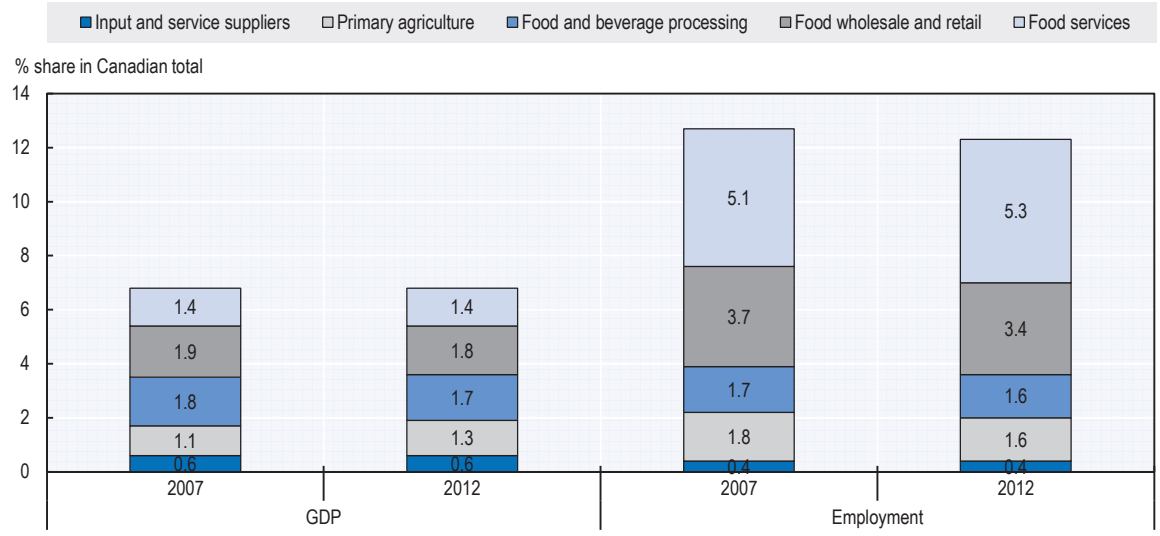
The Canadian food and agriculture system, from farm input and service suppliers and primary agriculture to food and beverage processors and retailers, plays a significant role in the Canadian economy. It accounted for 6.7% of total GDP in 2012 and is the seventh-largest contributor to national GDP after the financial services, non-food manufacturing, mining, oil and gas extraction, and health care and public administration sectors. Between 2007 and 2012, the share of the whole system in total GDP has been stable, indicating that it grows at the average economic pace (Figure 2.3).

The whole Canadian food and agriculture system also makes an important contribution to overall Canadian employment. In 2012, the system provided one in eight jobs, employing over 2.1 million people, to account for 12% of total Canadian employment (Figure 2.3). Over time, employment in the food and agriculture system has been increasing by about 1% per year, amounting to a 15% increase from 1997 levels. By comparison, overall employment in Canada grew by 28% over the period 1997 to 2012. The relatively lower rate of employment growth in the food and agriculture system is due, in part, to a continued reduction in the number of farms as the sector has restructured, technological improvements and increases in average farm size. The contribution of the wholesale and retail sector to employment has also decreased between 2007 and 2012 (Figure 2.3).

It should be noted, however, that the extent to which the food wholesale, retail and service sectors rely on domestic primary agricultural production varies by country and sub-sector. As in countries at similar levels of development, the share of primary agriculture and closely related input and processing industries in the economy is relatively modest, accounting for 3.4% of GDP and 3.7% of employment. Primary agriculture accounts for 1.1% of Canadian GDP and 1.6% of employment (Figure 2.3).

At about 10%, the share of agricultural products in Canadian exports is close to that in the United States. While Canada's agriculture and agro-food trade balance is largely positive, agricultural imports make a higher proportion of Canadian imports than is the case for other agricultural net exporting countries (Figure 2.4). The importance of agro-food exports and imports for the Canadian economy is also reflected in Figure 2.5, which compares across selected countries agro-food trade in relation to GDP (Panel A), and as well as indicators of agro-food imports and exports of value-added in relation to agro-food GDP, which shows how national industries (upstream in a value-chain) are connected to consumers in other countries, and how industries abroad (upstream in a value-chain) are connected to consumers at home, even where no direct trade relationship exists. These indicators show that Canada is relatively well-integrated in global value-chains.

Figure 2.3. Contribution of the food and agriculture system to the Canadian economy, 2007 and 2012

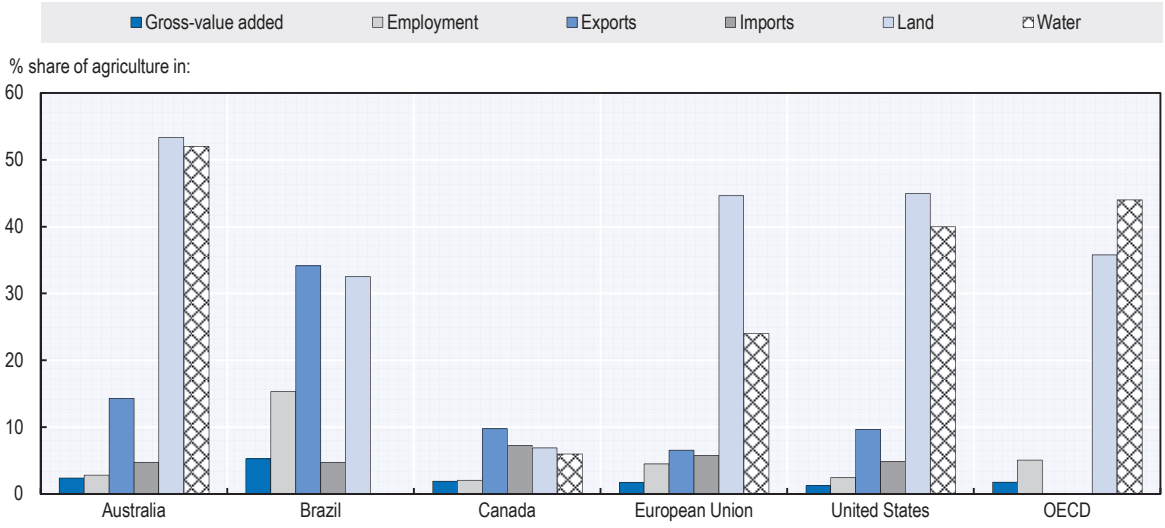


GDP shares are based on constant 2007 CAD.

Source: Agriculture and Agri-Food Canada (AAFC) (2014), *An Overview of the Canadian Agriculture and Agri-Food System 2014*, http://www.agr.gc.ca/eng/about-us/publications/economic-publications/alphabetical-listing/an-overview-of-the-canadian-agriculture-and-agri-food-system-2014/?id=1396889920372, Charts A.1 and A.3; and 2009 edition, Charts B1.1 and B1.3, available at: http://ageconsearch.umn.edu/bitstream/59885/2/overview_2009_e.pdf

StatLink http://dx.doi.org/10.1787/888933250192

Figure 2.4. Share of primary agriculture in the economy and in resource use, selected economies, 2012

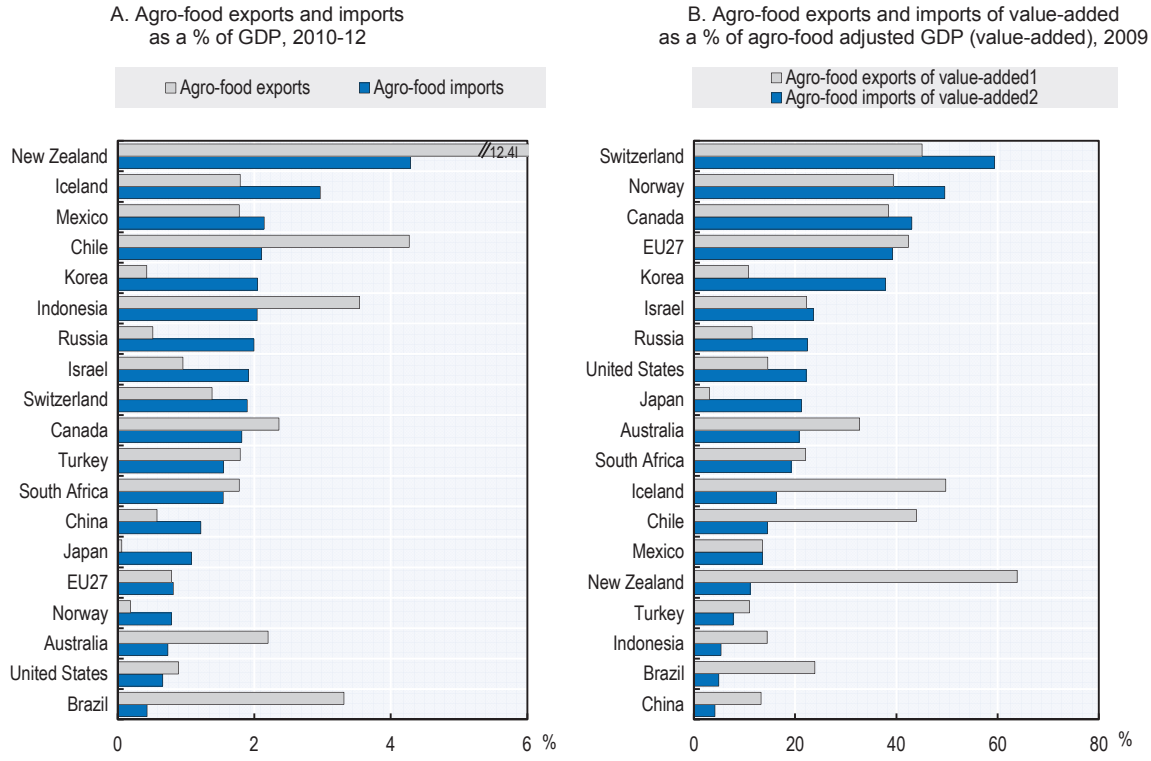


Data on Canadian Gross value added are for 2008; Land use and employment data are for 2011; water use is for the period 2008-10.

Source: OECD macroeconomic, labour and trade statistics and agri-environmental indicators (OECD.stat), published for OECD countries in OECD (2014b) *Agricultural Policy Monitoring and Evaluation 2014: OECD Countries*, OECD Publishing http://dx.doi.org/10.1787/agr_pol-2014-en.

StatLink http://dx.doi.org/10.1787/888933250207

Figure 2.5. Exposure to trade in agriculture and food products in selected countries



1. Value-Added embodied in Foreign Final Domestic Demand shows how industries export value both through direct final exports and via indirect exports of intermediates through other countries to foreign final consumers. They reflect how industries (upstream in a value-chain) are connected to consumers in other countries, even where no direct trade relationship exists. The indicator illustrates therefore the full upstream impact of final demand in foreign markets to domestic output. It can most readily be interpreted as "exports of value-added".

2. Foreign Value-Added embodied in Final Domestic Demand shows how industries abroad (upstream in a value-chain) are connected to consumers at home, even where no direct trade relationship exists. It can most readily be interpreted as 'imports of value-added'

Source: International Trade by Commodity Statistics (ITCS) Database and OECD-WTO Trade in Value-Added Database, 2013. http://www.oecd.org/industry/ind/measuringtradeinvalue-addedanoecd-wtojointinitiative.htm.

StatLink http://dx.doi.org/10.1787/888933250213

Canada differs from other agricultural net exporting countries in that agriculture accounts for a much smaller share of land and water use, reflecting its climate and geography. There are marked differences among Canadian regions related to agricultural water use. About 85% of agricultural withdrawals (surface and ground water) are used for irrigation (primarily in Western Canada) and 15% is used for watering livestock.

Characteristics of the food and agriculture sector

Agricultural production

Canada produces a wide variety of products such as grain and oilseeds, red meat, pulses, dairy, poultry and egg products and potatoes, with an almost equal share of crop and livestock products. In 2011 and 2012, however, grain and oilseed receipts rose as a share of the total market receipts because of higher prices, while the share of red meats fell. Market receipts from special crops (including pulses, beans, peas, mustard, sunflower and canary seeds) more than doubled between 2002 and 2012, while their market share increased from 2.7% to 3.7%. Market receipts for poultry, eggs and dairy

products, as a share of the total farm market receipts, fell slightly over this period, as did that of fruits and vegetables, including potatoes (AAFC, 2014).

Crop production is concentrated in the Western Prairies. Most milk production is located in Eastern Canada, which has a larger variety of crops, including fruits, vegetables, and tobacco. The red meat industries (i.e. hog and beef cattle) maintain a significant presence across Canada, especially in Western Canada, Ontario and Quebec.

Farm and industry structure

Primary agriculture in Canada has experienced profound structural changes over the past 50 years, resulting from a significant decline in the use of labour (and increased mechanisation of production), as well as urbanisation of the population. It was also due to the introduction of inputs such as fertilisers and pesticides in the production process over time. The adoption of many new technological advances by farmers, including the development and adoption of new crop varieties, new livestock breeds, feeding and management regimes, nutrient management practices, integrated pest management, new tilling methods (conservation and no-till), farm machinery innovations, precision agriculture (GPS), computers, internet (broadband) and smart phones usage, have all helped transform the sector.

Technological advances and increased productivity growth have also enabled farms to increase scale of operation and consolidate. The average farm size has more than tripled over the last 70 years to reach 315 hectares (ha) in 2011. Farm type varies from more intensive (100 ha farms in Ontario and Quebec) to more extensive farms in Saskatchewan, Alberta and Manitoba averaging twice the national average. Farm size has also increased in terms of livestock numbers, most notably in hog farming where the number of pigs per farm rose more than twentyfold from approximately 70 in 1971 to 1 720 in 2011 (Statistics Canada, 2011).

Larger farms continue to account for the majority of production. In 2011, farms with revenues of CAD 1 million or more represented only 4.6% of farms but accounted for 49.0% of total gross farm receipts, while the smallest farms, (revenues under CAD 100 000) represented 62.2% of farms but only 7.0% of receipts. Medium to large farms (CAD 100 000 to CAD 999 999) accounted for 33% of farms but 44% of receipts.

The Canadian food and beverage processing industry, as the major purchaser of agricultural commodities, was the largest manufacturing industry in Canada in 2011, as measured by its share of total manufacturing GDP. Most food processing establishments are small, with fewer than 50 employees, but large food processing establishments account for the bulk of production. In 2009, large establishments comprised 3% of the total number of establishments, but accounted for 50% of the total value of shipments. Many of these are multinationals with head offices overseas.

The Canadian retail food market in which these agriculture and food products are sold domestically is characterised by three large Canadian-owned national supermarket chains in addition to smaller "mom and pop" corner stores and local farmers' markets. Increasingly, a broad range of other types of stores are selling food and beverage products such as drugstores/pharmacies, general merchandisers and gas stations. In addition, the arrival of US mega-retailers with expanded grocery offerings (Wal-Mart, Target and Costco), the Canadian retail food market has become highly competitive, with low margins and continual merger and acquisition activity, leading to restructuring and consolidation as firms position themselves to compete with multinationals. Canadian consumers are benefiting however, with competitive prices and discount offerings, private labels and new products.

Agro-food trade

Canada is a net exporter of agricultural products. In 2012, food and agricultural exports accounted for 9% of total exports and Canada was the fifth-largest exporter of food and agriculture products after the European Union, the United States, Brazil, and China, with export sales of CAD 43.6 billion

(Figure 2.6). This represented 3.3% of the total value of world food and agriculture exports (AAFC, 2014).

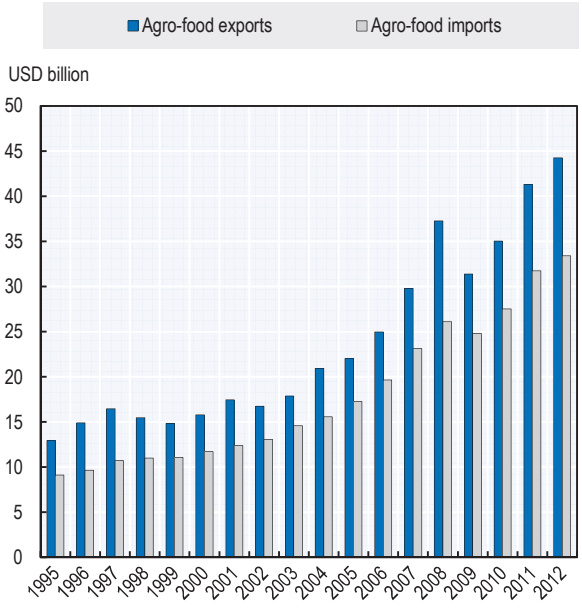
Canada is among the top five world producers and exporters of wheat, canola and pulses, and is a major exporter of beef and pork. While the United States is Canada's most important export destination, Canadian exports to China are growing in importance (Figure 2.6).

Canada is also a major importer of food and agriculture products, accounting for 2.7% of the total value of world food and agriculture imports in 2011. Canada was the world's sixth-largest importer after the European Union, the United States, China, Japan and Russian Federation. The value of food and agriculture imports has grown steadily from CAD 7.3 billion in 1988 to CAD 31.0 billion in 2011 (up 322%) (AAFC, 2014).

The domestic market is also very important for the Canadian agriculture and food industry. Most of the growth in output has been consumed at home. Three quarters of Canadian processed food and beverages are destined for the domestic market. While the industry is facing pressure from foreign competitors, opportunities are increasing for health- and environmentally-conscious products (e.g. organic, functional foods, locally-produced).

Figure 2.6. Canadian food and agricultural trade, 1995-2012

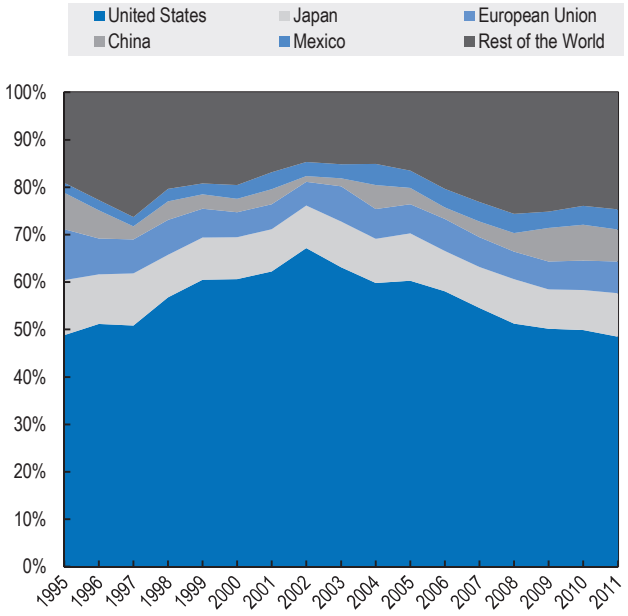
A. Trends in export and import values



Source: International Trade by Commodity Statistics (ITCS) database, http://stats.oecd.org/Index.aspx?DatasetCode=HS1988&lang=en.

B. Main export destinations

Percentage of total Canadian agricultural and agri-food exports



Source: Statistics Canada and Agriculture and Agri-Food Canada (AAFC) calculations

StatLink http://dx.doi.org/10.1787/888933250226

Commodity support

Canada has a dualistic agricultural sector as a matter of policy (Chapter 6). Commodities for which Canada is a competitive net exporter contrast with mainly inward looking "supply managed" subsectors (dairy and poultry, and related products), which are shielded from market forces through tariff quotas (with very high out of quota tariffs), export subsidies, production quotas, and other measures (WTO, 2011).

Input and output markets competitiveness

As measured by cost-efficiency, export-oriented agricultural commodity sectors are competitive on world markets, but supply-managed ones are not. Production quotas and price pooling are anti-competitive practices, and higher domestic prices for protected commodities increase production costs for the processing industry.

Farm input prices are critical to agricultural competitiveness. Generally, costs of animal and plant genetics, fertiliser, veterinary drugs, plant protection products and equipment are comparable with those of competitors. However, gaps, to Canada's disadvantage, often exist *vis-à-vis* the United States.

Productivity and sustainability performance of agriculture

The government has played a role in the transformation of the Canadian agricultural sector with past public investments in R&D in agriculture. At the same time, private sector investments in R&D have also increased, particularly in the areas of new crop varieties and livestock genetics. Public and private investments in innovation have greatly contributed to the growth in productivity performance, which accounts for a large and increasing share of agricultural production growth. At the same time, the adoption of more sustainable practices has improved the environmental performance of agriculture and reduced the pressure on natural resources.

Productivity performance

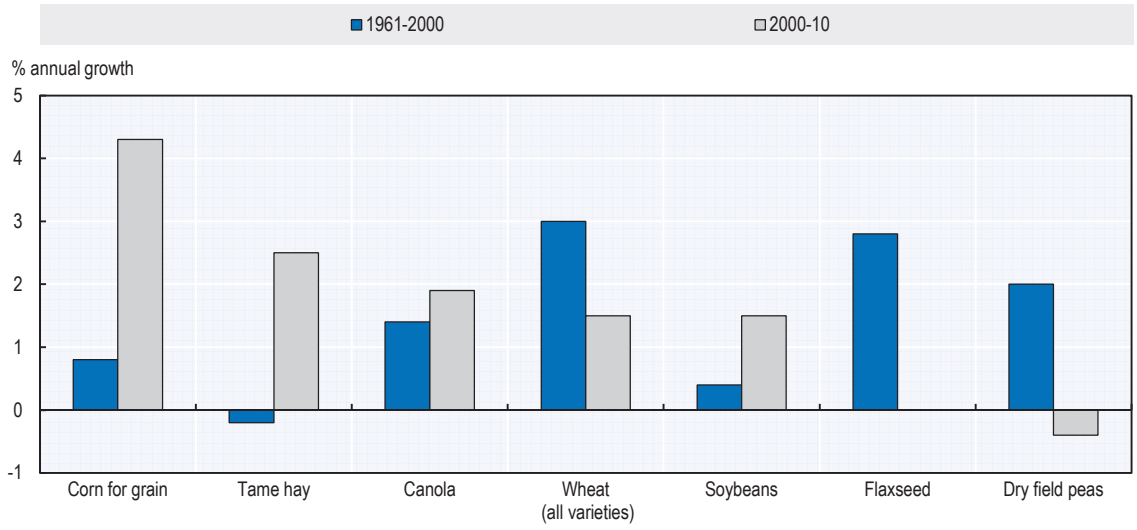
Principal crops grown in Canada including wheat, corn for grain, canola, soybeans, flax and dry field peas, have experienced various degrees of **yield growth**. Compared to the period 1961 to 2000, corn, canola, and soybean yields grew more over the period 2000 to 2010 (Figure 2.7). For example, corn yields (for grain) grew by only 0.8% in the earlier period relative to 4.3% from 2000 to 2010. This was the period when biotechnology transformed the hybrid seed industry and Plant Breeders' Rights laws were introduced in Canada (1990), the combination of which provided incentives for private industry to undertake R&D in these areas. On the other hand, yield growth for wheat and dry field peas has declined over this same period.

Research conducted in Agriculture and Agri-Food Canada (AAFC), suggests that real agricultural output in Canada grew by 2.3% annually between 1961 and 2006 (Cahill and Rich, 2012) (Figure 2.8). Over the same period, input use grew by only 0.7% per year. The remainder of the output growth was due to average **total factor productivity growth (TFP)**[1] of 1.6% per year. As a result, the Canadian agricultural sector needs about half the level of input that it used in 1961 to produce the same amount of food. Labour productivity grew faster than land productivity, and was the second highest in the OECD area at the end of the 2000s, after the United States and followed by Australia (OECD, 2011).

In recent years, TFP growth in primary agriculture has slowed down but its annual rate remains steady at about 1.6%. Recent cross country comparisons by the Economic Research Service of the USDA also indicate that Canadian TFP growth rates have declined in the last decade, but remain steady (Figure 2.9). This decline is much less pronounced than in Australia, but TFP growth is slower than in most other OECD countries, as well as in emerging or transition economies, where agricultural TFP is growing fast to catch up. As in many agricultural export-oriented countries, multifactor productivity increased at a faster rate in agriculture, hunting, forestry and fishing, than in the total economy, and in the manufacturing sector in the 1990s and the beginning of the 2000s. But it was no

longer the case in the late 2000s, probably because of lower agricultural production due to widespread adverse climatic events. Slower TFP growth in Canadian agriculture may also reflect a lower labour productivity, which is not compensated by an increase in land and machinery productivity.[2]

Figure 2.7. Average yield growth for principal field crops in Canada, 1961-2000 and 2000-10



Source: Statistics Canada.

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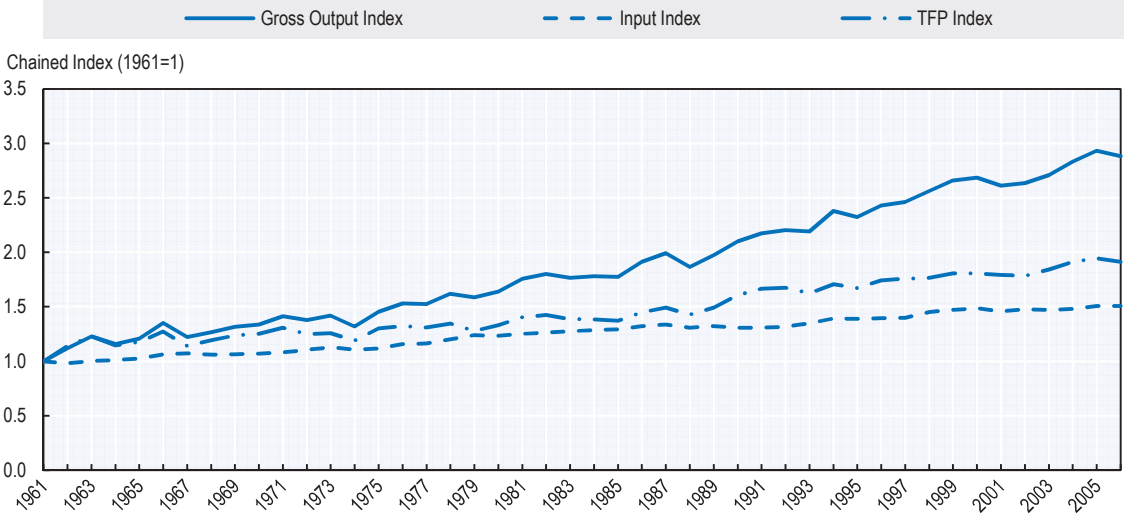
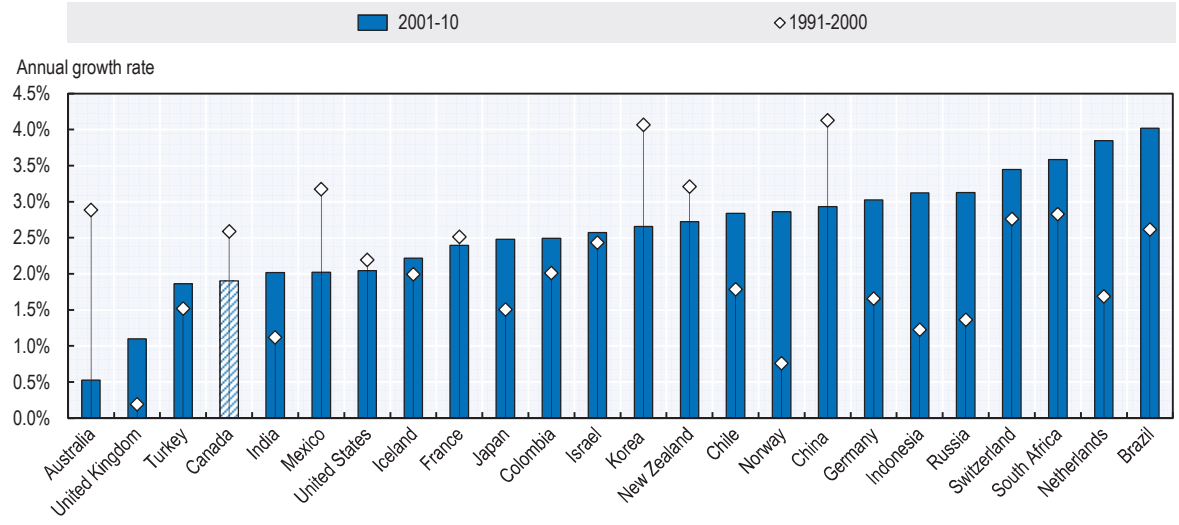
Figure 2.8. Gross output, input and total factor productivity (TFP) growth in Canadian primary agriculture, 1961-2006



Source: Cahill, S.A. and T. Rich (2012), "Measurement of Canadian agricultural productivity growth".

StatLink http://dx.doi.org/10.1787/888933250247

Figure 2.9. Total Factor Productivity growth in primary agriculture, by decade, selected countries, 1991-2010



TFP growth is calculated using FAOstat data and a different methodology than that used by AAFC.

Source: USDA Economic Research Service Agricultural Productivity database. Available at: www.ers.usda.gov/data-products/international-agricultural-productivity/documentation-and-methods.aspx#excel.

StatLink http://dx.doi.org/10.1787/888933250251

Recent OECD research suggests that Canadian farm performance in the field crops and beef sectors was similar to other OECD countries (Kimura and Le Thi, 2013). Field crop performance was similar to Australia and the United States, countries that also have large land endowments. However, Canadian farm performance lagged behind for the dairy sector once market price support was accounted for. Similar to the other countries, high performing Canadian farms accounted for a greater share of gross agricultural output, but did not necessarily operate larger land areas. Differences in management capacity and land quality could explain why higher performers earn higher returns with similar land sizes. In contrast to other countries in the study, low performing Canadian farms received a larger share of overall programme support.

Sustainability performance

Canadian agriculture benefits from relatively abundant resources and does not seem to generate widespread environmental problems. In the last two decades, agricultural production growth in Canada has occurred with minimal increased pressure on land or water, although there are regional differences with respect to resource abundance.

Since the early 1990s, agricultural land area has slightly increased and agricultural freshwater withdrawals have decreased. The nitrogen balance doubled from 1990-92 to 2007-09 and this increase was commensurate with agricultural production growth rate (Figure 2.10). At 23 kg/ha, nitrogen surplus intensity remains much below the OECD average (Figure 4.3 in OECD, 2003b). Phosphorous balance was negative in the 1990s and became slightly positive in 2007-09. Nutrient surplus intensities (e.g. nitrogen and phosphorous balance per hectare) at national level are relatively low but there are regions where excess nutrients place some burden on the environment and where nutrient deficits have the potential to undermine crop productivity. In particular, the chronic deficit in phosphorus in soils in some regions is a persisting concern in Canada (OECD, 2013b). At the same time, over-application and winter application leads to the proliferation of algae in other regions. In the last decade, pesticide use decreased by 2.6% per annum, while crop production increased by 0.5% per annum.

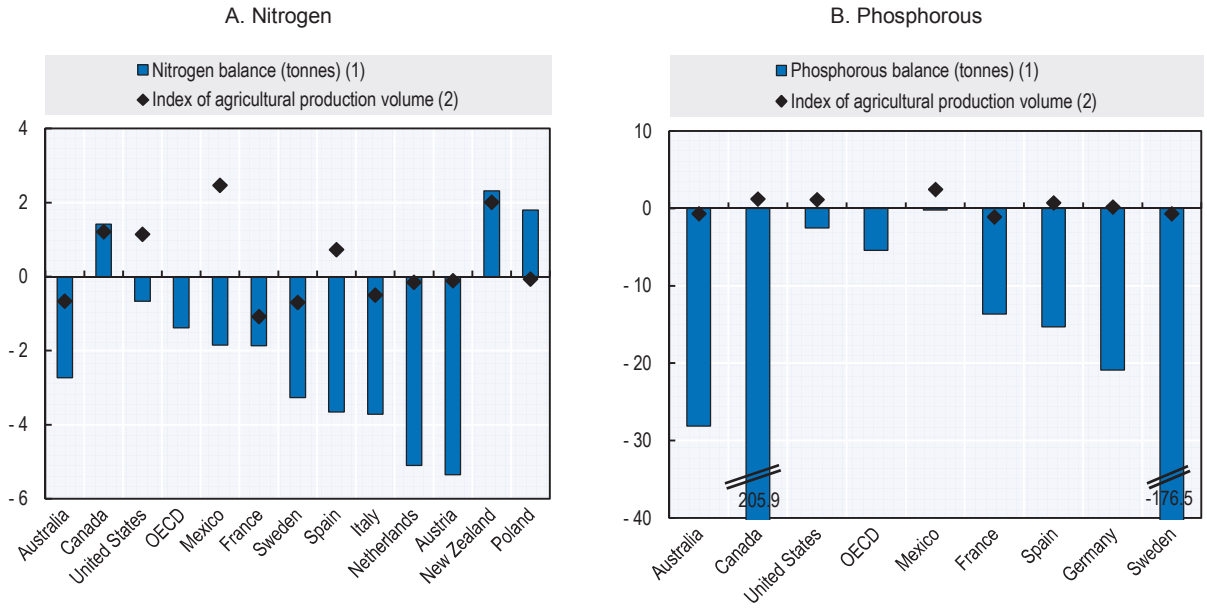
A very small proportion of agricultural land area is classified as having moderate to severe water erosion risk (2%) or as having moderate to severe wind erosion risk (1.7%). Past soil erosion problems

have been largely solved through changes in production practices, including reduced tillage intensity and reduced use of summer fallow, and innovation in machineries. Over the last few decades, land use on many of the more erodible soils has been converted to forage production and pasture.

Overall, the adoption of precision agriculture has contributed to improving the sustainability performance of Canadian agriculture. This trend also responds to the demand from food companies, which through sustainability requirements ensure a more to stable supply.

Figure 2.10. Nutrient balance trends, selected OECD countries

Average annual percentage change between 1998-2000 and 2007-09



1. The gross nutrient balance (surplus or deficit) calculates the difference between the nutrient inputs entering a farming system (i.e. mainly livestock manure and fertilisers) and the nutrient outputs leaving the system (i.e. the uptake of nutrient for crop and pasture production).

2. Index Base 100 = 2004-06.

Source: OECD (2013), *Agri-Environmental Database*; OECD (2013b).

StatLink http://dx.doi.org/10.1787/888933250268

Notes

1. Total factor productivity (TFP) growth is, like the partial measures, the increase in the ratio of output to input volumes. For the partial productivity measures, only one input is considered (land), while in the TFP measure, all inputs are accounted for: capital (machinery, land, buildings, livestock), labour (paid and unpaid) and intermediate inputs (purchased goods and services).
2. See productivity indicators published in the USDA Economic Research Service Agricultural Productivity database, available at: www.ers.usda.gov/data-products/international-agricultural-productivity/documentation-and-methods.aspx#excel.

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Chapter 3

Economic stability and trust in institutions in Canada

This chapter outlines the importance of economic stability and public institutions in fostering public and private investment. It provides an overview of the performance of the overall economy, outlines macroeconomic developments and challenges, explains the federal-provincial governance system, and presents an evaluation of public institutions.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

Macro-economic policy environment

At the broadest level, stable and sound macroeconomic policies play an important role in setting a favourable environment for investment by farms or agri-food firms seeking to introduce new products, to adopt new production methods, or to undertake organisational changes that can lead to higher productivity growth and more sustainable use of natural resources (OECD, 2010). Assessment of the country's overall growth and growth potential in the short- to medium-term has implications for sector specific prospects as well. In some circumstances, macroeconomic policies and their impact can contribute to implicit and perhaps unintended biases for or against the food and agriculture system.

Canada has enjoyed stable and sound macroeconomic conditions with fairly solid growth since the trough of the recession (OECD, 2014a) (Table 3.1). Federal fiscal plans are seen by markets as credible, favouring low borrowing costs, and real business investment and corporate profit margins have been restored to pre-crisis levels (OECD, 2012). As a result of the stimulus injection during the recession (worth about 4% of GDP at the federal level), the general government balance deteriorated from a surplus of 1.7% of GDP in 2007 to a deficit of 4.9% of GDP in 2010, progressively reduced to 2.7% in 2013. As a result, general government gross debt expanded by about 20 percentage points of GDP to reach 93% of GDP by the end of 2013 (Table 3.1).

National unemployment has fallen substantially since the recession peak and is in 2014, near its long-term average rate, as well as OECD estimates of its structural rate of about 7%. Inflation is low and stable. The last decade has brought significant structural changes to the value of the Canadian dollar relative to the US currency – a 32% appreciation between 2002 and 2008. The strength of the Canadian dollar, which was close to parity with the US dollar over 2010-13, has affected the competitiveness of Canadian export-oriented businesses (Table 3.1).

Canada ranks slightly higher than the OECD average for the stability of its macroeconomic environment, according to the World Economic Forum's Global competitiveness indicator (Figure 3.1). However, at over 5 out of a maximum score of 7, Canada ranks lower than fast growing and less indebted OECD countries and emerging economies.

In the latest *OECD Outlook* (OECD, 2014a), Canada's economic growth, led by exports and business investment, is projected to strengthen to reach 2.4% in 2014 and 2.6% in 2015 (Table 3.1). The improvement in export results from the recovery in foreign markets and the steps firms are taking to expand into the fastest-growing markets and to enhance their competitiveness. Business investment should be supported by declining spare capacity, and cheap and readily available credit. The general government balance is projected to be reduced to -2.0% in 2014 and -1.8% in 2015, and the inflation rate to increase to 2.0% in 2014 and 1.6% in 2015.

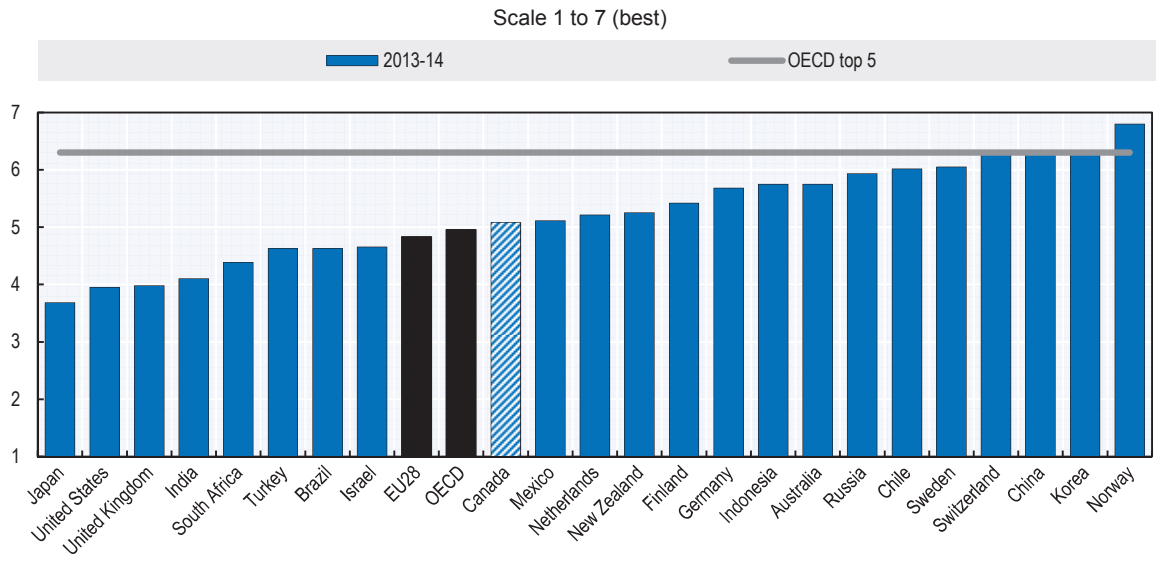
Table 3.1. Canada's key indicators of macroeconomic policy, 1990-2015

	1990	1995	2000	2005	2008	2009	2010	2011	2012	2013	2014e	2015e
Real GDP growth, %	0.1	2.7	5.1	3.2	1.2	-2.7	3.4	3.0	1.9	2.0	2.4	2.6
General government financial balance, % of GDP	-5.7	-5.2	2.9	1.7	-0.3	-4.5	-4.9	-3.7	-3.1	-2.7	-2.0	-1.8
General government gross debts, % GDP	77	104	84	76	75	87	90	93	96	93	94	94
Exchange rate (CAD per USD)	1.17	1.37	1.49	1.21	1.07	1.14	1.03	0.99	1.00	1.03	1.10	1.14
Inflation, annual %, CPI, all items	..	2.2	2.7	2.2	2.4	0.3	1.8	2.9	1.5	1.0	2.0	1.6
Unemployment rate, end year, % of total labour force	8.2	9.5	6.8	6.7	6.1	8.3	8.0	7.5	7.3	7.1	6.9	6.5

e: OECD estimate.
Source: OECD (2014a), *OECD Economic Outlook: Volume 2014/2,* OECD Publishing. http://dx.doi.org/10.1787/eco_outlook-v2014-2-en.

StatLink http://dx.doi.org/10.1787/888933250708

Figure 3.1. Global Competitiveness Index: Macroeconomic environment,[1] 2013-14



OECD top 5 refers to the average of the scores for the top five performers among OECD countries (Norway, Korea, Switzerland, Sweden and Luxembourg).

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

1. The index of macroeconomic environment integrates the following indicators: government budget balance; gross national savings; inflation; government debt; and country credit rating.

Source: World Economic Forum (2013), *The Global Competitiveness Report 2013-2014: Full data Edition*, Geneva 2013. http://reports.weforum.org/the-global-competitiveness-report-2013-2014/#=.

StatLink http://dx.doi.org/10.1787/888933250273

Governance and quality of public institutions

Good governance systems and high-quality institutions provide economic actors with the assurance that the government is accountable, transparent and predictable. They are a fundamental pre-condition both to encourage public and private investment in the economy and to enable those investments to achieve the intended benefits, both for investors and the host country. Moreover, governance systems play an important role in addressing market failure, influencing the behaviour of firms as well as the efficient functioning of input and output markets (OECD, 2013).

Canada is a federal state in which a number of areas of responsibility are shared among the ten provinces and three territories (Box 3.1).

Canada ranks 15th in the world for the quality of its public institutions according to the World Economic Forum's Global competitiveness indicator, which is based on business opinion surveys (Figure 3.2). Canada does particularly well in terms of protection of property rights, including Intellectual Property Rights (IPR)[1] and security (judicial independence and the reliability of policy services). Government efficiency, however, has a relatively lower aggregate score, mainly because of the lower performance in terms of alleged burden of government regulations (rank 52) and wasteful government spending (rank 24). Steps have been taken to review government spending and regulations, with a view to improving the efficiency of government intervention in various areas.

According to business opinion surveys, Canada performs even better in terms of the quality of its private institutions, ranking 8th in the world. Canadian regulations are renowned for the strength of investor protection and the strength of auditing and reporting standards.

Box 3.1. Governance structure in Canada

The 1867 Constitution Act gives the federal government responsibility for matters that concern all Canadians, most notably matters that cross interprovincial and/or international borders, such as defence, foreign affairs, the regulation of interprovincial and international trade and commerce, criminal law, citizenship, central banking and monetary policy.

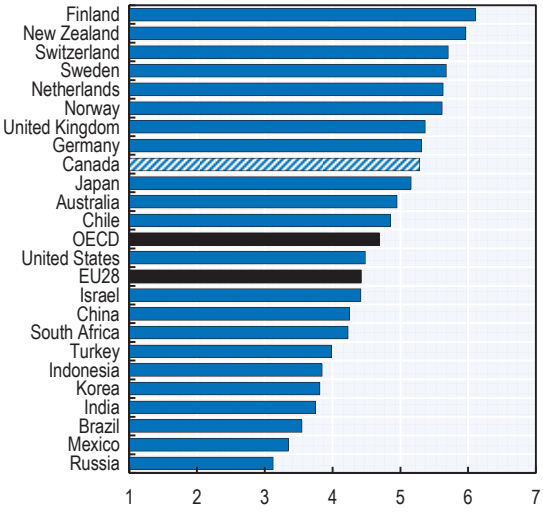
Provincial governments have jurisdiction in matters of local interest, for example primary and secondary education, health and social services, natural resources, property and civil rights, provincial and municipal courts, and local (municipal) institutions.

Some areas of responsibility are shared by both levels of government. For example, in the area of transportation, the federal government has jurisdiction in matters involving movement across provincial or international borders (aviation, marine transport and rail), whereas the provinces look after provincial highways, vehicle registration and driver licensing. Control over agriculture, immigration and certain aspects of natural resource management are also shared.

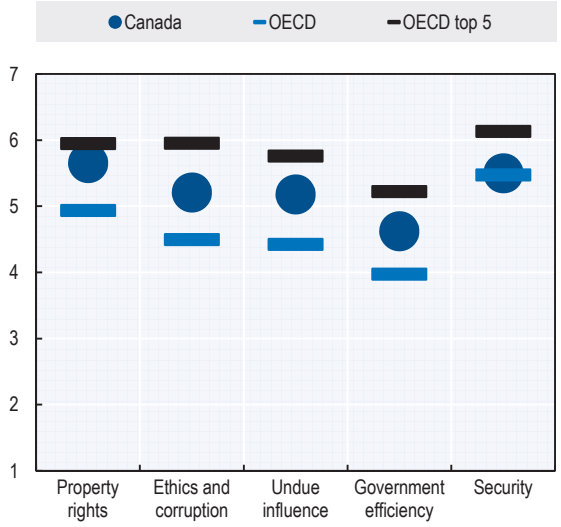
Figure 3.2. Global Competitiveness Index: Quality of public institutions, 2013-14

Scale 1 to 7 (best)

A. Index of quality of public institutions, by country



B. Canada's Index of quality of public institutions, by components



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

B. OECD top 5 refers to the average of the scores for the top five performers among OECD countries (Finland, New Zealand, Switzerland, Sweden and Netherlands).

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

Source: World Economic Forum (2013), *The Global Competitiveness Report 2013-2014: Full data Edition*, Geneva 2013. http://reports.weforum.org/the-global-competitiveness-report-2013-2014/#=.

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Note

1. Protection of intellectual property rights is one aspect of property rights with a direct link to innovation activity and will be discussed in this context.

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Chapter 4

Investment in the Canadian food and agriculture system

This chapter presents an overview of Canadian regulations governing entrepreneurship, access to natural resources and products and processes and discusses the extent to which they affect the adoption of innovative practices and the introduction of new products in the country. It also discusses Canadian policies related to trade, investment, finance and taxation and their impact on the capacity of farms and agri-food firms to invest and take advantage of market opportunities.

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Regulatory environment

The overall regulatory environment establishes basic conditions within which all firms, including farms, input suppliers, and food companies, operate and make investment decisions. Competitive conditions in domestic markets, including low barriers to entry and exit, can encourage innovation and productivity growth. Regulations may also enable or impede knowledge and technology transfer directly, contributing to more or less innovation. This section focuses on federal regulations governing competition and entrepreneurship, natural resource management, and agricultural and food products and processes. It also indicates the scope of provincial regulations and provides some examples.

Regulatory environment for entrepreneurship

The Competition Bureau, an independent law enforcement agency, ensures that Canadian businesses and consumers prosper in a competitive and innovative marketplace. Headed by the Commissioner of Competition, the Bureau is responsible for the administration and enforcement of the Competition Act, the Consumer Packaging and Labelling Act[1], the Textile Labelling Act and the Precious Metals Marking Act.

The Bureau investigates anti-competitive activities including: price fixing, bid-rigging, false or misleading representations, deceptive notice of winning a prize, abuse of dominant position, exclusive dealing, tied selling and market restrictions, refusal to deal (carry on business), mergers, multi-level marketing plans and pyramid selling schemes, deceptive telemarketing, and deceptive marketing practices.

Under the Competition Act, mergers of all sizes and in all sectors of the economy can be subject to review by the Commissioner of Competition to determine whether they will likely result in a substantial lessening or prevention of competition.

Internationally, Canada's Competition Bureau co-operates with counterparts in other countries to counter anti-competitive practices that cross borders. It also participates in international fora such as the Organisation for Economic Cooperation and Development (OECD), the International Competition Network (ICN) and the International Consumer Protection and Enforcement Network (ICPEN) to develop and promote coordinated competition laws and policies in the increasingly globalised marketplace.

A Competition Policy Review Panel created in 2007 concluded that Canada has a competitive strength with primary advantages in location, natural resources, a diverse economy, a high quality public education, and institutional and political stability. The Panel, however, stated that a greater openness to talent, capital and innovation, vigorous competition, and a more ambitious mind-set would enhance Canada’s productivity and competitiveness.

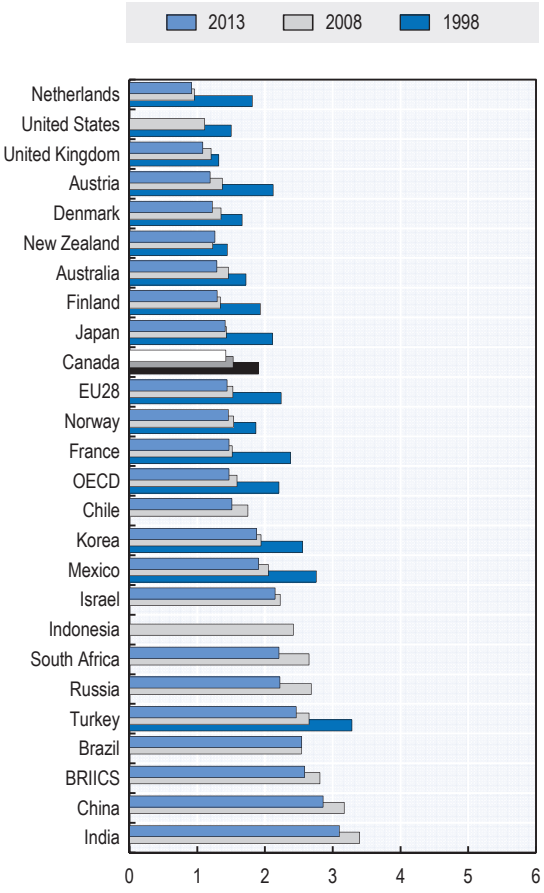
In 2011, the OECD’s *Going for Growth* (OECD, 2011) identified Canada’s network sectors and professional services as offering ample scope for regulatory improvement. There are signs that some of these barriers are being recognised and tackled, notably to improve competition in telecoms and mutual recognition of certified workers across provinces (OECD, 2012).

According to OECD Product Market Regulation (PMR) indicators, which measure the degree to which countries’ regulatory frameworks promote or inhibit competition, regulations in Canada have become less restrictive in the last 15 years, a trend found in many OECD countries. Restrictions remain, however, higher than in Australia, the Netherlands, the United Kingdom and the United States (Figure 4.1). In 2013, barriers to trade and investment and barriers to entrepreneurship in Canada were less restrictive than state control, with scores in all three areas of product market regulation very close to the OECD average. Canada is also close to the OECD’s five least restrictive countries regarding state control and barriers to entrepreneurship.

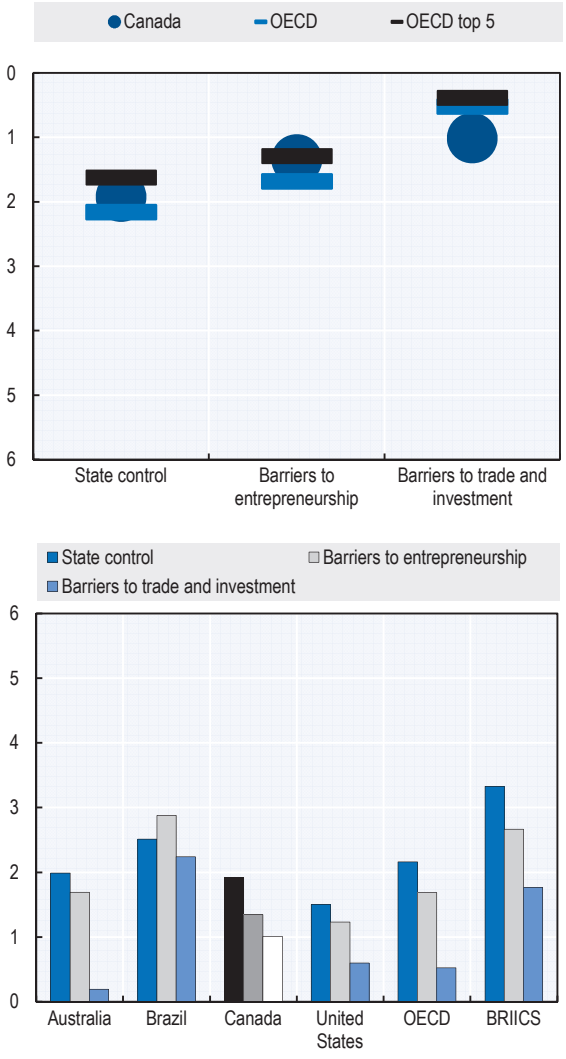
Figure 4.1. OECD Integrated Product Market Regulation (PMR) Indicator, 1998, 2008, 2013

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

A. Trends in Integrated PMR index, by country, 1998,2008, 2013



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



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

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

OECD Product Market Regulation (PMR) indicators measure key regulations in the areas of state control, barriers to entrepreneurship, and barriers to trade and investment.

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

StatLink http://dx.doi.org/10.1787/888933250308

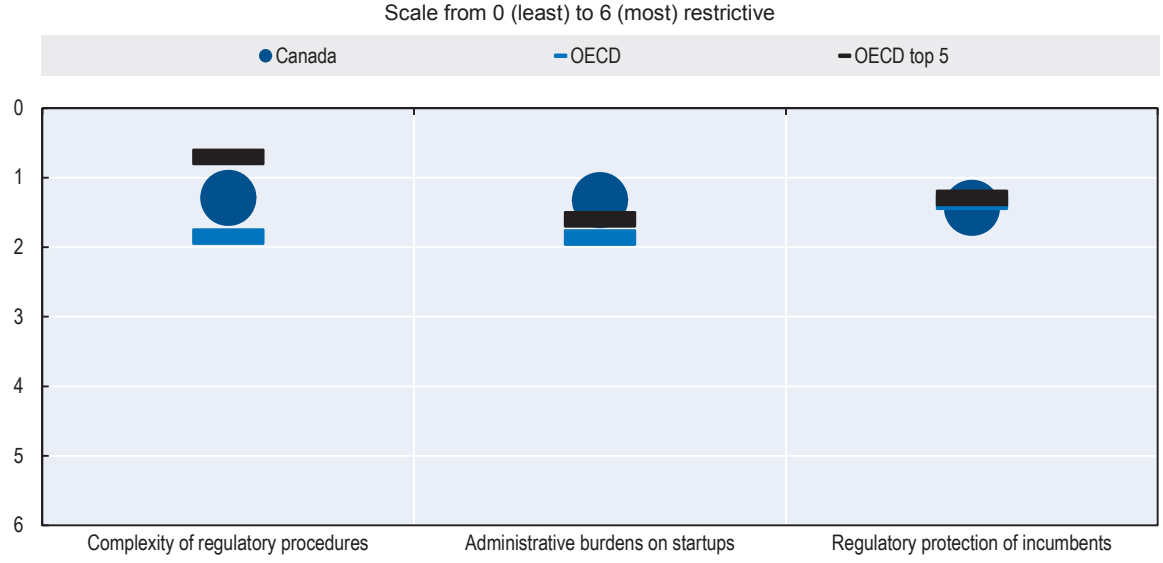
Among barriers to entrepreneurship, Canada is less restrictive than the OECD average in terms of complexity of regulatory procedures and administrative burdens on start-ups, but more restrictive regarding regulatory protection of incumbents (Figure 4.2).

Efforts to streamline regulations and improve transparency continue at federal and provincial levels. The Red Tape Reduction Action Plan[2] introduces systemic changes that will reduce administrative burden on businesses, including through the implementation of two fundamental systemic regulatory reforms:

- The "One-for-One" Rule requires that any new administrative burden on business from regulatory changes is offset through a commensurate reduction in burdens from existing regulations. It also requires that a regulation be removed each time a new regulation that imposes administrative burden is created.
- The Small Business Lens requires regulators to ensure that the particular challenges of small business are accounted for in regulatory design.

Efforts to reduce unnecessary regulatory burden and increase transparency are also taking place at the provincial level. For example, *Open for Business* reforms in **Ontario** include posting new proposed regulations for comment on the Regulatory Registry. It also includes working with industry leadership to define priority areas for the Ontario government to reduce regulatory burden and improve industry competitiveness and investment climate. **Saskatchewan** is taking steps to make regulatory frameworks simpler to navigate through the passage of the Regulatory Modernisation & Accountability Act. Under the provisions of the Act, the government is required to measure, report and reduce red tape across all sectors of the economy in an effort to promote commerce and innovation.

Figure 4.2. Barriers to entrepreneurship indicator, by regulatory area, 2013



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

OECD top 5 refers to the average of the scores for the top five performers among OECD countries (Slovak Republic, New Zealand, Netherlands, Italy and United States), with US data referring to 2008.

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

StatLink http://dx.doi.org/10.1787/888933250313

The extent to which business regulations affect innovation in farm and agri-food businesses would require closer examination of specific dimensions of PMR and information on any specific application of general rules to these businesses. Agricultural policy measures such as supply management and price pooling restrict competition in some commodity sectors. As in many countries, commodity boards and co-operatives are excluded from competition policy rules.

Regulations on natural resources

Regulations on natural resources are central to ensuring their long term sustainable use. In large part, they influence access to land, water and biodiversity resources and the impact that food and agricultural production systems have on those resources.

General regulations governing access to natural resources such as water and biodiversity

Natural resources in Canada are regulated under both the federal (e.g. Environment Canada, Natural Resources Canada, Fisheries and Oceans) and provincial jurisdiction. Subject to some exceptions, provinces exercise proprietary rights over **water resources** and have the authority to legislate in the areas of water supply, use, pollution control, hydroelectric development, irrigation and recreation.

The Canadian Parliament legislates on water and water-related activities over which the federal government has jurisdiction:[3] fisheries, the protection of navigable waters, shipping, some specific aspects of environmental protection, drinking water in areas of federal jurisdiction, international water management, and federal-provincial-territorial cooperation in water resources planning and management.

Some of the recent changes to the *Fisheries Act* (June 2012) are meant to increase the efficiency and predictability of the regulatory system.[4] The new regulation distinguishes waterways that need protection (i.e. supporting fisheries) from those that do not (e.g. ditches and agricultural channels).[5] Farmers and landowners can now make changes to ditches and other agricultural changes without the need for an environmental assessment (re: fisheries) allowing them to be more innovative in their farming practices and to improve their use of the water resources, subject to other processes in place.

There is an enormous variation from province to province in how water is governed, depending on specific issues related to provincial water resources. For example, a prior allocation system is used in Alberta, while in Ontario those wishing to take more than 50 000 litres of water per day must acquire a permit from the provincial government. For agricultural water users, the result is a widely varied security of access to water across provinces.

Local governments and communities (including rural communities within watershed groups) establish local by-laws. Municipalities have key responsibilities for drinking water provision and land use planning under the authority of provincial statutes.

In Canada, natural resources like **wildlife** and fish are held in trust on behalf of citizens by provincial governments, but the federal government also has some jurisdiction in national parks and wildlife areas. The habitat in which these resources exist is a mix of private land, Crown land that is leased for use by the private sector, and Crown land managed by government. The private sector owns or manages under lease a significant portion of the habitat used by publicly owned natural wildlife. Federal and provincial governments have addressed the market failure associated with this un-priced social benefit by enacting endangered species legislation. There are also a number of provincial endangered species acts, such as the Ontario Endangered Species Act and the federal Species at Risk Act (Environment Canada). Farmers who provide habitat for endangered species are eligible for some cost share programmes, under which they can recover some of the additional incurred costs.

Environmental regulation

The federal government has minimal environmental responsibility through its exclusive jurisdiction over federal land, but is involved in several areas. The *Fisheries Act* and the *Canadian Environmental Protection Act* are examples of federal regulatory legislations related to agriculture. The *Canadian Environmental Protection Act* administered by Environment Canada addresses air pollution and toxic substances and involves the agriculture sector when developing risk management plans for listed substances. The *Fisheries Act*, administered by the Department of Fisheries and Oceans, provides protection of fish, fisheries and fish habitat from pollution, prohibiting the deposition of harmful substances into fish-bearing waters or watercourses that may eventually enter fish-bearing water. Harmful substances include suspended solids, fertiliser, manure, fuel and pesticides. The *Fisheries Act* has been amended to require reviews only when the development will cause "serious harm to fish," which is the death of fish or any permanent alteration to, or destruction of, fish habitat. Municipalities could be in violation of the Act if their effluent is harmful to fish. Many other federal departments/agencies are directly or indirectly involved in environmental issues (e.g. Transport Canada, Natural Resources Canada, etc.).

Provinces have primary responsibility over property and civil rights. Certain provinces have control over principal agricultural operations and concrete environmental issues related to agriculture. Many provinces have delegated some of this responsibility to local governments through their land use planning and zoning powers.

Regulations on agricultural practices

Regulations play an important role in the agri-environmental policy approaches to water quality in several provinces, ranging from broad prohibitions or requirements, to very prescriptive details about farm management practices (Vojtech, 2010). Canadian agri-environmental regulations focus on various aspects of production and include prohibitions and requirements on waste and nutrient management, water use and quality, limits on the storage and application of chemicals and pesticides, buffer strips and green coverage requirements. Some of these requirements are specific only to agriculture, while others are part of broader national environmental legislation affecting many sectors, including agriculture. Environmental regulations can come from both federal and provincial governments. Selected federal and provincial programmes for the adoption of agri-environmental practices are mentioned in Box 6.4.

Agricultural land regulation

Regulations governing agricultural factor markets will affect the type of innovation developed and adopted. Land, in particular, is subject to a number of rules such as land ownership systems, rental arrangements, inheritance laws, land tax provisions and regulations on land transactions, which can have specific provisions for farm land in some countries (OECD, 2005).

In Canada, land use policies (e.g. property rights, property taxes, zoning and urban development) are solely under provincial/municipal jurisdiction and vary by province. Some provinces like Quebec, protect agricultural land through strict zoning. In Manitoba, municipalities have a development plan designating lands for specific purposes. The provincial government encourages them to adopt zoning by-laws and land use policies that enable agricultural producers to diversify their on-farm operations, often in farm-related activities such as processing and agri-tourism. Ownership restrictions vary greatly by province, with some provinces having rules in place to limit or restrict foreign ownership of farm land (Alberta, Saskatchewan, Manitoba, Quebec and Prince Edward Island) and others having few restrictions. For example, the Saskatchewan Farm Security Act includes regulations affecting agricultural property rights with the aim to maintain opportunities for Saskatchewan residents to acquire farm land for agricultural purposes and to support the development of strong rural communities.

According to the 2011 Census of Agriculture from Statistics Canada, over 60% of total land in agriculture was owned by those who operate it (Statistics Canada, 2011). However, the share of rented land and land leased from government increased slightly over the last decade. There were several factors contributing to this increase, such as rising land prices and an ageing farm population. Land rental is a less capital-intensive means of expanding an operation. The current practice of non-farmers and investment funds investing in land and renting it out to farmers also contributes to this trend.

In the last several years, Canada has seen an increasing proportion of land being purchased by non-farmer investment groups such as AgCapita, Bonnefields Financial, Assiniboia Capital Corp and others (Carlberg, 2011). Institutional investors appear to be most active in markets where relatively low-cost land is still available, but these areas are becoming fewer all the time. In areas where land prices are relatively high, non-farmers generally appear to be less willing to compete with area farmers when land becomes available although this is not universal across provinces In Ontario, for example, companies have been relatively active outside of near-urban areas.

Regulations on products and processes

Regulations on products and processes aim to protect the environment and human, animal and plant health and can also impact natural resource use. There is also evidence that good product market regulation is associated with increased inflows of foreign direct investment and thus technology spill-overs. Environmental and health related regulations could boost innovation by building consumer and societal trust in the safety and sustainability of new products or processes, but unnecessary or disproportionate regulations can stifle innovation and technological developments.

General principles for federal regulations and standards affecting new processes and products

Canadian regulations are science-based and informed by consultations with stakeholders. Regulations for new processes can be developed when a need or a gap is identified by government, industry, consumers, or other stakeholders.

The Cabinet Directive on Regulatory Management (2012) provides guidelines to regulators.[6] Standard regulatory development requires that Canadian regulators consider using international standards, where they exist, before adopting a Canadian standard. The Standards Council of Canada[7] leads on the development of standards in Canada and represents Canada in foreign and international forums.

Departments and agencies can also work with stakeholders to develop or modernise processes. An expansion of the uses of a regulatory tool, "incorporation by reference,"[8] is currently being discussed in the Canadian Parliament. The adoption of the Bill would allow regulators to more easily incorporate standards and requirements created by an international standard setting body, or to adopt requirements that have already been adopted by another jurisdiction or expert body. One of the advantages of incorporation by reference is that the regulation-making authority does not have to reproduce the incorporated material in its entirety. This helps to avoid duplication and may promote inter-jurisdictional harmonisation.[9]

Current priorities for regulatory frameworks include the modernisation of regulations. This involves rationalising the government's role, adopting incorporation by reference to update regulations rather than changing the whole regulation, increasing the use of outcome-based regulations rather than prescriptive ones, increasing regulatory alignment with the United States (Box 4.1), and reducing administrative burden (Red Tape Reduction Action Plan mentioned above). Efforts will also be made to improve predictability of regulations and to reduce certification time (Service Standards).

In general, the difference between federal and provincial regulatory authorities pertaining to products is that federal regulations apply to goods traded across provinces or internationally, while provincial regulations apply within the boundaries of a province. Most differences in product and process regulations between provinces and with federal regulations are the result of the natural

evolution of different regulatory systems and differences in updating schedules, but some of them act as trade barriers protecting stakeholders from interprovincial and international competition. The negotiation of bilateral trade agreements provides an opportunity to revisit provincial regulations, but difficulties arise when provincial specificities remain and limit the scope of bilateral agreements.

Box 4.1. Canada-United States regulatory co-operation

The Canada-United States **Regulatory Cooperation Council (RCC)** was created in February 2011. The initial RCC Joint Action Plan was launched in December 2011 to foster new approaches to regulatory cooperation. Agencies in both countries worked together on 29 initiatives identified in the plan (including ten initiatives with an agriculture focus); using a variety of tools, such as enhanced technical collaboration, joint development and recognition of standards, work-sharing and lasting solutions to avoid future misalignments from developing. These 29 initiatives covered a wide range of regulatory work, from transportation and agriculture to emerging areas such as developing a consistent approach to the regulation of nanomaterials.

The initial Joint Action Plan has delivered a number of important, specific results, including in the agriculture area:

- **Zoning for Foreign Animal Diseases**: The US Department of Agriculture and the Canadian Food Inspection Agency have adopted an arrangement for the mutual recognition of animal disease zoning decisions. Guidance for implementing the arrangement, including agreed-upon processes and conditions for zoning recognition, has been developed.

- **Crop Protection Products**: Canada's Pest Management Regulatory Agency and the US Environmental Protection Agency worked on aligning product reviews and risk assessment methodologies, including the development of a joint review process for pesticides with minor uses, which will reduce administrative burden on industry and provide simultaneous product access to growers.

Other cross sectoral initiatives of importance to agriculture include:

- **Nanotechnology**: The RCC Joint Action Plan proposes to share information and develop joint Canada-US approaches on regulatory aspects of nanomaterials. This will include developing consistent approaches to the risk assessment and management of nanomaterials, as well as sharing scientific and regulatory expertise. A nanotechnology work plan guiding efforts in this area was completed in 2012.

- **Small Business Lens**: The RCC Joint Action Plan proposes to share approaches and tools being developed by Canada and the United States to assess and account for the needs of small businesses when developing regulations. During the winter and spring of 2012, the small business lens working group's Canadian and American co-leads coordinated the completion of the small business lens work plan guiding efforts in this area.

The RCC Joint Forward Plan presented in 2014 discusses what has been accomplished with the initial 29 initiatives, and reflects on lessons learned by regulators and stakeholders who have worked on this effort. An approach to deepen and broaden our regulatory cooperation partnership moving forward is also presented.

Source: http://actionplan.gc.ca/en/page/rcc-ccr/regulatory-cooperation-council and http://actionplan.gc.ca/page/rcc-ccr/cross-sectoral.

Regulations on purchased farm inputs, food, plants and animals

In matters related to **food safety**, Health Canada is responsible for the development of policies, standards and regulations under the authority of the *Food and Drugs Act*, which provides overarching protection for consumers from any foods that are unsuitable for consumption, including those marketed exclusively within provinces. The Canadian Food Inspection Agency (CFIA)[10] is responsible for the enforcement of food safety standards through its food inspection and compliance activities. *The Safe Food for Canadians Act*[11] of 2012 consolidates food provisions administered and enforced by the CFIA to strengthen oversight of food commodities being traded inter-provincially or internationally. It is expected to be implemented in 2015.

Regulation of Canadian plant and animal health also falls under the mandate of the CFIA, which is currently carrying out a multi-year, systematic regulatory modernisation.[12] This modernisation is expected to result in the drafting and adoption of regulations that are, to the extent possible, outcome-

based, enabling more latitude in the processes that are used as long as the end result meets the required outcome.

Under Health Canada, the **Pest Management** Regulatory Agency (PMRA) works with its counterparts in other countries to align the processes used to regulate pest control products and ensure the protection of health and the environment. International regulatory cooperation includes standardisation of the type and scope of studies required to register a pesticide, the protocol followed in carrying out these required studies, the format and presentation of the submissions provided in support of a registration application, and the methods used to evaluate submissions and prepare reports. For example, the PMRA led an OECD Working Group on Pesticides to develop harmonised registration requirements microbial pest control agents and products.[13]

Standards related to the registration requirements of an innovative pest control product are reviewed based on need and in coordination with international regulatory partners. The PMRA also re-evaluates all pesticides on a 15-year cycle, to ensure they meet the latest health and environmental risk assessment standards.

Some **fertilisers** and most supplements are subject to registration and require a comprehensive pre-market assessment prior to their import and/or sale in Canada. The *Fertilizer Act* and associated regulations are intended to ensure fertiliser and supplement products imported into and marketed in Canada are safe for the environment when used as directed - which in turn would mean that farming land would be protected from harm from regulated products as long as they were used correctly. However, authorities do not extend "on-farm" or capture labour practices and farm enterprises, as land and labour are outside of the jurisdiction of the Act. Products that are exempt from registration are still subject to regulation and must meet all the prescribed standards at the time of sale or import. Products with a well-established history of safe use are typically exempted from the requirement to obtain pre-market registration.

The ***Organic Products*** *Regulations* (OPR) were introduced in 2006 in response to a stakeholders' request to enable Canadian organic producers to retain access to the European Union, United States and Japanese markets. The OPR incorporates by reference the following two standards: General Principles and Management Standards [CAN/CGSB 32.310] and Permitted Substances List [CAN/CGSB 32.311]). They apply to organic agricultural products which cross provincial and international boundaries. The competent authority for the OPR is the CFIA Canada Organic Office. It is mandated that the OPR be reviewed every five years; however, this mandatory review did not take place in 2011 as expected due to lack of funding.

The regulatory framework regarding **animal health** reflects concerns that government and industry have about animal health, the economic impacts associated with animal disease and potential human health issues associated with animal disease. Standards reflect a perspective that pertains to preventing or responding to animal diseases.

Multiple factors and diseases play a role in developing the import conditions that are necessary to provide an appropriate level of protection (ALOP) for public and animal health. Import conditions have been established for many species and commodities following country evaluations and hazard identification for the particular animal or commodity to be imported. For animals or commodities that do not have previously established import conditions, a risk assessment can be undertaken, with the associated fees paid by the prospective importer, to evaluate whether the development of New Import Protocols – Procedures for Clients is warranted. The full costs of the assessment to determine whether import is feasible are assumed by the potential importer.

The CFIA also uses its regulatory authority as the basis for recognition of a specific country, or part of a country, as being free of, or as posing a negligible risk for, a particular disease. Import conditions or restrictions related to specific diseases, such as foot and mouth disease (FMD), tuberculosis (TB), and brucellosis, are often necessary. Once established, the specific conditions are published.

When innovations develop in processing or treatment, CFIA evaluates them when requested to determine if an equivalent level of protection can be established for the new methodology. If the regulations are outcome-based, then new import conditions can be implemented. Some regulations are not outcome-based, but are prescriptive in nature (i.e. "thou shall not" or "thou must" do x, y, or z for a particular import). These are reviewed and when possible are being revised to provide an ALOP to Canada with flexibility for assessing and adopting changes in science and technology.

The CFIA evaluates and regulates all **feed** ingredients, including those that are derived from innovative methods, in the same manner. Any feed ingredient that is new (i.e. not already listed in the Feeds Regulations), or has been modified such that it differs significantly from a conventional ingredient, is required to undergo a pre-market assessment and approval. The purpose of all feed assessments is the same: to ensure that the feed ingredient is safe (in terms of animal health, human health via food residues and worker/by-stander exposure, and the environment) and effective for its intended purpose prior to marketing. Box 4.2 explains how the regulation regarding the use of distillers' grains as a feed ingredient was adapted.

Box 4.2. The example of distillers' grains (DG) from the fuel ethanol industry

The use of distillers' grains as a feed ingredient is regulated under the Feeds Act and Regulations administered by the CFIA. In the mid-to late 1980s, a variety of types of distillers' grains, including those from barley, corn, rye, sorghum, and wheat, were listed as approved feed ingredients under Section 5.5, "Brewers' and Distillers' Products," in Schedule IV, Part I, of the Feeds Regulations. These feed ingredient definitions were developed to cover DGs obtained from distilleries producing alcoholic beverages, based on processes using food-grade ingredients and additives. Approval took into account the fact that beverage alcohol producers need to use approved processing additives and are already regulated under the *Food and Drugs Act* and its regulations.

In 2004, the CFIA's Feed Program began conducting inspections in ethanol-producing plants to obtain an overview of the manufacturing process and the processing additives used. From these inspections and from information supplied by the fuel ethanol industry, it was apparent that some of the additives used in the fuel ethanol manufacturing process are different from those used in the beverage alcohol production process - some had not been assessed for safety. Because of these differences, DGs resulting from fuel ethanol production were not automatically considered equivalent to the DGs listed in the *Feeds Regulations*.

The CFIA published on its website a regulatory guidance document entitled Ethanol Distillers' Grains for Livestock Feed, which set out the policy on the use of DGs produced as by-products of ethanol manufacturing that are sold, manufactured or imported into Canada as livestock feed. It is important to note that this policy document only serves to clarify how the existing *Feeds Regulations* apply to DGs, and does not introduce new regulations. It does not set out regulatory requirements for the manufacture of fuel ethanol or potable alcohol, as this is outside of the CFIA's mandate.

Source: Agriculture and Agri-Food Canada (AAFC), http://www.agr.gc.ca/.

Annex 4.A1 describes how standards for purchased inputs, feed and food products are established, evaluated and communicated.

The wide variety of challenges faced by different actors in the agricultural innovation system suggests a continuum of views on regulatory approaches by governments. When asked about the regulatory challenge to innovation, a panel of stakeholders from academia, innovation institutions and the industry pointed to the length of approval procedures, information requirements and unclear rules for some bio-products. They also mentioned some areas where regulations are missing and that insufficient human resources in the federal government working in regulatory areas contributed to delays in needed improvements. The difficulty for food products to obtain health claims was mentioned. As in many countries, the approval process for plants with novel traits is also very costly and drives small investors out of the sector. Experts recognise the difficulty for the regulatory process to be effective and fast, and at the same time transparent and open. While recognising the values of the system, in particular the science-based approach, many of the stakeholders surveyed would welcome a more pro-active, forward looking system that incorporates risk management aspects.[14]

Trade and investment policies

Trade can facilitate the flow of goods, capital, technology, knowledge and people needed to innovate. Openness to trade and capital flows is conducive to innovation as it provides a larger market for innovators, reinforces competition, increases access to new technologies, ideas and processes, including from Foreign Direct Investment (FDI) and related technological spill-overs, and facilitates cross-country collaboration. Trade and investment openness can influence innovation throughout the food supply chain, from input suppliers to food service and retail firms. Input and output markets that operate effectively can foster productivity growth and more environmentally sustainable production.

Importance of trade

The Canadian economy and the food and agriculture sector are exposed to trade and integrated in global value-chains. Mobility of goods and services is high (as is mobility of capital and labour), particularly following the 1980s US-Canada free trade agreement and the 1990s North American Free Trade Agreement (NAFTA). In 2010, three-quarters of Canada's exports went to the United States, and more than half of Canadian manufacturing sales were by affiliates of US multinationals. To reduce the dependence of the Canadian economy on US markets, the Government of Canada has concluded or is negotiating trade and investment agreements with other regions, in particular Latin America, Asia and the European Union. In particular, Canada joined the Trans-Pacific Partnership (TPP) negotiations with a view to deepen trade relationships with the Asia-Pacific region (OECD, 2013b). Agri-food trade is generally covered by these agreements. On 18 October 2013, Canada and the European Union have reached a political agreement on the key elements of a Comprehensive Economic and Trade Agreement (CETA). The agreement will remove over 99% of tariffs between the two economies and create sizeable new market access opportunities in services and investment. The European Union is Canada's second most important trading partner. When implemented after approval by respective institutions, the agreement is expected to increase trade flows in sensitive agricultural products such as beef and dairy products.

Barriers to trade and investment

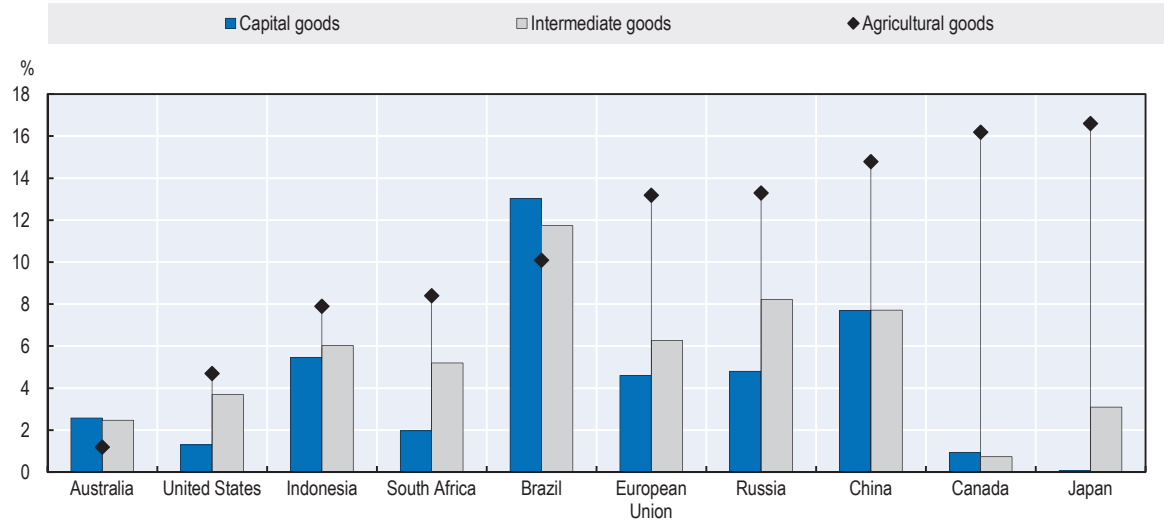
Industrial tariffs are relatively low in Canada, and contrast with relatively high agricultural tariffs (simple average of applied most-favoured-nation (MFN) tariffs) (Figure 4.3). In particular, tariff and non-tariff protection for capital and intermediate goods are very low in Canada. In 2009 and 2010, Canada unilaterally decided to eliminate tariffs on a broad range of manufacturing inputs, machinery and equipment. An OECD analysis (Miroudot, Rouzet and Spinelli, 2013) found that the resulting greater availability of specialised inputs and machinery equipment is likely to reduce production costs, improve efficiency in production processes and enhance the ability to innovate in downstream manufacturing industries, bolstering their own external competitiveness. The expected gains can be further boosted by a rise in foreign investment in Canada.

OECD PMR indicators also show that restrictions to trade and investment are relatively low in Canada, as in many OECD countries (Figures 4.1 and 4.4). On a scale from 0 to 6, the index of regulatory restrictions to trade and investment is below 1 on average, and no component is above 2. In terms of differential treatment of foreign suppliers, however, Canada is much more restrictive than the OECD average.

According to OECD **trade facilitation indicators**, which cover the full spectrum of border procedures,[15] Canada performs significantly better than the OECD average in the areas of fees and charges, simplification and harmonisation of documents, automation, governance and impartiality and is relatively on par with the OECD average for information availability, involvement of the trade community, advance rulings, appeal procedures and streamlining of procedures, according to OECD trade facilitation indicators (Figure 4.5).

Figure 4.3. Tariffs for industrial and agricultural goods, 2012 or latest available year

Simple average MFN applied tariff rates[1]



MFN: Most favoured Nation. 1. Tariff rates for agricultural products include both *ad valorem* duties and specific duties in *ad valorem* equivalent, while tariff rates for agricultural products only include *ad valorem* duties.

Source: UNCTAD Trade Analysis Information System (TRAINS) (for non-agricultural products) and World Tariff Profiles, 2013 (for agricultural products).

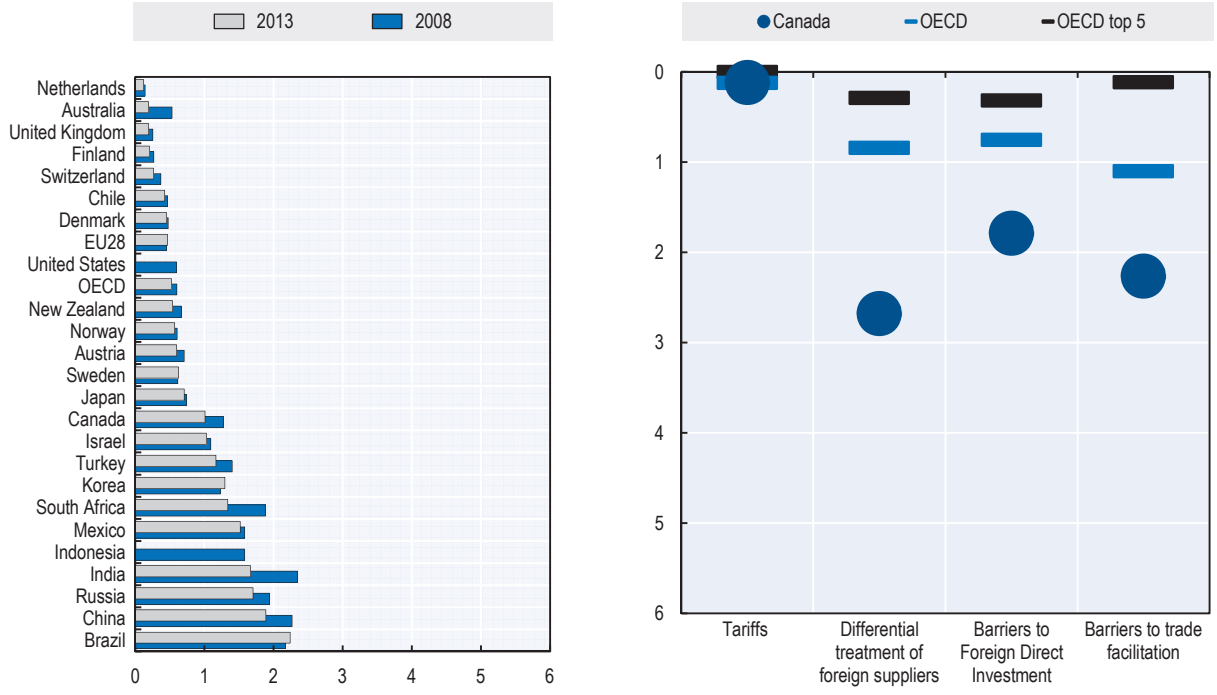
StatLink http://dx.doi.org/10.1787/888933250323

Figure 4.4. Index of regulatory restrictions to trade and investment, 2008 and 2013

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

A. Index of regulatory restrictions to trade, by country, 2008 and 2013

B. Canada's index of regulatory restrictions to trade, selected component, 2013



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

Barriers to trade facilitation refer to the extent to which the country uses internationally harmonised standards and certification procedures, and Mutual Recognition Agreements (MRAs) with at least one other country.

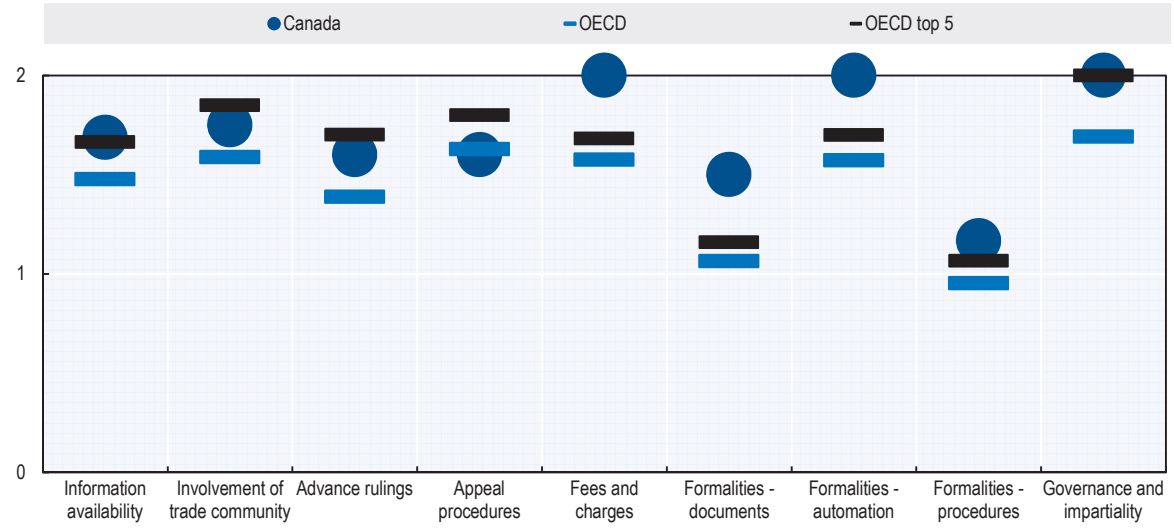
OECD top 5 refers to the average of the scores for the top five performers among OECD countries (Netherlands, Belgium, Australia, United Kingdom and Finland).

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

StatLink http://dx.doi.org/10.1787/888933250334

Figure 4.5. Canada's trade facilitation performance, 2010

Latest available data, where 2 = best performance



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

OECD top 5 refers to the average of the scores for the top five performers among OECD countries (Australia, United States, Netherlands, Switzerland and United Kingdom).

Information availability refers to the publication of trade information, including on internet, enquiry points.

Involvement of trade community refers to consultations with traders.

Advance rulings refer to prior statements by the administration to requesting traders concerning the classification, origin, valuation method, etc., applied to specific goods at the time of importation; the rules and process applied to such statements.

Appeal procedures refer to the possibility and modalities to appeal administrative decisions by border agencies.

Fees and charges refer to disciplines on the fees and charges imposed on imports and exports.

Formalities – automation refers to electronic exchange of data; automated border procedures; use of risk management.

Formalities – documents refers to simplification of trade documents; harmonisation in accordance with international standards; acceptance of copies.

Formalities – procedures refers to streamlining of border controls; single submission points for all required documentation (single windows); post-clearance audits; authorised economic operators.

Governance and impartiality refers to customs structures and functions; accountability; ethics policy.

Source: OECD Trade Facilitation Indicators. http://www.oecd.org/trade/facilitation/indicators.htm.

StatLink http://dx.doi.org/10.1787/888933250349

Foreign Direct Investment policies

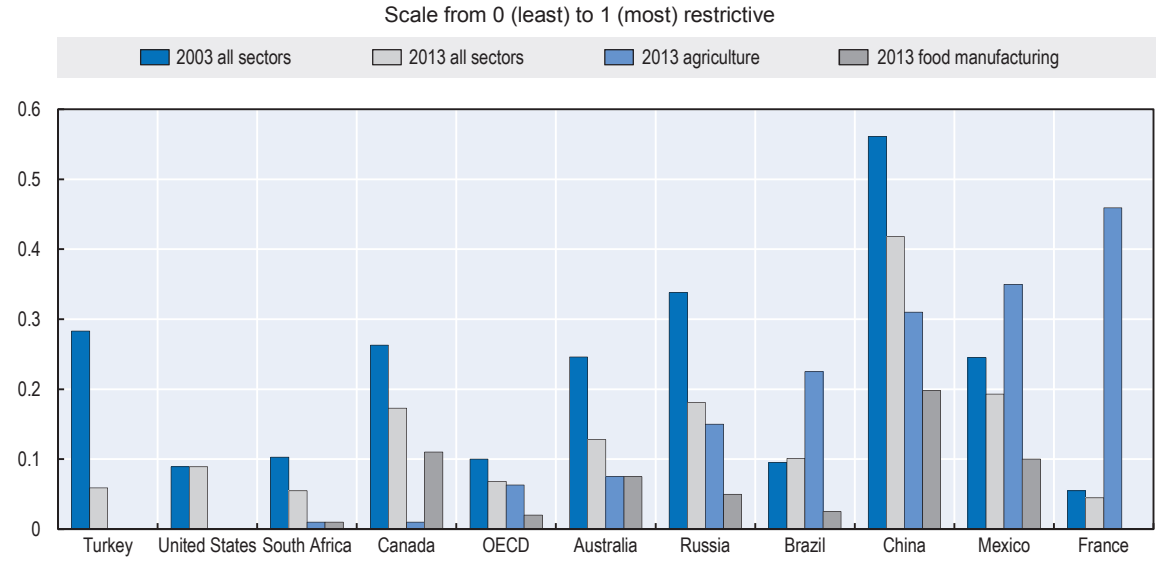
According to OECD data, restrictions to FDI in Canada have been reduced in the last decade and are now relatively modest (index 0.16 on a scale of 0 to 1), but they remain higher than in the United States, Australia, Brazil or France (Figure 4.6). They concern mainly screening procedures and prior approval of requirements, and foreign equity restrictions. Restrictions affecting FDI in agriculture are very low and those affecting FDI in food manufacturing are lower than the average of all sectors.

Low barriers to inwards FDI contributed to the rise in FDI stocks as a percentage of GDP from 0.20% in the mid-1990s to 0.36% in 2012 (Figure 4.7). This rate of penetration is higher than the OECD average.

In 2012, the stock of FDI in Canadian agriculture, forestry, fishing and hunting was CAD 1.5 billion, down slightly from CAD 1.6 billion in 2011. The stock of FDI in the Canadian food processing industry has increased from CAD 14.4 billion to CAD 16.0 billion between 2011 and 2012.

60% of this FDI originated from the United States, with Europe being the source for another 36% (Figure 4.8). In 2012, FDI in agriculture and food processing accounted for 2.5% of total FDI in Canada, compared to a share in GDP of 2.3%. If FDI in the beverage and tobacco industry is included, this percentage amounts to 3.4%.

Figure 4.6. OECD FDI Regulatory Restrictiveness index, by sector, 2003, 2013



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

Four types of measures are covered by the FDI Restrictiveness Index: 1) foreign equity restrictions; 2) screening and prior approval requirements; 3) rules for key personnel; and 4) other restrictions on the operation of foreign enterprises.

Source: OECD Investment Statistics, http://www.oecd.org/investment/fdiindex.htm.

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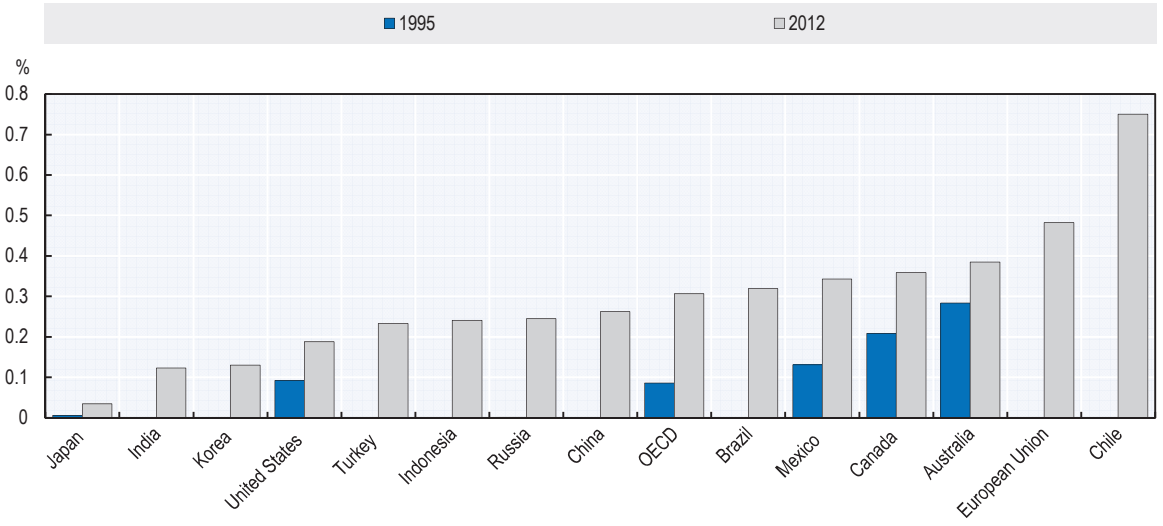
Figure 4.7. Total FDI stocks as a percentage of GDP, 1995, 2012



Source: OECD Investment Statistics, http://www.oecd.org/investment/fdiindex.htm.

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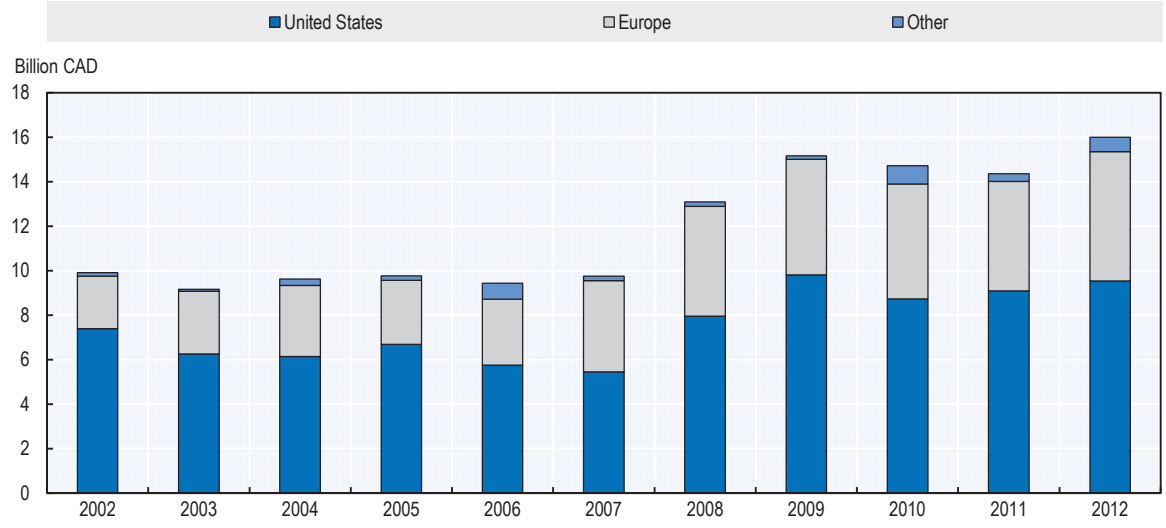
Figure 4.8. Stock of inward FDI in the Canadian food processing industry, by country of origin, 2002-2012



The Europe region includes the whole European continent.
Figures are estimates and subject to revisions by Statistics Canada.

Source: Statistics Canada and AAFC calculations.

StatLink http://dx.doi.org/10.1787/888933250379

Finance policy

Efficient financial services are one key to enable balanced development of any economy and society. Policies that improve the functioning of financial markets can facilitate productivity enhancing investments in agriculture. Low-cost loans and venture capital[16] can also be an important source of funding for innovative firms with high growth sectors potential. Business angels[17] also play an important role in financing early stages of innovation (OECD, 2010).

Financial institutions and markets are well developed in Canada, with the size of credit by the banking sector, the market capitalisation of businesses and stocks traded above the OECD median (Figure 4.9). According to the World Economic Forum Global Competitiveness Index, Canada ranks 12th in terms of financial market development, with very high scores in terms of bank soundness and availability of financial services, but lower ones in terms of ease of access to loans, financing through local equity market, and venture capital availability (Figure 4.9).

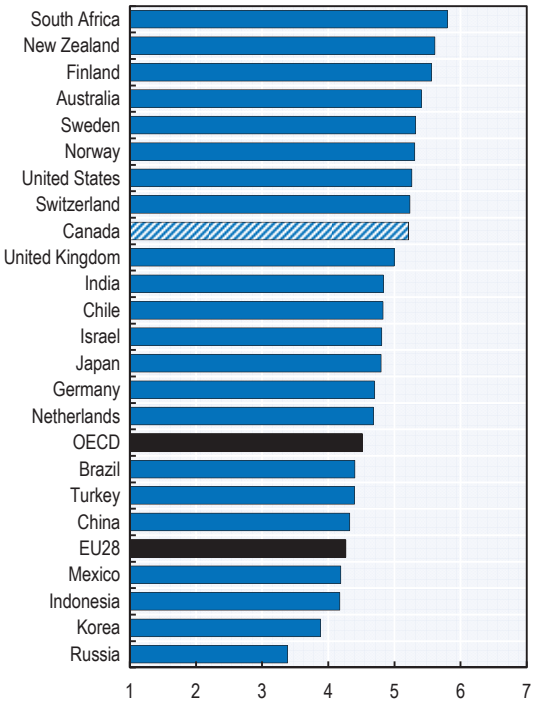
Farm Credit Canada (FCC) is Canada's largest provider of business and financial services to farms and agribusiness (Box 4.3). The Business Development Bank of Canada (BDC), a Crown corporation, fulfils its mandate by providing financing, venture capital and consulting services to entrepreneurs, with a focus on small and medium-sized enterprises (SMEs). The Business Development Program, offered by the Atlantic Canada Opportunities Agency (ACOA), provides support for the start-up and expansion of SMEs across rural Atlantic Canada by offering interest-free loans.

As a result, the food and agriculture sector is generally well served by the banking sector. Key lenders include banks, FCC, credit unions and trust companies. In addition, a few provinces also have provincial crown lenders serving the industry. Some evidence suggests however, that smaller firms in processing sectors, such as in the functional foods and natural health product areas, may have experienced difficulty in acquiring capital for product development activities in the past (Cranfield et al., 2006).

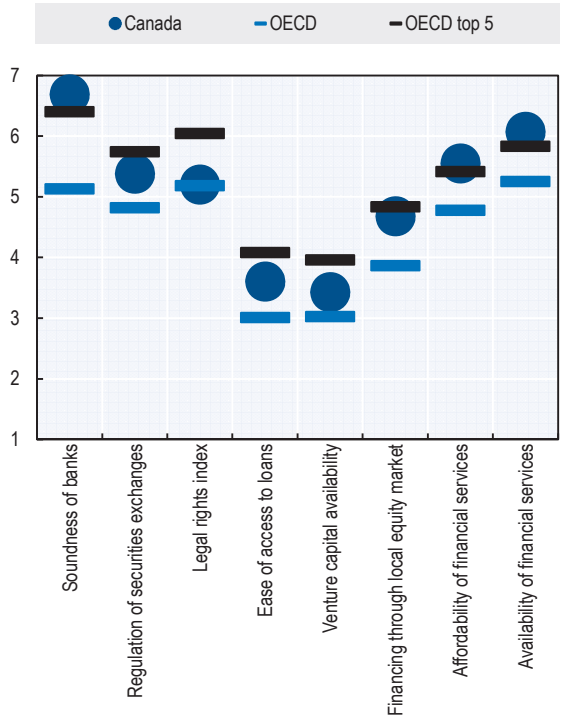
Figure 4.9. Global Competitiveness Index: Financial market development, 2013-14

Scale 1 to 7 (best)

A. Total index of financial market development, by country



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



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

Top 5 refers to the average of the scores for the top 5 performers among OECD countries (New Zealand, Finland, Australia, Sweden and Norway).

The Legal rights index is scored on a scale from 1 to 10 based on calculations by the WEF from the World Bank–International Finance Corporation's Doing Business 2013.

Source: World Economic Forum (2013), *The Global Competitiveness Report 2013-2014: Full data Edition*, Geneva 2013. http://reports.weforum.org/the-global-competitiveness-report-2013-2014/#.

StatLink http://dx.doi.org/10.1787/888933250298

The Federal Ministry in charge of agriculture, AAFC, also offers a number of programmes that provide financing or government backstopping for the sector and facilitate access to loans. AAFC agricultural credit programmes include the Canadian Agricultural Loans Act (CALA) Program and the Advance Payments Program (Box 6.3).

Canada's venture capital market as a percentage of GDP is relatively low compared to the United States and several other OECD countries (OECD, 2012, Figure 13). There has been concern that the sector is underserved with respect to venture capital financing compared to other sectors and countries (Van Dusen, 2009). This shortage existed prior to the recession for a variety of reasons:

- Lack of understanding of the opportunities within the agricultural sector by venture capital funds.
- Historically low short-term returns on investment from private investment in agriculture in comparison with sectors such as Information and Communications Technology (ICT) (in contrast with public research, which shows good return on investment in the long run in certain areas).

- Insufficient numbers of successful agri-entrepreneurs investing in the area.
- Length of time for an agri-technology to succeed (break-even) is longer than in ICT.
- Perception that the Canada Food and Inspection Agency (CFIA)'s regulatory process is long and complex for approving new innovations.
- Provincial restrictions on the political boundaries and criteria where public funds can be invested or spent.
- Lack of attraction to programmes or mechanisms needed in order to facilitate foreign investment in Canadian companies.

The total number of venture capital firms in Canada has dropped from a high of 176 firms in 1998 to less than 45 today (Thompson-Reuters; Canadian Venture Capital Association, CVCA). This likely cannot be characterised as a consolidation, but rather a decrease in numbers due to fund performance and market conditions. Investments are cyclical in nature. Investments made by venture capital funds totalled CAD 2.0 billion in 2013, or 31% more than the CAD 1.5 billion invested in 2012, representing the highest level since the peak of the previous cycle in 2007 (CVCA). Venture capital data specifically for the agricultural sector is difficult to obtain, although it is reported that there were a total of 19 different firms investing in agri-related deals in Canada between 2008 and early 2013 (Thompson-Reuters). Many innovations and ventures are peripherally related to agriculture, such as clean tech, green tech, health and bio-economy related. One issue is to better define the areas of investor interest such as crop science, livestock and animal health, bio-industrial products, to name a few.

While angel investor activity has increased marginally, angels are geographically dispersed across great distances (Ottawa, Vancouver, Toronto, Calgary). As such, they rarely co-invest with one another. Canada does not have the necessary critical mass of organised angel activity to have meaningful impact on seed capital investing. Historically, most angel activity is focused on medical and ICT sectors.

Box 4.3. Farm Credit Canada

Farm Credit Canada (FCC) is a commercial crown corporation, whose mandate is "advancing the business of agriculture." It was initially established in 1927 as a long-term mortgage lender to address a perceived lack of credit availability for farmers, notably in Western Canada (Bergevin and Poschman, 2013). Its mandate was broadened in 1959 to include consulting services and its lending rate was set at 5%, well below what was needed at the time to remain profitable, accordingly providing an interest rate subsidy to farmers. Its mandate was expanded further in 2001 when the FCC was allowed to offer a broader range of financial and business management services such as business planning and risk management and to a broader clientele including farm related businesses that are not farmer owned.

Today, the FCC provides specialised and personalised business and financial services to small and medium-sized businesses that are related to farming. It also provides insurance, software, learning programmes and other business services to producers, agribusinesses, such as suppliers and processors, and agri-food operations. The FCC also assists farm businesses with the development of their respective business plans, including future research and development efforts, lists of any patents or intellectual property owned by the farm.

It is financially backed by the Government of Canada and currently provides financing and other services to more than 100 000 primary producers through a chain of 100 primarily rural offices. Its loans receivables stood at CAD 23.2 billion at the end of 2012 fiscal year.

Source: Farm Credit Canada: http://www.fcc-fac.ca.

To address the market shortage of venture capital financing for agricultural innovation, FCC established and co-seeded the Avrio Ventures capital fund. The federal government announced a new Venture Capital Action Plan (VCAP) in Budget 2013, although the majority of this fund-of-funds approach[18] is targeting sectors outside of agriculture.

FCC is a limited partner and investor in *Avrio Venture's capital funds*.[19] Avrio's investment premise is to focus on identifying innovative companies in the food and agriculture sector that are meeting global challenges related to health, wellness and sustainability. The fund pursues investments in commercialisation to growth stage companies. In 2011, Farm Credit Canada provided a CAD 50 million commitment to Avrio's new Limited Partnership Fund II. The second closing of this fund has also attracted CAD 40 million in other capital commitments from Export Development Canada, Alberta Investment Management Corporation, Alberta Enterprise Corporation and BDS Investments Inc., bringing the fund total to over CAD 91 million.

There are several other federal efforts to improve commercialisation at the regional/provincial level. For example, the Federal Economic Development Agency for Southern Ontario has a 2:1 matching investor programme. However, these types of programmes are predicated on having an ample supply of investors to whom matching incentives can be provided.

Since its launch in 2001, the Atlantic Innovation Fund (AIF) has been helping Atlantic Canadians compete in a global knowledge-based economy through the development and commercialisation of new ideas, technologies, products and services. In 2013, Western Economic Diversification Canada introduced a five-year CAD 100 million Western Innovation Initiative (WINN) for small- and medium-sized enterprises (SMEs) with operations in Western Canada to move their new and innovative technologies from the later stages of research and development to the marketplace.

In Canada, venture capital represents CAD 15 billion or 18% of the total private equity capitalisation (AAFC, 2014; Van Dusen, 2009). However, agriculture differs greatly in terms of financing methods from other sectors, such as the high-tech sector. Even within agriculture, it is likely that private sector behaviour in financing commercialisation of innovation has different characteristics between farmers, food manufacturing and agricultural biotechnology companies.

Tax policy

Tax policy affects innovation, productivity and sustainability in many ways: it affects the decision of firms and households to save or invest in physical and human capital, and thus the adoption of innovation; it raises government revenues, which can then finance public services, including those enabling innovation such as education and skills, R&D, and strategic infrastructure; it can also be used to provide direct incentives, for example preferential tax treatment to investments in private R&D or to young innovative companies. In addition to its economy-wide impacts, tax policy influences the conduct, structure and behaviour of farm, input suppliers and food companies.

Tax provisions for farmers and agri-food businesses

In Canada, agriculture and agri-food businesses are subject to a combination of federal and provincial incomes taxes, federal and provincial sales/excise taxes, and provincial/municipal property taxes. Tax rates, exemptions, deductions on agricultural land vary from province to province.

According to OECD data, the average corporate income rate tax in Canada (26%) is close to the OECD median rate (25%) and lower than that in Australia (30%, Brazil (34%) or the United States (39%).

Income tax rates paid by farmers vary depending on the way the farm business is organised. Most farms in Canada operate as sole proprietorships or partnerships, which are subject to personal income tax rates. Incorporated farms, on the other hand, pay corporate income taxes. The federal general corporate tax rate has been reduced to 15% in 2012 from over 22% in 2007, and is now much lower than the personal income tax rate (Table 4.1). Further personal income taxes will become payable as

profits are withdrawn from the company and distributed to owners, whether through salaries or dividends. Many farmers incorporate a business to take advantage of the lower small business tax rates. The small business corporation tax rates are generally applicable to the first CAD 400 000 to CAD 500 000 of income, depending on the province.

Table 4.1. Income tax rates by tax category, 2012

Tax category	Federal tax	Provincial tax	Top combined marginal rates
Personal	29%	10% to 21%	39% to 50%
Small Business Corporation	11%	0 to 8%	11% to 19%
Corporate (regular)	15%	10%* to 16%[1]	28% to 34%

1. Lower rates of 2.5% (Yukon) and 5% (Newfoundland and Labrador) apply to manufacturing and processing activities.
Source: Canadian legislation.

There are a number of federal special tax provisions for farmers that can impact or encourage investment in the sector as well as facilitate transfers to the next generation. They include capital gains tax exemptions; mechanisms to defer capital gains over ten years or on the transfer of an eligible farming business to a direct descendant; and provisions to reduce taxable income through cash accounting or deduction of farm losses from other income for part-time farmers up to a maximum (Box 4.4).

Box 4.4. Selected federal tax provisions for farmers

Lifetime Capital Gains Exemption (LCGE): The income tax system provides an individual with a LCGE on up to CAD 750 000 of capital gains realised on the disposition of qualified property: qualified small business corporation shares, and qualified farm and qualified fishing property. Budget 2013 increased the LCGE on up to CAD 800 000 of capital gains realised by an individual on qualified property, effective for the 2014 taxation year. In addition, the LCGE will be indexed to inflation for taxation years after 2014.

Deferral of Capital Gains through the Intergenerational Transfer of Family Farms: The intergenerational transfer allows for a tax deferral on the transfer of an eligible farming business to a direct descendant. This rule permits the taxpayer to elect to transfer the property at any amount between its cost amount and its fair market value at the time of the transfer. The elected amount is deemed to be the cost of the property to the descendant.

Deferral of Capital Gains through a Ten-Year Capital Gains Reserve: Farmers are entitled to claim a capital gains reserve over a ten-year period where the proceeds of disposition have not been fully received and the property has been transferred to the farmer's descendant. The reserve allows farmers to average the inclusion of capital gains and the corresponding tax liability over a maximum of ten years. A minimum of 10% of the taxable portion of the gain must be brought into income each year. In the context of transfers of family farm businesses to persons other than a child, the farmer may claim a reserve over a five-year period if the proceeds of disposition are not all receivable in the year of the sale. Under the five-year capital gains reserve, a minimum of 20% of the taxable portion of the gain must be brought into income each year.

Cash Basis Accounting: Taxpayers engaged in businesses are generally required to use the accrual method of accounting for tax reporting (i.e. revenues are declared when earned, and expenses claimed when incurred). However, farmers may elect instead to use the cash-basis method of accounting and report farm income when received, and expenses when paid (subject to certain inventory adjustment requirements).

Restricted Farm Loss Provision for Part-Time Farmers: If farming (or a combination of farming and some other source) is not the chief source of income and if the farm operations generated a loss, the farm loss the taxpayer can deduct from other income is restricted to a maximum of CAD 8 750. Any loss that is not claimed in a given year due to the restriction can be carried forward 20 years and back three years to deduct against any farm income in those years. Budget 2013 amended the restricted farm loss rules to clarify that a taxpayer's other sources of income must be subordinate to farming in order for farming losses to be fully deductible against income from those other sources. Budget 2013 also increased the RFL limit to CAD 17 500 of deductible farm losses annually (CAD 2 500 plus ½ of the next CAD 30 000).

The Atlantic Investment Tax Credit (AITC): AITC is a 10% credit available for certain investments in new buildings, machinery and equipment used in the Atlantic region and the Gaspé Peninsula region of Quebec. Currently, the credit supports investments in farming, fishing, logging, manufacturing and processing, oil and gas, and mining, but this programme is being gradually phased out.

Source: Department of Finance Canada.

Food processors can benefit from a tax provision introduced in 2007, the temporary accelerated Capital Cost Allowance. It allows new investment in machinery and equipment in the manufacturing and processing sector to be depreciated at a faster rate (50% on a straight line basis). By allowing a faster write-off of eligible investments, this measure provides investment support to businesses.

Provincial and municipal governments also offer provisions to farmers, such as discounted land and property taxes and special provincial income tax incentives. For example, the provincial income tax in Manitoba exempts totally small businesses with income under CAD 400 000; Ontario grants the temporary extension of the accelerated Capital Cost Allowance deduction for income tax purposes; reductions in the corporate tax rate have been made in Saskatchewan.

Some provinces have exemptions on farm inputs. For example, in some provinces, "purple" gasoline or diesel is available for farm-use only and is taxed at a different rate than fuel for non-agricultural uses ("purple" referring to the colour marking employed to distinguish it from other fuel).

Tax incentives to support R&D

Both federal and provincial governments use tax incentives to support private investments in R&D. The Scientific Research and Experimental Development **(SR&ED) Tax Incentive Program**[20] is the single largest federal programme supporting business R&D in Canada, providing more than CAD 3.6 billion in tax assistance in all sectors of the economy in 2012. Federal tax assistance is supplemented by related provincial credits for R&D, estimated at CAD 1.5 billion in 2011 (OECD, 2012a). Activities eligible for the SR&ED tax incentives involve systematic investigation or search carried out in a field of science or technology by means of experiment or analysis. In general, three broad categories of activity are eligible: basic research, applied research, and experimental development. These tax incentives are available to agricultural corporations and agri-food business.

The SR&ED tax incentive programme has two components:

- An income tax deduction, which allows immediate expensing of all eligible expenditures: salary and wages, materials, overhead, contracts and capital expenditures (other than most buildings).
- An investment tax credit with the following characteristics (until 1 January 2014):
  - The federal general rate is 20%. An enhanced rate of 35% is provided to small and medium-sized Canadian-controlled private corporations on their first CAD 3 million of eligible expenditures.
  - The provincial rate ranges from 10% (e.g. in Alberta and Ontario) to 37.5% in Quebec, with 15%-20% rates in most other provinces.
  - The tax credit is non-refundable; however, unused credits may be carried forward up to 20 years or carried back up to three years. In addition, unused credits earned in a year are generally fully refundable for small and medium-sized Canadian-controlled private corporations on their first CAD 3 million of current expenditures.[21]

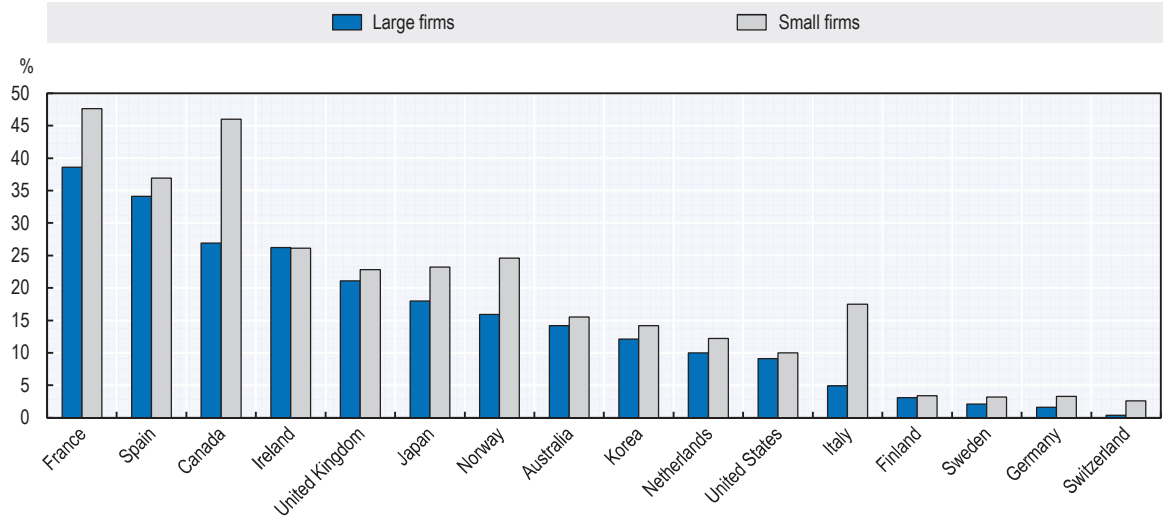
In January 2013, the profit element was removed for arm's length third-party contracts (i.e. only 80% of an arm's length contract is now eligible) for the purpose of calculating SR&ED tax credits. From January 2014, major changes were implemented:

- The general SR&ED investment tax credit rate was reduced to 15%, affecting primarily larger enterprises.
- Capital expenditures were removed from the expenditure base.

- The prescribed proxy amount, which taxpayers can use to claim SR&ED overhead expenditures, has been reduced from 65% to 55% of the salaries and wages of employees directly engaged in SR&ED activities in Canada.

The 2012 *OECD Economic Survey of Canada* (OECD, 2012) found that the SR&ED tax credit was one of the most expensive R&D tax expenditures in Canada. This is the second highest among a sample of OECD countries after France (Figure 4.10), whereas direct funding of business innovation is one of the lowest. The high cost of the SR&ED reflects the high rate of subsidisation rather than intensity of business R&D activity. Both the income tax deduction and the investment tax credit provide a significant benefit to firms. The SR&ED credit adds to complexity in the tax code, raising administrative and compliance costs.

Figure 4.10. Tax subsidy rate on investment in R&D[1], 2009



1. The data include income tax deductions and R&D tax incentives provided by sub-national governments. The element of income tax deductions corresponding to an economic depreciation allowance is not a subsidy and thus not included.

Source: Department of Finance (2009), Tax Expenditures and Evaluations 2009, Part 2, "An International Comparison of Tax Assistance for Investment in Research and Development", Ottawa. http://www.fin.gc.ca/taxexp-depfisc/2009/taxexp09-eng.asp.

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Notes

1. At the time of publication, the enforcement of relevant provisions related to food in this act are in the process of being transferred to the Canadian Food Inspection Agency (CFIA) under the *Safe Food for Canadians Act*.
2. Red Tape Reduction Action Plan: http://www.tbs-sct.gc.ca/rtrap-parfa/rtrapr-rparfa-eng.asp.
3. For an overview on water governance and regulations, see: http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=87922E3C-1.
4. Fisheries Act: http://www.dfo-mpo.gc.ca/habitat/changes-changements/index-eng.htm.
5. Responsible Protection and Conservation of Canada's Fisheries: http://www.dfo-mpo.gc.ca/media/back-fiche/2012/hq-ac12a-eng.htm.
6. The Cabinet Directive on Regulatory Management (2012) stipulates that Canadian regulators when regulating will: Protect and advance the public interest in health, safety, and security,

the quality of the environment, and the social and economic well-being of Canadians; Advance the efficiency and effectiveness of regulation by ascertaining that the benefits of regulation justify the costs; Make decisions based on best available evidence; Promote a fair and competitive market economy; Monitor and control the administrative burden; Create accessible, understandable, and responsive regulation; and Require timeliness, policy coherence, and minimal duplication throughout the regulatory process. For more information see: Cabinet Directive on Regulatory Management: http://www.tbs-sct.gc.ca/rtrap-parfa/cdrm-dcgr/cdrm-dcgrtb-eng.asp.

7. Standards Council of Canada: http://www.scc.ca/en/about-scc.
8. Incorporation by Reference in Regulations Act: http://www.parl.gc.ca/LEGISInfo/BillDetails.aspx?Language=E&Mode=1&billId=5756559.
9. Parliament of Canada: Legislative Summary of Bill S-2: An Act to amend the Statutory Instruments Act and to make consequential amendments to the Statutory Instruments Regulations http://www.parl.gc.ca/About/Parliament/LegislativeSummaries/bills_ls.asp?source=library_prb&ls=S2&Parl=41&Ses=2&Language=E&Mode=1.
10. Canadian Food Inspection Agency: http://www.inspection.gc.ca..
11. Safe Food for Canadians Act: http://www.inspection.gc.ca/about-the-cfia/acts-and-regulations/regulatory-initiatives/sfca/overview/eng/1339046165809/1339046230549.
12. Multi-Year Regulatory Modernization Plan: http://www.inspection.gc.ca/about-the-cfia/acts-and-regulations/regulatory-initiatives/consultation/eng/1342405651215/1342405905957.
13. DIR2001-02, Guidelines for the Registration of Microbial Pest Control Agents and Products: http://www.hc-sc.gc.ca/cps-spc/pubs/pest/_pol-guide/dir2001-02/index-eng.php.
14. Survey undertaken for the OECD.
15. The OECD trade facilitation indicators cover the full spectrum of border procedures — Advance Rulings; Appeal Procedures; Co-operation with other countries and between border agencies of the country; Fees and Charges; Formalities regarding automation, documents and procedures; Governance and Impartiality; Information availability; and Involvement of the Trade Community — for 133 countries across income levels, geographical regions and development stages. Updated and more complete information will be available at the end of 2014. For more information, see: http://www.oecd.org/trade/facilitation/indicators.htm.
16. Venture capital is a form of private equity. Returns on venture capital investment stem from a trade sale (sale to, or merger with, another company) or an initial public offering in which the company becomes authorized to sell its stock to the general public on a stock exchange. Venture capital funds will not only provide money but will mentor their investee firms (IO, 2012).
17. An angel investor is usually an experienced entrepreneur who provides backing to very early-stage businesses or business concepts.
18. A "funds of funds" portfolio consists of investments in several venture capital funds.
19. AVRIO venture capital: http://www.avriocapital.com/.
20. Canada Revenue Agency website for the Scientific Research and Experimental Development (SR&ED) Tax Incentive Program: http://www.cra-arc.gc.ca/txcrdt/sred-rsde.
21. Entities other than Canadian-controlled private corporations cannot receive the credit amount as income, but may use the amount to offset taxes owed.

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Annex 4.A1

Procedures to establish, evaluate and communicate standards for purchased inputs, feed and food products

Who provides scientific evidence?

Canada considers any scientific evidence that is brought before it. Industry can submit scientific evidence for consideration as part of an application for approval of novel products or processes. During various stakeholder consultations, feedback from industry has indicated that the combination of lengthy Service Delivery Standards and the time required to generate the efficacy data needed to support registration delays the introduction of innovative products into the Canadian marketplace.[1]

AAFC undertakes scientific research, development and technology transfer activities for the benefit of Canadians. AAFCs Pest Management Centre (PMC) undertakes scientific research to support growers' access to new minor use pesticides and reduced risk pest management solutions.[2] Since 2006, 480 regulatory submissions have been made on behalf of Canadian growers, resulting in over 330 registrations and more than 1 230 new uses. A company proposing the registration of an innovative pest control product must also submit the required scientific evidence to the Pest Management Regulatory Agency (PMRA). As with any pesticide, the PMRA reviews the evidence to ensure that that the product is acceptable in terms of safety, merit and value before it may be allowed for sale and use in Canada.

Through the public consultations as part of the regulatory development process, any person or company can submit information for consideration by regulators. Canada is working on many fronts to try to better align regulatory requirements with those of other jurisdictions (e.g. Canada-US Regulatory Cooperation Council[3]) to decrease the burden on industry and to facilitate the introduction of safe innovative products to the marketplace.

Canada is also participating in international efforts, such as OECD's Global Joint Review for Pesticides to develop and share scientific data related to pre-market applications. Canada is increasingly exploring similar work-sharing arrangements relating to new products. Similar international regulatory cooperation and knowledge sharing is also being undertaken by Health Canada's Veterinary Drugs Directorate.

For fertilisers and feed, product proponents are required to submit scientific evidence substantiating product safety. For feed products, specific requirements for a safety and efficacy assessment are dependent on the nature of the feed in question. Data requirements are tailored based on history of use and complexity of the product. The Canadian Food and Inspection Agency (CFIA) provides guidance to stakeholders on how to meet the data requirements for the assessment process through workshops, one-on-one consultations and the publication of guidance documents.

Who evaluates the scientific evidence?

For fertilisers, safety assessments are conducted by a team of CFIA evaluators, who examine all ingredients in a fertiliser or supplement including the active components, the formulants, carriers, additives, potential contaminants and by-products that might be released into the environment as a result of product's use and application to soil. In addition to evaluating the desired effect of the product as a nutrient or plant growth supplement, the CFIA also examines unintended and potentially adverse effects, including bystander and worker exposure (e.g. retailer, farmer, home owner), safety of food

crops grown on land that has been treated with the product, impacts on animals and plants other than the target crop species, and ecosystem effects including impact on soil, biodiversity, leaching to waterways, etc.

For livestock feeds in Canada, the *Feeds Act* and *Regulations* currently provide authority to the CFIA for pre-sale product evaluation, safety assessment of new ingredients, product registration, and marketplace compliance verification that includes inspection and sampling activities. The current regulatory framework focuses on approval of individual ingredients and registration of mixed feeds, with exemptions for registration or streamlined approval processes for ingredients that are well characterised and have a history of safe use.

How often are standards being reviewed?

For fertilisers, safety assessments are conducted on a case by case basis and consider product ingredients, their source, the method of manufacture, quality control and the quality assurance systems in place to ensure that the final product does not contain contaminants at levels that may be harmful to humans, animals, plants and the environment. The CFIA maintains internal safety standards for contaminants (heavy metals, faecal coliforms, salmonella, dioxins and furans, etc.) and also considers standards maintained by other federal and international regulatory bodies. There is no set timeline for standards review. As new information becomes available regarding potential risks, the Fertiliser Program will seek to review (at times in collaboration with other regulatory partners and academia) internal standards.

Standards in domestic disease control are reviewed every one or two years, or when new information (science or industry practices) becomes known.

The *Feeds Regulations* are not prescriptive in terms of data requirements. The specific data requirements for the assessment are contained in policy via current regulatory guidance documents (see following link for current feed regulatory guidance documents.[4] Information requirements outlined in these documents allow data needs to be addressed by either empirical methods or valid scientific rationale. The use of peer-reviewed scientific literature or foreign data, where appropriate is also be permitted. The current documents are updated and new documents are created as needed.

Assistance to navigate the regulatory system

AAFC helps the sector adapt to a changing domestic regulatory environment through engagement and collaboration with industry and regulatory agencies.

In general, government departments and agencies have many online tools to help stakeholders in the agriculture sector navigate the regulatory system, including manuals, compliance examples/models, guidance documents, information, links to related websites/partners and contact names for further direction.

The CFIA worked closely with Canadian General Standards Board and the private sector to create the national standard for organic production and the related Organic Products Regulations. By involving industry to such as a high degree (i.e. stakeholders drove the development of the national organic standard), industry is very knowledgeable about the organic regulatory system.

The PMRA publishes guidance documents on its web site to aid stakeholders in navigating the pesticide regulatory system. In addition, the PMRA offers a pre-submission consultation service at no cost to provide regulatory advice to registrants or applicants prior to the submission of an application to register or amend a pest control product. The pre-submission process may offer advice on study protocols or the data required to support a registration of a particular pest control product. Furthermore, the PMRA operates a toll-free pest management information service to respond to stakeholder queries and comments.

There are also electronic navigation tools in place that help businesses find information about business permits (BizPal) and agricultural programmes and services (AgPal). These federally-led tools endeavour to capture information from all three levels of government (municipal, provincial and federal).

Canada has initiated the Open Government initiative, which aims to increase information sharing as well as stakeholder engagement. In addition to the 'Open Data' and 'Open Information' streams, the 'Open Dialogue' stream of the initiative includes increasing stakeholder input into regulations and is linked to the Red Tape Reduction Action Plan. In 2013, as part of this action plan, the Government of Canada initiated the online posting of the forward regulatory plans for all federal departments and agencies. This provides consumers, industry and other interested stakeholders greater opportunity to participate in the development of regulations (re: transparency) and to better plan for the future (re: predictability).

Setting standards, evaluation and communication

It is the Government of Canada's role to communicate with the public in a timely and clear manner with information that is accurate, objective and complete about its policies, programmes, services and initiatives to help build public confidence in the regulatory system as well as the safety of approved innovative practices and products.

- The Communications Policy of the Government of Canada prescribes communications activities by institutions, ensuring that communications across the government are well-coordinated, effectively managed and responsive to the diverse information needs of the public.

The government's approach is to safeguard and protect the environment, public health and safety, and animal and plant health through science-based assessments. Once safety is assessed, market decisions are left to industry and to the consumer. It communicates this approach through print public education materials, website FAQ (Frequently Asked Questions), and press releases.

- Example: Health Canada webpage information on Genetically Modified food from the standpoint of the Canadian economy and safety.

For AAFC, this includes a broad communications campaign around Growing Forward 2 (2013-2018) Canada's current agricultural policy framework focused on innovation, competitiveness and market development. Communications activities to support the launch of GF2 focused on innovation as a key driver to long term prosperity in the agricultural sector and the Canadian economy.

- AAFC communications activities on Growing Forward 2 included a broad sector engagement strategy to obtain stakeholder input into the development (in-person meetings and online discussions with various stakeholders and interested parties from across the country). Federal, provincial and territorial governments engaged industry and the public at various stages.
- Upon reaching an agreement, AAFC communications activities included: a direct mail piece to all Canadian farm households to raise awareness of the new programmes; advertising in specialty media in each province and in both official languages; Ministerial events across the country to announce bilateral agreements with provinces and territories; news releases to promote programmes and mark important milestones and application dates; as well as multiple new postings to the AAFC website.

The federal government also promotes research and innovation initiatives specifically through websites and a science portal. The results of AAFC research are regularly published in peer-reviewed journals, communicated to stakeholders, shared with international research partners and promoted to media and to Canadians through a variety of communications channels including media events to announce investments in science and technology, new discoveries and partnerships; proactive media outreach that includes pitching success stories about scientific achievements and innovation

milestones; participation by scientists in events that highlight their work such as Open Houses and Field Days; corporate and regional exhibits; videos such as "Check Out Agriculture" showing how AAFC research goes into everyday grocery items; print material such as fact sheets and newsletters; AAFC website with over 4000 scientific abstracts and profiles of our scientists; and collaboration with other science-based government departments and intergovernmental communities such as Science and Technology Cluster.

It is important the government be involved in communicating the existence of new standards, and clarifies where further information can be obtained. For example, before national organic standards were enacted, "organic" or "certified organic" labels were open to interpretation by consumers. The introduction of the Organic Products Regulations has somewhat alleviated this concern; however, recent polls suggest there is still work to be done, as words such as "natural" continue to confuse consumers, and blur with the regulated term "organic".

The Pest Management Regulatory Agency uses its Annual Report to Parliament to emphasise that innovative pesticides (such as microbial pest control agents) must meet the same stringent standards as other pesticides registered in Canada. Products which pose unacceptable risks to human health or the environment are not registered for sale or use in Canada.

The CFIA communicates its standards and risk assessment processes to stakeholders, regulated parties, and Canadians using a variety of tools and approaches:

- Information is made available on the CFIA's website.
- A ListServe tool is available where interested individuals may subscribe to CIFA notification services for topics of interest.
- The CFIA technical representatives and senior managers attend stakeholder organisation meetings and workshops and share relevant information.
- When introducing new standards into regulation, the CFIA conducts consultation sessions with regulated parties and industry stakeholder organisations and in preparing to introduce standards through regulation or legislation publishes information in the Canada Gazette.
- On-line tools are available to regulated parties (e.g. Automated Import Retrieval System (AIRS), which provides regulated parties with information on the standards or requirements for importing regulated products into Canada.

On CFIA's website, information is available about risk assessments and how information is used in decision-making. From a plant perspective, the CFIA conducts risk assessments for livestock feed and environmental safety, while Health Canada conducts a food safety risk assessment. CFIA scientists conduct risk assessments of diseases and pests that have been, or could be, introduced into Canada and threaten its plants and animals. CFIA works closely with federal and provincial partners to share expertise, and collaborate with the international community for intelligence sharing, to identify risks posed by foreign plant and animal diseases and pests.

Notes

1. Proposal for Provisional Registrations under the *Fertilizers Act*. Canadian Food Inspection Agency. 2011. http://www.inspection.gc.ca/plants/fertilisers/registration-requirements/provisional-registrations/eng/1330934645843/1330934850861 (accessed on May 8, 2013).

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Chapter 5

Capacity building and services for the Canadian food and agriculture system

This chapter outlines the role of infrastructure capacity, skills and education in facilitating innovation in agri-food. It describes the governance of policies to improve rural infrastructure, outlines main regional programmes and reviews briefly the quality and coverage of rural services. It then discusses efforts to respond to skills demand from the agri-food sector through labour, immigration and education policy. It also reports on trends in education expenditure and outlines the performance of education system. Finally, it provides an overview of education levels in agricultural, and enrolment in agricultural programmes, outlining the gap between skills supply and demand in the sector.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

Infrastructure and rural development policies

Investments in physical and knowledge infrastructure, from Information and Communications Technology (ICT) to transportation facilities, are important for overall growth and development. They are vital to the delivery of and access to important services and play a critical role in linking farmers and related businesses to markets, reducing food waste, boosting agriculture productivity, raising profits, and encouraging investment in innovative techniques and products. Productive and profitable enterprises have higher incentives to invest in sustainable practises that yield long term benefits.

Broader rural development measures also affect agricultural development and structural adjustment. Increased off-farm income and employment opportunities mitigate farm household income risks, facilitate farm investment, and enable a wider range of farm production choices. Improved rural services, from banking to ICT, are important to ensure needed connectivity to suppliers, customers, and collaborators. Rural policy can also attract innovative upstream and downstream industries, with possible spill-over effects locally. By reducing inequalities in economic development and access to services across regions, rural development policies improve the diffusion of innovation.

Governance structures to ensure policy coherence across infrastructure, rural development and agriculture policies

In Canada, a large number of federal and provincial ministries and government agencies contribute to rural development in line with their responsibility: agriculture, communication, education, health, transport, etc. Governments finance rural infrastructure and services directly, or provide incentives to private provision.

Historically, the balance of federal-provincial-territorial responsibilities on rural development has varied in practice, with political and economic opportunities evolving over time. Canada does not have an official national rural policy. The federal approach to rural policies and procedures does not fall under the exclusive jurisdiction of one organisation in particular; rather all federal departments and agencies have a role to play in supporting rural development. Regional development agencies are key federal institutional players in Canada's rural development, and also in infrastructure and agriculture. They are responsible for regional and sub-regional economic development strategies, which also promote sustainable economic development and diversification, with a particular emphasis on small and medium-sized enterprises (SMEs).

Since 2002, *Infrastructure Canada* has been the liaison of the Government of Canada on matters of infrastructure. It manages various funding programmes that support infrastructure projects throughout the country. Following the 2006 *Building Canada Plan*, the 2013 federal budget established the *New Building Canada Plan*, which includes over CAD 53 billion to build roads, bridges, subways, commuter rail, connectivity and broadband and other public infrastructure in cooperation with provinces, territories and municipalities (Budget Plan, 2013).

At the federal level, a number of mechanisms have been put in place to ensure coherence between government policies and initiatives such as infrastructure, rural development and agriculture that have an impact on innovation in the food and agriculture sector:

- The different levels of **Federal-Provincial-Territorial Government (FPT) Committees** consist of representatives of the federal government and representatives from each province and territory from the agricultural ministries. They provide a mechanism for cooperation at the national level in order to improve public policies and initiatives. FPT Working Groups support the efforts of the Ministers and other senior-level FPT Committees. It is through this FPT process that the multilateral agreement on Growing Forward 2 was negotiated, improving the consistency of agricultural policies across the country.
- Government organisations conduct an **interdepartmental review** early in the public policy development process when changes may be made. Through the federal government's

interdepartmental consultation process, public servants have the opportunity to receive expert advice from their colleagues in other department and agencies. For example, AAFC has worked with other departments on issues affecting the agricultural sector, including rail and other methods of transportation, labour and infrastructure.

- Since the 1980s, coordination at the federal level has been carried out by **Regional Federal Councils**. These networks promote a coordinated approach to carry out federal activities in each region, but do not have executive powers or programme delivery responsibilities.

Government initiatives to encourage private sector investment in rural communities

Governments encourage private sector investment via business or rural community oriented initiatives. Business initiatives offer the private sector direct incentives to invest in rural communities and can include, for example, tax policy/tax rebates, financing or supporting the use of public-private partnerships. Rural community oriented initiatives, on the other hand, enable a community to market themselves as an attractive economic environment to private sector investors.

Governments at various levels – federal, provincial, territorial or local (municipal, regional or First Nations) – encourage private sector investments independently or in collaboration with each other. Collaborative approaches include federal-provincial joint funding, matching grants or cost-sharing initiatives. One example is the federal government's **Building Canada Fund**, with a particular emphasis on the Communities Component of this fund, which targets projects in communities with populations of less than 100 000. The Fund works by making investments in public infrastructure owned by provincial, territorial and municipal governments, and in certain cases, private sector and non-profit organisations. Funding is allocated to each province and territory based on population. All projects funded through the Building Canada Fund are cost-shared with provinces and municipalities, with the maximum federal contribution to any single project being 50%.

Federal government support for private sector investment tends to target the trade environment and business climate (e.g. tax policy, regulation, and financing discussed in previous sections). Initiatives that specifically target rural areas and agriculture and other resource sectors are usually more local in nature, such as **Community Futures (CF) organisations** or Farm Credit Canada. CF organisations are federally funded, but operate independent of government as non-profit organisations. The mandate of the organisations is rural community and business development. Each delivers a variety of services ranging from strategic economic planning, technical and advisory services to businesses, loans to small and medium-sized businesses, self-employment assistance programmes, and services targeted to youth and entrepreneurs with disabilities. Each of the six Regional Development Agencies[1] provides funding to CF organisations that support community economic development and small business growth through each of their networks.

To encourage the development of **public-private partnerships (P3s)** for the delivery and the maintenance of infrastructure, the Government of Canada developed *PPP Canada*,[2] a Crown corporation which works with provincial, territorial, municipal, First Nations, federal and private partners to support greater adoption of public-private partnerships in infrastructure procurement. Examples of P3 Canada Fund investments in rural communities (a funding programme run by *PPP Canada*) include the Iqaluit International Airport Improvement project (Iqaluit, Nunavut) and improved water infrastructure at Lac La Biche's Biological Nutrient Removal Wastewater Treatment Facility (Lac La Biche County, Alberta).

Industry Canada provides targeted, infrastructure investment through its strategy to extend broadband coverage to as many unserved households as possible. The strategy includes funding programmes (such as the Broadband Canada: Connecting Rural Canadians Program which closed March 2012) and spectrum auctions (where the government is applying specific measures in the 700 Megahertz (MHz) category to see that Canadians in rural areas have access to advanced wireless services in a timely manner).

Infrastructure Canada works to address Canada's public infrastructure needs through collaborative infrastructure initiatives, such as the Building Canada Plan (which includes broadband and connectivity). Regional Development Agencies work with Infrastructure Canada to deliver infrastructure investment in rural areas through various programmes, usually implemented in cooperation with the provinces, territories, and municipalities, as well as First Nations and the private sector. Examples include: the Community Improvement Fund, the Building Canada Fund and the Municipal Rural Infrastructure Fund.

Examples of Community Economic Development include:

- The Southern Ontario Development Program (SODP) of the Federal Economic Development Agency for Southern Ontario (FedDev Ontario), which stimulates local economies and enhances the growth and competitiveness of local businesses and communities through strategic funding.
- The Northern Ontario Development Program (NODP),[3] of the Federal Economic Development Initiative for Northern Ontario (FedNor), which provides repayable and non-repayable contributions to not-for-profit organisations and small and medium-sized enterprises (SMEs) for projects focussed on one of three priorities (community economic development, business growth and innovation).
- The Aboriginal Economic Development of the Canadian Northern Economic Development Agency (CanNor), a suite of national contribution programmes.

Provinces and territories focus their efforts to encourage private sector investment in rural communities through both business and rural community oriented initiatives, while also using tax and regulatory instruments (The Canadian Chamber of Commerce, 2011). Provincial government examples include:

- Offering low corporate taxes that attract investment from around the world and/or low personal taxes that attract and retain skilled workers. For instance, the Alberta government offers no provincial retail sales tax (PST), provincial capital taxes, payroll taxes or machinery and equipment taxes as a means of attracting private sector investment.[4]
- Nova Scotia offers Community Economic Development Investment Funds (CEDIF), a structure used to raise local capital for business ventures and provide investors with access to generous tax credits in exchange for investing locally.
- Manitoba's Partner 4 Growth programme, focused on partnerships between the province and rural Manitoba communities, provides cost shared funding for regions to identify and pursue economic development opportunities based on identified regional strategic advantages. The projects are cost-shared between the province and eligible applicants (including rural municipalities, First Nations communities, non-profit organisations, chambers of commerce and other Manitoba communities and not-for-profit organisations).[5]
- Ontario's Business Retention and Expansion (BR+E) programme is a comprehensive economic development programme that builds locally based strategies to support businesses, retain and create new jobs and growth opportunities in Ontario's rural communities.[6]

Where they have the capacity, local communities work to attract and retain business and to develop their communities. Many rural communities are collaborating on a regional basis to develop and implement strategic plans. One example is the South Central Ontario Region (SCOR), a partnership of five counties (Brant, Elgin, Middlesex, Norfolk and Oxford) in south-central Ontario, supporting business development and economic growth in their region.

Coverage and quality of public services

Given the size of the country, providing good quality infrastructure for the development of rural areas and good access to public services is a challenge, which is met through active and diverse policy intervention. While Canada's population is concentrated in urban areas, more than 6 million Canadians, representing 18% of the population, lived in rural areas in 2011.

To facilitate access to **government services**, Service Canada offers a single-window into federal services and benefits on subjects such as Education and Training; Employment; Health; Housing; Immigration; Income Assistance; Legal Assistance; and Starting a Business. Service Canada's network includes 620 points of service across the country, providing 95% of Canadians with access to government services and programmes within 50 kilometres of their homes.

Banks and co-operative financial institutions are well represented in Canadian rural areas.[7] There are 6 205 bank branches across Canada, of which approximately 2 100 are rural and small town branches.[8] There are 771 credit unions and *caisses populaires* across Canada, with 3 117 locations.[9]

The **postal service** is expected to be a universal service in Canada.[10] There were 6 400 post offices in Canada in 2012 (Canada Post, 2012), with service to rural areas provided by 3 800 rural retail outlets and more than 7 300 rural routes. Approximately 88% of Canadian households received postal delivery services to their residences, apartment buildings, immediate neighbourhoods or rural roadside postal boxes through delivery agents (e.g. letter carriers); approximately 12% of Canadian households (usually located in smaller rural communities) obtained their mail at local post offices or through postal boxes. The postal service is, however, running losses and in December 2013, Canada Post released the Five-point Action Plan, to realign how it delivers and prices postal services to meet Canadians' emerging and future needs, while reducing costs substantially (Canada Post, 2013). It will involve in particular the development of Community mail boxes to replace individual ones.

Regarding **health services**, rural populations have relatively good access to family medicine physicians with 14.6% located in rural areas in 2011 for a rural population representing 18% of the total population. As in many countries, however, specialist services are lower than in urban areas. To ensure wide coverage of health services, proactive policies encourage medical staff to settle in deficit regions through conditional education grants. In addition, the Government of Canada offers Canada Student Loan forgiveness to eligible family doctors, residents in family medicine, nurse practitioners, and nurses who work in rural or remote communities. It also provides enhanced health services for First Nations and Inuit through various targeted programmes. Since the mid-2000s, the number of physicians in rural areas increased six times faster than the population. All provinces and territories (except Yukon) reported an increase in physicians, with the Northwest Territories, Prince Edward Island and Saskatchewan reporting increases of more than twice the Canadian average (12%, 9.7% and 8.4% versus 4.1%, respectively). Jurisdictions reporting smaller increases included British Columbia (0.4%) and Newfoundland and Labrador (2.3%).

The Canadian **education** system is managed at regional level and performs well (Chapter 5). There were approximately 15 500 schools in Canada in 2008, when the population was roughly 33.2 million.[11] In 2013, there were 98 universities in Canada, with 1.2 million students in degree programmes: 898 400 full-time students; 275 800 part-time students; and 42 000 full-time professors.[12] In addition, there are 128 colleges spread out on over 1 000 campuses in Canada.[13]

The relationship between **infrastructure accessibility** and employment growth in the primary sector (including agriculture) is weak, but reliable infrastructure, especially good access to roads and rail, are required to bring domestic production to consumption and export markets. Given the long distances involved in Canada, the export orientation of the main agricultural industries suggests that the transport infrastructure is sufficient to ensure transportation costs are not prohibitive.[14]

Throughout the 20th century, publicly-owned electric companies at the provincial levels helped complete the **electrification** of the most inhabited rural areas in Canada. With the exception of some remote-rural northern communities (e.g. Tuktoyaktuk, Northwest Territories) where electricity is provided by diesel generators,[15] most inhabited rural communities have access to electricity through power lines.

Hydroelectricity is one of the pillars of Canada's rural economies in some provinces. Rural Canada is also a large user of electricity through its energy intensive industries, such as mining, pulp and paper, iron and steel, and smelting and refining, non-ferrous. Agricultural electricity usage, on the other hand, was low relative to total electric energy disposal, with only 1.7%.

Quality **Information and Communications Technology (ICT)** services are critical to maintaining rural quality of life and improving rural economic opportunities. The availability of high-quality and affordable telecommunication and Internet services enhances delivery of business and other services and communication and collaboration with peers. As a key enabling technology, these services are critical in determining innovation capacity in a region.[16]

In 2010, Canada had approximately 50 fixed **telephone** line and 70 cellular subscribers per 100 persons (World Bank, 2012). Canada's cellular services appear to be underdeveloped compared to other countries in the OECD. For example, in 2010, the United States had 90 cellular subscribers per 100 persons, France had 97, Australia 101, Sweden 116, Germany 128, and the United Kingdom 130. All countries cited, including Canada, reported that 99-100% of their population was covered by mobile networks.

There exists a gradually narrowing digital divide in Canada with regards to **Internet** usage between rural and urban regions. In 2007, 65% of rural Canadians used the Internet compared to 76% of urban Canadians. By the end of 2009, 72% of rural Canadians used the Internet compared to 83% of urban Canadians, while 84% of rural households had access to broadband, compared to 100% of urban households. By 2011, when including mobile broadband access (HSPA+ and LTE), virtually all Canadian households had access to broadband Internet services of at least 1.5 megabits per second (CRTC, 2012).

In terms of agricultural Internet usage, producers are using computers and the internet to manage farm business (Statistics Canada, 2011; and AAFC, 2013). In 2011, 60% of all farms reported using a computer in the management of their business; and 55% used the internet and 45% had high speed internet access. Across the country, access to high speed internet ranged from 41% in Quebec to 50% in Prince Edward Island.

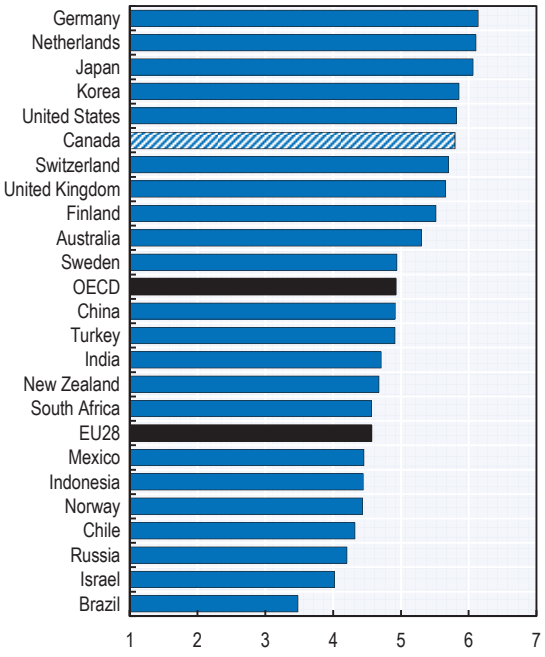
In the broadest sense, access to **water** is not a major problem in Canada; however, there are annual variations that can present regional challenges for agriculture producers. Agriculture is not Canada's largest user of water, but it consumes 71% of the water it diverts, making it by far the greatest consumer. Groundwater use, though relatively small in comparison to surface water volumes, provides 26% (6.2 million people) of domestic water supply overall, with 82% of rural Canadians (about 4 million people) relying on groundwater for supply (Environment Canada, 2004).

According to WEF Global Competitiveness Index, Canada ranks relatively high in terms of coverage and quality of transport, electricity and telephony infrastructure, in absolute terms and relative to its large geographical size (Figures 5.1 and 5.2). As noted above, the only weak point is the number of mobile telephone subscriptions per 100 inhabitants, which is lower than the OECD average.

Figure 5.1. Global Competitiveness Index: Quality of transport infrastructure, 2013-14

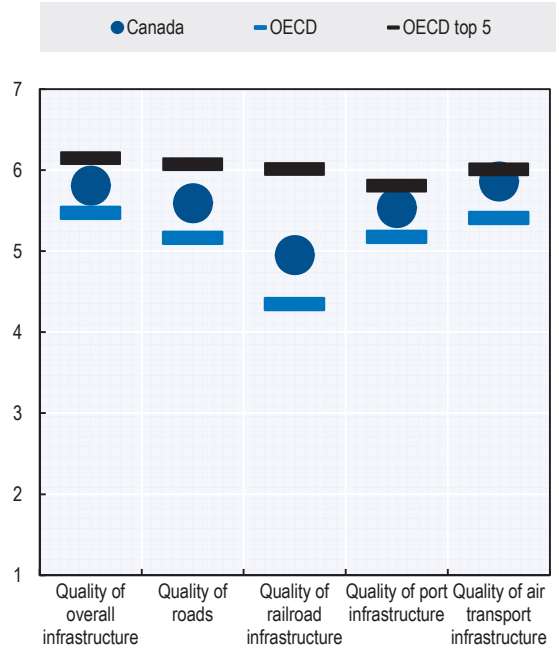
Scale 1 to 7 (best)

A. Index of transport infrastructure quality by country



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

B. Canada's index of transport infrastructure quality by component



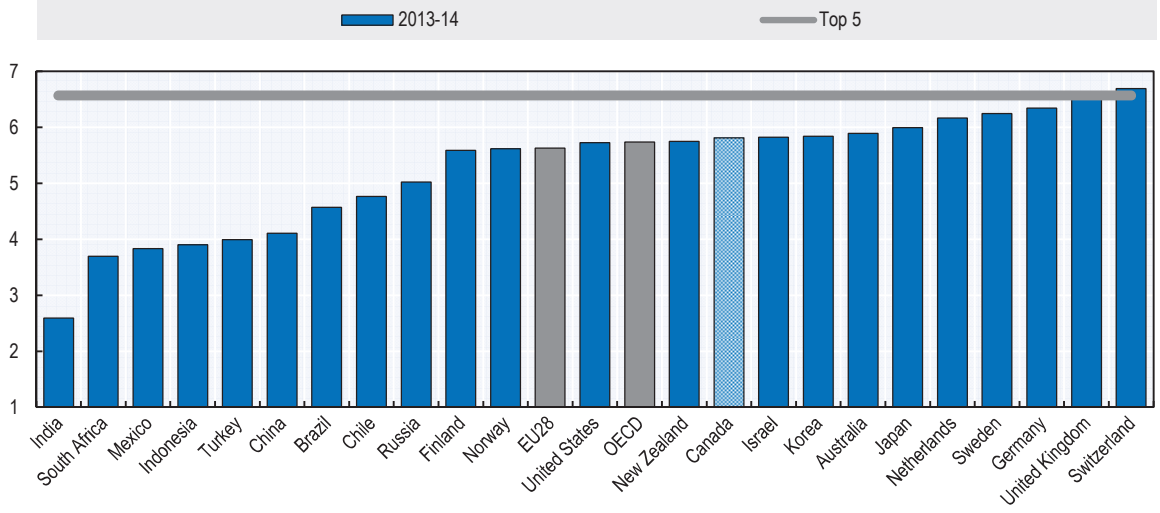
Top 5 refers to the average of the scores for the top 5 performers among OECD countries (France, Germany, Spain, Netherlands and Japan).

Source: World Economic Forum (2013), *The Global Competitiveness Report 2013-2014: Full data Edition*, Geneva. http://reports.weforum.org/the-global-competitiveness-report-2013-2014/#.

StatLink http://dx.doi.org/10.1787/888933250393

Figure 5.2. Global Competitiveness Index: Quality of electricity and telephony infrastructure, 2013-14

Scale 1 to 7 (best)



Indices for EU28 and OECD are the simple average of member-country indices.
Top 5 refers to the average of the scores for the top 5 performers among OECD countries (Luxembourg, Switzerland, United Kingdom, Austria and Germany).
Source: World Economic Forum (2013), The Global Competitiveness Report 2013-2014: Full data Edition, Geneva. http://reports.weforum.org/the-global-competitiveness-report-2013-2014/#.

StatLink http://dx.doi.org/10.1787/888933250403

Labour policy

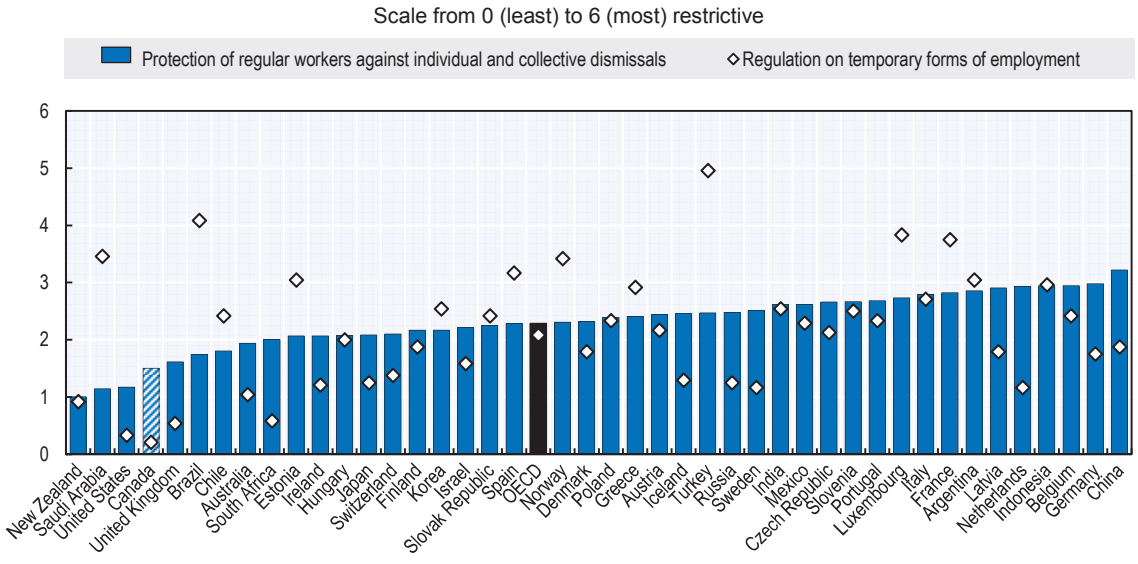
Labour market policy influences employment composition and labour mobility, in particular by facilitating (or discouraging) labour to adapt to new circumstances. It can play an important role in facilitating structural adjustment, including farm consolidation, by assisting excess labour in farming to exploit more remunerative non-farm income and employment opportunities. Policy on international mobility of human resources can also help to better match labour supply with demand, and can affect innovation and knowledge transfer through exchange of skills and skilled labour.

In Canada, an employment law statutory framework standardises the core aspects of the employee-employer relationship, including minimum wages, health and safety in the workplace, anti-discrimination, and pay equity. In general, the federal government has jurisdiction over a small number of Canadian workers (around 10%) in industries expressly listed within the constitution (e.g. airlines, banks, railways and grain elevators, feed and seed mills, among others). Most employees in Canada are under provincial jurisdiction.

Depending on the province of work, many farm employees are not subject to a number of employment standards, including minimum wage, hours of work, overtime, vacation pay and general holiday pay. In addition, some provinces (e.g. Alberta, New Brunswick and Ontario) have exempted agricultural workers from the right to associate and to strike. However, the share of hired labour has increased over time in the agricultural sector, suggesting that labour laws will have an increasingly important role in the sector going forward.

Overall, the Canadian employment legislation is among the most flexible in OECD countries and emerging economies, in particular regarding temporary forms of employment (Figure 5.3). This facilitates adjustment for seasonal labour needs in agriculture.

Figure 5.3. OECD indicators of employment protection legislation 2013[1]

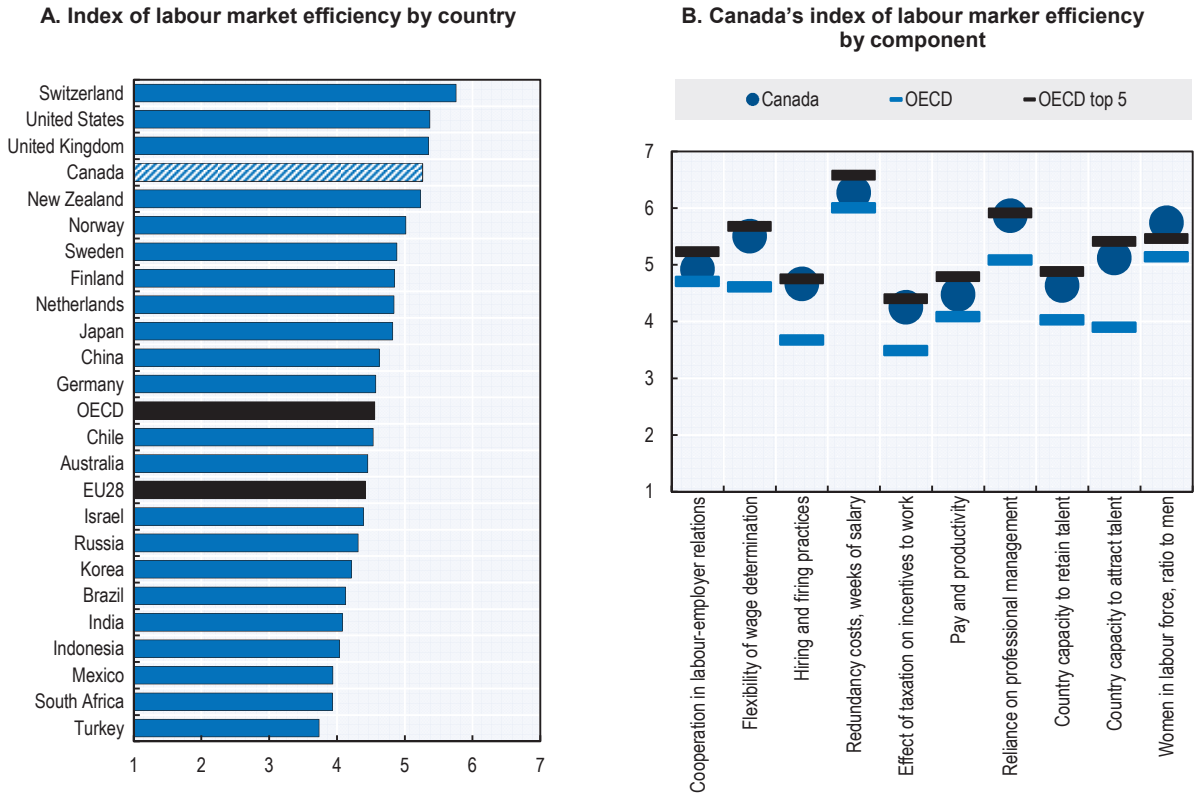


The OECD Indicators of Employment Protection refer to labour market flexibility regarding the procedures and costs required to dismiss workers and the procedures involved in hiring workers.
1. Data refer to 1 January 2013 for OECD countries and Latvia and 1 January 2012 for other countries.
Source: OECD (2013), *OECD Employment Protection Database*, www.oecd.org/employment/protection.

StatLink http://dx.doi.org/10.1787/888933250410

Figure 5.4. Global Competitiveness Index: Labour market efficiency, 2013-14

Scale 1 to 7 (best)



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

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

Source: World Economic Forum (2013), *The Global Competitiveness Report 2013-2014: Full data Edition*, Geneva. http://reports.weforum.org/the-global-competitiveness-report-2013-2014/#.

StatLink http://dx.doi.org/10.1787/888933250425

According to WEF Global Competitiveness Index, which is based on an executive opinion survey, Canada is among the top five OECD countries in terms of labour market efficiency (Figure 5.4). The country is ranked high in particular regarding its capacity to retain talent, which is important for innovation. While women participation in the labour force is higher than in the OECD average, it is well below the OECD top 5 performers.

There is evidence of a mismatch in Canada between demand and supply of skills by region, industry and occupation. Employers in the fastest growing industries and regions are reporting skills shortages, which can be expected to intensify as unemployment rates decline further (Human Resources and Skills Development Canada, 2012). Due to unmet labour demands and the seasonal nature of some sectors, many Canadian employers are relying heavily on temporary foreign workers.

Government initiatives to address labour market unbalances help Canadian workers develop skills and find employment, encourage movements in regions with significant labour shortage, and facilitate the permanent or temporary immigration of workers with skills demanded.[17] Requests for temporary foreign workers to meet labour demands are increasing across all skill levels. The main Federal programmes are listed in Box 5.1.

Similar to other industries, agriculture, food and seafood employers have indicated that recruiting and retaining qualified and reliable workers is an ongoing concern, one which can affect the competitiveness of the industry. Many agricultural enterprises rely on the Temporary Foreign Worker Program (TFWP), including the Seasonal Agricultural Worker Programs (SAWP) during peak seasons, to fulfil their labour requirements when a domestic workforce is not available and to employ workers with the skill set required to produce innovative products at competitive prices. Paid seasonal employees play an important role in the primary agriculture sector. In 2011, close to two-thirds of paid employees were seasonal or temporary (this includes temporary foreign workers), with higher proportions of seasonal employees reported in the provinces of Nova Scotia, Prince Edward Island, New Brunswick, and British Columbia.

Box 5.1. Federal programmes to address labour market unbalances

Labour Adjustment Initiatives: Through its skills and employment programmes, the Government of Canada (in some instances in collaboration with provinces and territories):

- Helps Canadian workers adapt to a changing labour market by becoming more self-reliant;
- Supports Canadian employers by helping them meet their labour-force needs; and
- Improves labour market efficiency.

Youth Employment Strategy: The Youth Employment Strategy focuses on three programme streams: skills development, career development and summer jobs. These programmes provide funding to allow employers to create job opportunities, work experience and training programmes for the youth. In 2011 alone, the programme helped connect 70 000 Canadian youth with work experience and skills training. The Apprenticeship Completion Grant is a federal government commitment (announced as part of Canada's Economic Action Plan 2013) of CAD 40 million per year to encourage skilled trades and apprenticeships.

Permanent Immigration (Citizenship and Immigration Canada)

A main objective of Canada's immigration programme is to promote economic development through labour market participation. The Government of Canada currently has plans to continue to enhance its economic immigration programmes by developing a "just-in-time" system that will recruit people with the right skills to meet Canada's labour market needs, and fast track their immigration.

The Provincial Nominee Program (PNP) is designed to facilitate immigration of foreign nationals to specific provinces/territories in order to target explicit economic needs. Individuals who immigrate to Canada under the PNP have the skills, education and work experience needed to make an immediate economic contribution to the province or territory which nominates them.

Temporary Immigration (Citizenship and Immigration Canada, and Employment and Social Development Canada): The Temporary Foreign Worker Program (TFWP) allows Canadian employers to hire foreign nationals to fill temporary labour and skill shortages when qualified Canadian citizens or permanent residents are not available. The Government of Canada is continually working at refining the TFWP rules to accommodate the changing needs of workers and employers. Most of the recently announced changes to TFWP are intended to encourage the hiring of Canadians, but they explicitly exempt the primary agricultural sector in most instances. The Seasonal Agricultural Worker Program (SAWP) is a sub-stream of the TFWP which facilitates hiring seasonal labour in primary agriculture, for a duration of no more than eight months, from Mexico and some Caribbean countries.

Federal Skilled Trades Program (FSTP): The FSTP was introduced under Canada's Economic Action Plan in 2012 (www.actionplan.gc.ca/). The objective is to help the economy grow by addressing serious regional labour shortages. It is designed for individual foreign citizens who want to become permanent residents based on their qualifications in a skilled trade. In 2014, no more than 5 000 applications will be processed.

Education policy

Education policy affects innovation in at least three ways: a high level of general and scientific education facilitates acceptance of technological innovation by society at large; innovation systems require well-educated researchers, teachers, extension officers, and producers to develop relevant innovations; it is generally easier for farmers and business operators with higher education and skills to adopt some technological innovations (Latruffe, 2010, OECD, 2011).

General context

There is no federal department of education nor an integrated national system of education. Departments or ministries of education in the provinces and territories are responsible for the organisation, delivery, and assessment of education at the elementary and secondary levels, for technical and vocational education, and for postsecondary education. Some jurisdictions have separate departments or ministries, one having responsibility for elementary-secondary education and another for postsecondary education and skills training.

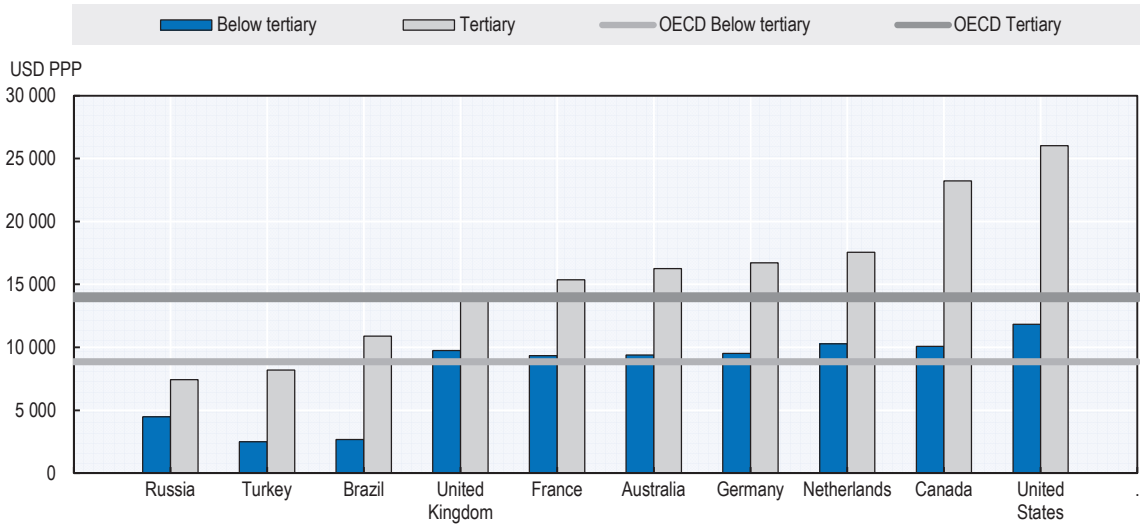
While there are many similarities in the provincial and territorial educational systems across Canada, there are significant differences in curriculum, assessment, and accountability policies among the jurisdictions that express the geography, history, language, culture, and corresponding specialised needs of the populations served.

Local governance is usually entrusted to school boards, school districts, school divisions, or district education councils. Their members are elected by public ballot. The power delegated to the local authorities is at the discretion of the provincial and territorial governments, and generally consists of the operation and administration (including financial) of the group of schools within their board or division, curriculum implementation, responsibility for personnel, enrolment of students, and initiation of proposals for new construction or other major capital expenditures (CMEC, 2013).

The Canadian education system is comprehensive, diversified, and widely accessible. As a result, Canada has a highly educated population, due in large part to high attainment rates at the college level. In 2012, close to 90% of the population aged 25 to 64 attained at least upper secondary education, and 53% of Canadian adults held a tertiary qualification, the highest share among OECD countries (OECD average: 32%) (OECD, 2014). At 57% respectively, this latter percentage was higher for the younger generation (aged 25-34), indicating continuous progress in education achievements. Canada also ranks high in the number of scientists, engineering, and business graduates.

Total expenditures per student in public elementary and secondary schools averaged CAD 10 678 (current dollars) across Canada in 2007/08, up 35% from 2001/02 (Statistics Canada, 2010). Over the same period, the inflation rate in Canada was 14%. According to OECD statistics, Canada's annual public expenditure per student below tertiary education is close to the OECD average and to that of most countries with a similar level of development, but it is significantly higher for tertiary education, including R&D activities (Figure 5.5). In 2011, public expenditures on education accounted for 13% of public expenditure and 7% of GDP, both of which are close to the OECD average (Figure 5.6). The share of private funding is higher than the OECD average. In 2010, private expenditures accounted for about a quarter of total expenditure on education institutions on average, compared to 16% on average for OECD countries, while the share of private expenditure on tertiary education institutions reached 43% in Canada and 31% in the OECD area.

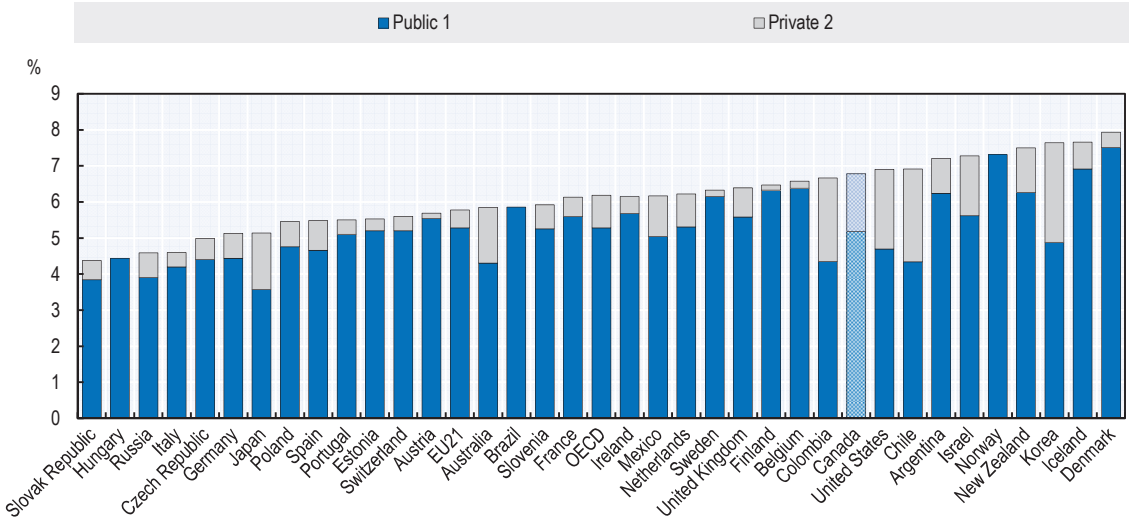
Figure 5.5. Average public expenditure per student by educational institutions, 2011



Source: OECD (2014), *Education at a Glance 2014: OECD Indicators*, OECD Publishing, Paris.
DOI: http://dx.doi.org/10.1787/eag-2014-en.

StatLink http://dx.doi.org/10.1787/888933250433

Figure 5.6. Public and private expenditure on educational institutions as a percentage of GDP, 2011



Data for Canada refer to 2010 and for Chile 2012. EU21: EU member states that are members of the OECD.

1. Public expenditure includes public subsidies to households attributable for educational institutions, and direct expenditure on educational institutions from international sources.

2. Private expenditure is net of public subsidies attributable for educations institutions.

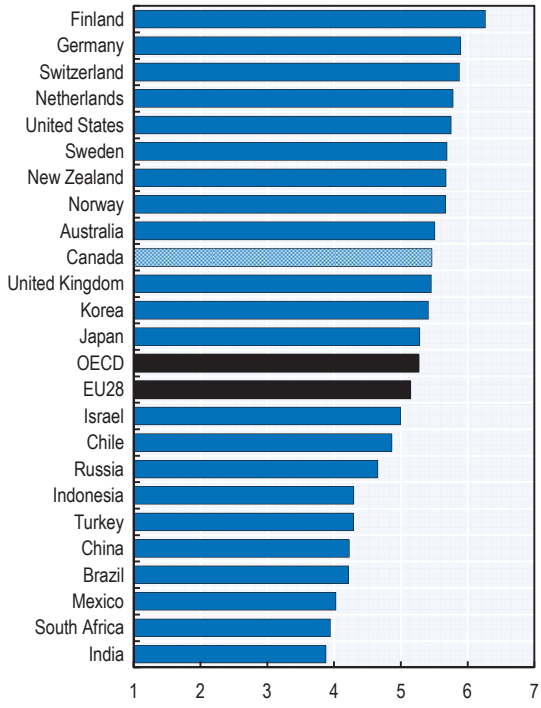
Source: OECD (2014), *Education at a Glance 2014: OECD Indicators*, OECD Publishing, Paris.
DOI: http://dx.doi.org/10.1787/eag-2014-en.

StatLink http://dx.doi.org/10.1787/888933250447

Figure 5.7. Global Competitiveness Index: Higher Education and Training, 2013-14

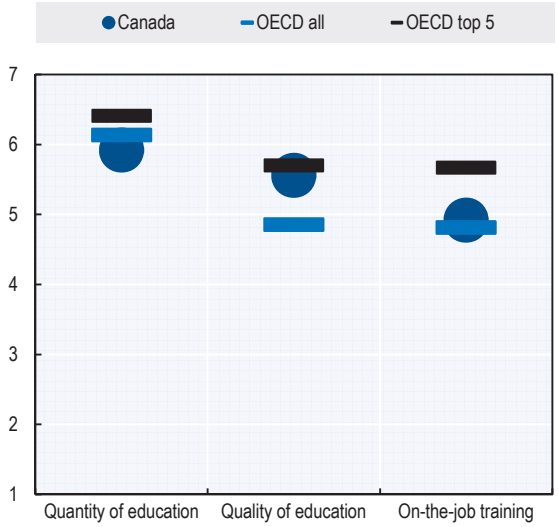
Scale 1 to 7 (best)

A. Index of higher education and training, by country



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

B. Canada's index of higher education and training by component



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

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

Source: World Economic Forum (2013), *The Global Competitiveness Report 2013-2014: Full data Edition*, Geneva. Executive Opinion Survey; Data for the Quantity of education index comes from UNESCO Institute for Statistics. http://reports.weforum.org/the-global-competitiveness-report-2013-2014/#.

StatLink http://dx.doi.org/10.1787/888933250455

Canada's secondary education system performs well, with a high rate of educational enrolment and achievement. Canada scores high in the OECD Survey of students performance (PISA), ranking 5th among the 34 members of OECD for reading literacy, 6th in science knowledge and 7th in mathematics.[18] Moreover, Canada is better than many OECD countries at helping low-income children achieve learning in public schools (OECD, 2014).

The tertiary education system in Canada also performs well in fostering a skilled workforce with generally good labour-market outcomes and is internationally recognised for its research contributions. The OECD survey of adult skills (PIAAC) found that Canadian adults rank near the OECD average on numeracy and literacy skills development, while Canadian youth rank above average.[19] However, this performance reflects higher education rates and Canada falls below the OECD average when compared with people with the same level of education (OECD, 2014). As in other OECD countries, highly skilled workers are rewarded by higher employment rates and higher employment income (OECD, 2014).

According to WEF Global Competitiveness Index, which is based on an executive opinion survey, Canada is among the top 5 OECD countries in terms of quality of higher education (Figure 5.7). This index reflects business executives' assessment of: how well the educational system meets the needs of a competitive economy; the quality of math and science education in schools; the quality of business schools; and the prevalence of widespread Internet access in schools. According to business executives, provision of on-the-job training in Canada, i.e. the availability of high-quality, specialised training services and the extent to which companies invest in training and employee development, is at the OECD average.

Agricultural education

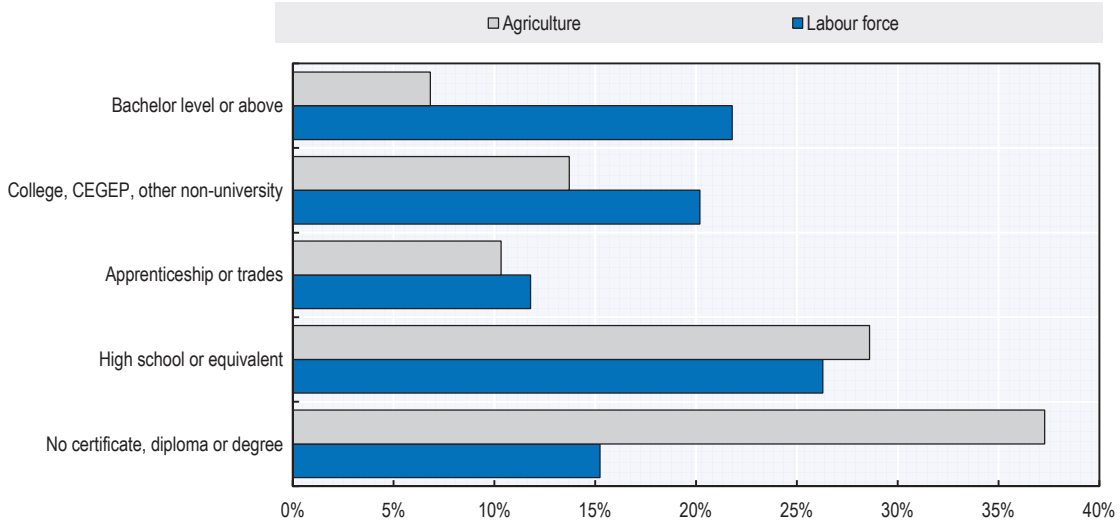
Agriculture education is integrated in the general system. The sector's perceived lack of attractiveness appears to be a barrier to enrolment and, as in several other sectors, there seems to be a mismatch between skills and labour market needs.

New technologies and increasing mechanisation in the food and agriculture sector are requiring new knowledge and skill sets. As technology becomes more sophisticated, the need for educated workers will likely increase and ongoing training will continue to be an issue.

Education levels in the food and agriculture labour force

According to the most recent population census, the agriculture sector has a higher share of workers without a high school diploma than the overall labour force – 37% compared to 15% (Figure 5.8). The share of the agriculture labour force with certificates or diplomas is comparable to the total labour force, but is lower for university education (AAFC, 2012b).

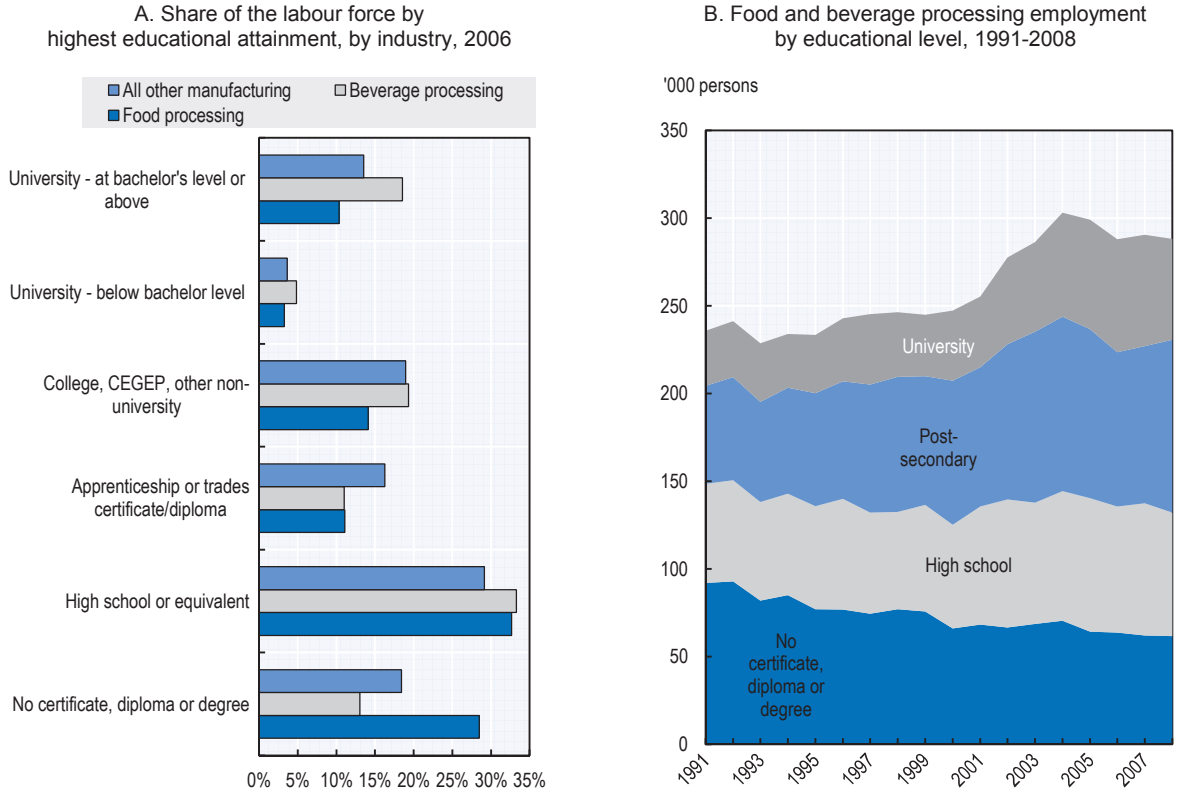
Figure 5.8. Labour force by highest educational attainment, share by industry, 2006



CEGEP: collège d'enseignement général et professionnel.
Source: Statistics Canada, Census of Population, 2006.

StatLink http://dx.doi.org/10.1787/888933250460

Figure 5.9. Education level in the food industry, 2006



CEGEP: collège d'enseignement général et professionnel
Source: Statistics Canada, Census of Population, 2006.

Source: Statistics Canada, Labour Force Survey, special tabulation.

StatLink http://dx.doi.org/10.1787/888933250473

Similarly, food processing has a higher share of workers without a high school diploma (about 28%) than the rest of the manufacturing sector (18%). In general, workers in beverage processing have higher education levels compared to food processing, where almost 35% of workers have at least a high school diploma as the highest level of educational attainment (Figure 5.9).

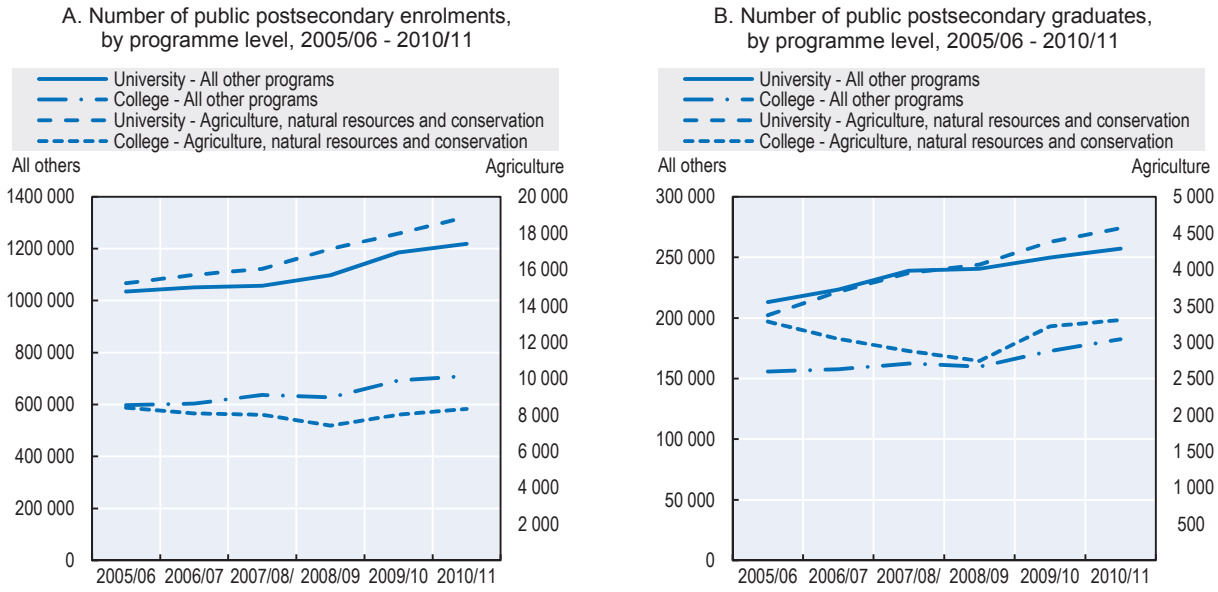
Similarly, food processing has a higher share of workers without a high school diploma (about 28%) than the rest of the manufacturing sector (18%). In general, workers in beverage processing have higher education levels compared to food processing, where almost 35% of workers have at least a high school diploma as the highest level of educational attainment (Figure 5.9).

Enrolment trends

Annual data indicates that the number of enrolments in **agriculture**-related university degrees rose steadily between 2005/06 and 2010/11. The trend in the number of graduates is similar over the same period. Enrolments and graduates in agriculture college programmes dropped in 2008/09 but have increased back to 2005/06 levels recently (Figure 5.10).

Several colleges and other post-secondary institutions offer educational programmes in **food processing** (Food Processing HR Council, 2011, p. 23). There were over 5 000 students enrolled in such programmes in 2008, with, 1 000 graduates. Some 2 000 of these students were enrolled in food processing apprenticeship programmes in 2008. At the high school level, no programmes specifically related to food processing are available.

Figure 5.10. Enrolment and graduates in agriculture college programmes, 2005/06 to 2010/11



Source: Statistics Canada, "Post-Secondary Student Information System", CANSIM Table 477-0019 and 0020.

StatLink http://dx.doi.org/10.1787/888933250487

The number of enrolments in food and food processing-related programmes continues to increase (Food Processing HR Council, 2011, p. 23). The Canadian Faculties of Agriculture and Veterinary Medicine (CFAVM) acknowledge that enrolments have been stable or rising after a period of modest decline (CFAVM, 2013). Based on the latest enrolment figures (2010-11) at Canadian agri-food and veterinary medicine faculties, graduates in 2010-11 were distributed over ten specialisations, the highest being in food (25%), environment (12%) and other (32%).

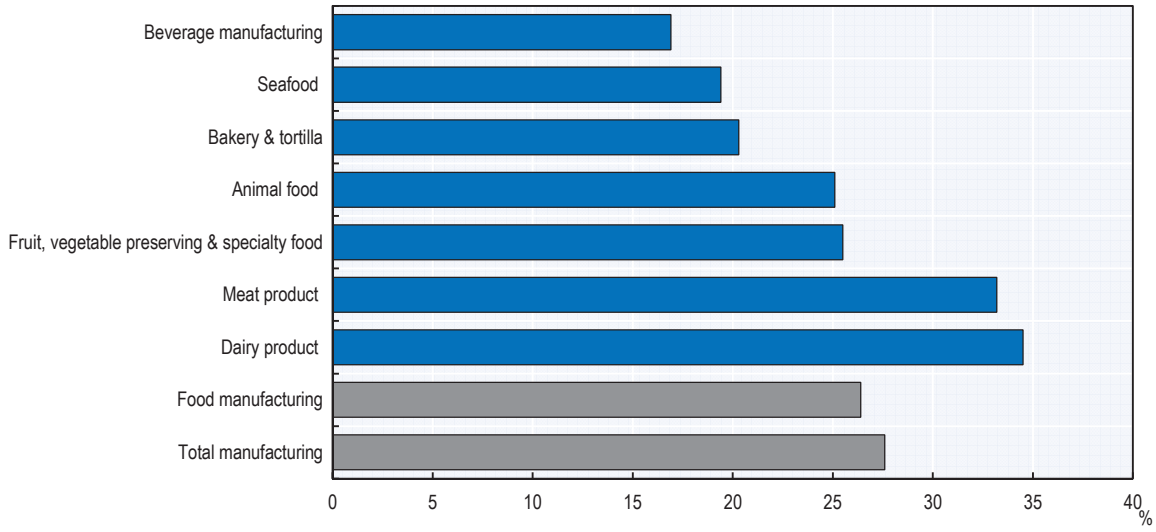
The growth in enrolments at the regional level has been greatest at the University of Manitoba and the University of Alberta. Demographically, two-thirds of new students are female and over half are foreign students. Course offerings in all faculties are broadening beyond traditional agri-food disciplines, but the CFAVM notes that highly qualified people (HQP) development across universities is limited despite well-established collaboration on research.

Matching demand

Agriculture and food employers have indicated that recruiting and retaining qualified and reliable workers is a concern. Universities in provinces also mention the difficulty of keeping up with growing and changing needs, despite efforts to attract students and adapt programmes to future labour market demand.[20]

A number of studies show that it is difficult to fill vacancies in agriculture (e.g. Mussell and Stiefelmeyer, 2005) and producers have indicated that job advertisements have resulted in no hiring because the appropriate skills could not be found.

Figure 5.11. Share of enterprises in the food processing sub-industry that face obstacles to innovation due to lack of skilled labour, by food processing sub-industry, 2009



Source: Statistics Canada (2009), *Survey of Innovation Business Strategy, 2009.*

StatLink http://dx.doi.org/10.1787/888933250496

Recent studies of the food processing industry also report that firms face obstacles due to skilled labour shortages. A recent innovation survey indicates that over 25% of firms in food processing reported lack of skilled labour as an obstacle to innovation (Figure 5.11). Relatively more firms in meat and dairy processing faced this obstacle compared to the rest of the industry. In 2009, over 25% of food processing firms claimed that they were slow to innovate due to a lack of skilled labour, while 27% of firms in overall manufacturing reported this as an obstacle (Statistics Canada, 2009). Most stakeholders surveyed by the Food Processing HR Council indicated that the current number of spaces in post-secondary programme available does not adequately meet the needs of the industry, particularly in the case of skilled workers (e.g. butchers, meat cutters, bakers, blenders).

Some provinces report important excess demand of skilled labour in food and agriculture (for example three to one in Ontario where the sector is booming). They also note the higher enrolment of foreign students. The Canadian Faculties of Agriculture and Veterinary Medicine (CFAVM, 2013) notes that by graduation, University of Manitoba graduates in the sector have had 1.85 job offers and that there have been no involuntary unemployed graduates from veterinary programmes.

The public's perception of the food and agriculture sector has been identified as a significant barrier to attracting new entrants. In contrast to communications and marketing strategies that are attracting youth to other sectors, such as construction, retail, tourism, etc., many agricultural stakeholders have noted that the agricultural sector has not effectively marketed itself to youth and/or other potential entrants (Canadian Agricultural Human Resource Council, 2009, p. 34). A number of initiatives, however, contribute to promoting careers in agriculture (Box 5.2).

For agriculture, there are various ways that governments are addressing the sector's labour needs: immigration programming, recruitment and retention initiatives, skills development and training, etc. (Box 5.1). Most initiatives exist at the provincial level. For example, Alberta supports internship programmes and cooperative training programmes, while research on these issues is important for Ontario and Quebec. Forward-looking planning and communication between the ministries, universities and industry are recognized by several provinces as being important. Saskatchewan, as well as a number of other provinces like Manitoba and Ontario, also distributes agricultural student scholarships.

In addition to collaborating with academia, the federal government works in partnership with industry to address the sector's labour needs (Box 5.3).

Box 5.2. Promoting careers in agriculture

Through the "**Working in Canada**" website, the Government of Canada provides customised reports that combine job postings, occupational profiles, labour market information and forecasts, certification and skills requirements, and training and education information. While the website does not specifically promote careers in agriculture, information on agricultural careers is available.

The government also funds **partnership-based projects** (that are national in scope and/or nationally significant) that support the development of labour market information, national occupational standards and certification/accreditation regimes. The goal of these projects is to help address skills shortages in strategic sectors of Canada's economy.

Promoting the positive attributes of Canadian products is seen as a key benefit to industry. AAFC uses a variety of external communication activities and initiatives to promote the benefits agriculture. For example, AAFC supports **Agriculture in the City** events which strive to increase the awareness of urban consumers about where their food comes from, how it is produced, and the science behind it. In 2010, Agriculture in the City events took place in Winnipeg, Manitoba and Burnaby, British Columbia, with attendance reaching over 25 000 and around 120 000, respectively.

Through federal-provincial-territorial government cost-shared programming, the Government of Saskatchewan has recently announced an "**Agriculture Awareness Initiative**" which will provide 50% funding to producers, commodity organisations, agribusinesses and agencies to develop and implement agriculture awareness and education activities. The Youth Leadership and Mentorship Program also provides funding in industry associations to co-ordinate and support mentorship between young producers and industry leaders.

In 2012, Farm Credit Canada launched "**Agriculture More Than Ever**", a multi-year initiative aimed at changing perceptions about agriculture and to close the gap in perceptions between producers and the public.

Agriculture in the Classroom organisations strive to enhance the knowledge, understanding, and appreciation of agriculture in everyday life. There are four provincial 'Agriculture in the Classroom' organisations (Ontario, Manitoba, Saskatchewan and British Columbia). In the other provinces, the provincial government (or the Federation of Agriculture in Newfoundland and Labrador) is administering Agriculture in the Classroom initiatives. There is also a national, informal network of provincial Agriculture in the Classroom organisations – Agriculture in the Classroom Canada – which aims to provide a national forum for provincial organisations to work together, share information and educational resources, develop programming, and coordinate professional development opportunities.

The **Canadian Agricultural Human Resource Council** is a national, industry-led, non-profit organisation focussed on addressing human resource issues facing agricultural businesses across Canada. It receives funding from the Federal Government. The organisation has recently developed a career pathway tool (**Agri-Pathways**) aimed at helping farm workers make informed choices on the types of skills and knowledge to acquire. It will also be useful to students and foreign trained workers who are exploring their potential entry into the on-farm sector.

Recruitment and retention has recently been studied by the Canadian Agricultural Human Resource Council (CAHRC, 2009), the Alliance of Ontario Food Processors (AOFP, 2004) and the Food Processing Human Resource Council (FPHRC, 2008). CAHRC is involved in two initiatives targeted at building career image in the agriculture sector, while both AOFP and FPHRC have begun work to identify and address (through their training programmes) issues related to retention of workers in food processing.

Box 5.3. Federal initiatives to address food and agriculture labour needs

Beginning in 2003, **sector-specific value-chain roundtables** (that include participation from across the value chain) were established by AAFC to strengthen industry-government partnership in order to address key issues in the respective sectors. The Horticulture Value Chain Roundtable in particular has had a labour working group that looks at a number of human resource issues including sector promotion and career awareness, skills and training, government policies and regulations, and innovation.

AAFC created a **Labour Task Force** in the fall of 2012 to review the labour challenges facing the agriculture, agri-food and seafood industries. The Task Force brought together representatives from government, industry and academia to find short and long term solutions to the concerns identified. It released its final report, a national Labour Action Plan (LAP)[1] for the agriculture and agri-food industry in 2013, which aims to both increase the supply of labour; and improve the knowledge and skills of workers. On the supply side, the plan includes measures to facilitate access to temporary and seasonal labour by reducing transaction costs, and measures to improve information on job and career opportunities for domestic labour, notably the development of an on-line jobs resource tool. On the skills improvement side, the plan proposes the development of an on-line learning resource tool to improve access to all forms of learning options; reviewing current programs to ensure they provide needed skills and knowledge, and improving Human Resource Management in businesses. The report recommended that the Canadian Agricultural Human Resource Council lead on the LAP, in collaboration with industry and relevant government partners.

Box 5.3. Federal initiatives to address food and agriculture labour needs (*cont.*)

The **Canadian Agricultural Human Resource Council (CARHC)** is connected to the Canadian learning system in a variety of ways. For example, the Canadian Association of Diplomas in Agriculture is an *ex-officio* member of the CAHRC Board of Directors; the Council maintains a close working relationship with the Association of Canadian Community Colleges; and several agriculture educational institutions are members of CAHRC project advisory groups (CAHRC, 2012, p. 15).

In addition, CAHRC and the Food Processing Human Resource Council (FPHRC), both supported by federal funds, are actively pursuing research and analysis in the areas of labour and human resource needs for the agriculture and food processing industries. The Councils work with industry leaders, governments and educational stakeholders to research, develop and communicate human resource strategies to address the challenges in employment, training and skills development in the agriculture and the food processing industry. Due to ongoing budgetary constraints, the level of government funding for industry-led groups has been reduced in some instances.

1. Addressing Labour Shortages in the Agriculture & Agri-Food Industry through a National Labour Action Plan, October 2013. http://www.cahrc-ccrha.ca/sites/default/files/ltf%20labour%20action%20plan%20-%20oct%2011%202013.pdf.

Notes

1. Regional Development Agencies in Canada, are: Atlantic Canada Opportunities Agency (ACOA); Canada Economic Development for Quebec Regions (CED); Canadian Northern Economic Development Agency (CanNor); Federal Economic Development Agency for Southern Ontario (FedDev Ontario); Federal Economic Development Initiative for Northern Ontario (FedNor); Western Economic Diversification Canada (WD).
2. PPP Canada: http://www.p3canada.ca/home.php.
3. FedNor Business Plan 2012-2013, http://fednor.gc.ca/eic/site/fednor-fednor.nsf/eng/fn03792.html#21.
4. Alberta Government, *Reasons to Invest*, http://www.albertacanada.com/business/invest/reasons-to-invest.aspx.
5. Manitoba Government, http://news.gov.mb.ca/news/index.html?archive=&item=17303.
6. Ontario Government, http://www.omafra.gov.on.ca/english/rural/edr/bre/index.html.
7. OSFI, 31 March 2012, cited on the Canadian Bankers Association website.
8. Canadian Bankers Association website: http://www.cba.ca/en.
9. Credit unions and caisses populaires are co-operative financial institutions, owned and controlled by their members. One of the fundamental principles of a credit union is democratic control.
10. Transport Canada website http://www.tc.gc.ca/eng/mediaroom/infosheets-canadapost-1770.htm.
11. Statistics Canada http://www.statcan.gc.ca/pub/81-582-x/81-582-x2007001-eng.htm.
12. Association of Universities and Colleges of Canada: http://www.aucc.ca/canadian-universities/facts-and-stats/.
13. Association of Universities and Colleges of Canada: http://www.accc.ca/xp/index.php/en/members/memberinstitutions.

14. Agri-Food Trade Service – Fact Sheets – Canada at a Glance: http://www.ats-sea.agr.gc.ca/stats/4679-eng.htm.

15. Pembina Institute – Renewable Energy: http://www.pembina.org/arctic/renewable-energy.

16. *Rural Innovation: Critical Issues Affecting the Innovation Capacity of Canada's Rural Regions,* Global Advantage Consulting Group and Blue Sky Strategy Group, 2010, unpublished contracted study.

17. Jurisdiction over immigration is a shared responsibility between the federal and the provincial and territorial governments. Under the Constitution, provinces and territories have the authority to legislate immigration matters, as long as such legislation is consistent with federal laws.

18. The Programme for International Student Assessment (PISA) is a triennial international survey which aims to evaluate education systems worldwide by testing the skills and knowledge of 15-year-old students. See http://www.oecd.org/pisa/pisaproducts/; http://www.oecd.org/pisa/keyfindings/pisa-2012-results-overview.pdf; and http://gpseducation.oecd.org/CountryProfile?primaryCountry=CAN&treshold=10&topic=PI.

19. The Survey of Adult Skills is a product of the OECD Programme for the International Assessment of Adult Competencies (PIAAC). http://www.oecd.org/site/piaac/.

20. For example, overall demand for new hires (directly from university) in Ontario is estimated to increase by 10% to 20% over the next few years, and the demand potential for Ontario Agricultural College graduates exceeds the supply offering (JRG consulting, 2012).

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AAFC (2012), *An Overview of the Canadian Agriculture and Agri-food System 2012*, Agriculture and Agri-Food Canada, available at: http://www.publications.gc.ca/site/eng/408552/publication.html.

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Chapter 6

Canadian agricultural policy: Structural change, sustainability and innovation

This chapter provides an overview of domestic and trade agricultural measures, outlining those supporting investment, the adoption of innovation or environmental practices, and the development of bio-products. It also reports trends on the level and composition of support and discusses the likely impacts of agricultural policy measures on structural change, environmental performance and innovation in the sector.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

Policy incentives

Domestic agricultural and associated trade measures affect farm investments and practices through a variety of instruments, with different impacts on structural change, sustainability and innovation.

OECD analysis has shown that measures that distort input and output markets, such as border protection, supply controls, output-based payments and variable input subsidies, reduce producers' incentives to use production factors more productively (OECD, 2012). As such, they hinder structural adjustment and discourage producers to innovate to become more competitive. These distorting measures can maintain resources in the sector that would otherwise be reallocated to more productive uses; they can encourage more intensive production, sometimes on marginal or fragile land; and they can encourage production practises that do not always take adequate consideration of longer term environmental sustainability.

Broad-based income support decoupled from commodity production is more effective in transferring income to producers and thus increasing their capacity to invest and innovate. It also leaves more flexibility to producers to undertake new activities and switch to new products. However, even if decoupled from production choices and targeted, income support slows structural adjustment needed to facilitate economies of scale, attract new entrants and thus foster innovation and productivity growth. If conditional on the adoption of environmentally-friendly practices, this support can improve sustainable resource use.

Agricultural measures that support innovation directly are likely to create stronger incentives and capacity for innovation among agricultural producers and will help structural change. Similarly, agri-environmental payments that target explicitly the desired environmental outcome would steer farmers towards innovative sustainable practices more effectively.

Domestic agricultural policy

Agricultural policy framework and main instruments

Agricultural policy in Canada seeks to create an innovative, competitive, adaptable and profitable sector. Most commodity sectors (e.g. field crops, red meat, horticulture) are export-oriented, while some commodity markets are focused on the domestic market and regulated by supply management (e.g. dairy, poultry and eggs), and marketing agencies. These products are supported through tariffs and production quotas that are tradable only within provinces, as well as a system of domestic price-setting.

The general agricultural policy framework is governed by joint federal, provincial, and territorial (FPT) agreements. The current five-year policy framework for the food and agriculture sector, which was implemented in April 2013, is **Growing Forward 2 (GF2)**. It builds on previous frameworks and continues to provide support for risk management tools, but with an emphasis on risks beyond business management capacity. It also stresses three broad priority areas: innovation; competitiveness; and market development, with new emphasis on innovation (AAFC, 2012).

Under this framework, the two main policy instruments to support an innovative, competitive, adaptable and profitable sector are **Strategic Initiatives** and **Business Risk Management (BRM) programmes**.

BRM programmes provide producers with risk management tools to help them manage risks due to market volatility and disaster situations. From 2007 to 2012, BRM programmes provided over CAD 12 billion in support to producers across Canada. These programmes are cost-shared 60:40 by the federal and provincial governments.

The programmes work together by providing protection for different types of losses, as well as cash flow options. The four BRM cost-shared programmes are:

- **AgriInvest**, which provides support to a producer-managed savings account, and thus subsidises farm savings.
- **AgriStability**, which provides some support in case of large declines in farm margins.
- **AgriInsurance**, which provides insurance (cost-shared premiums) against natural perils.
- **AgriRecovery**, which provides *ad hoc* disaster assistance.

GF2 **Strategic Initiatives** provide CAD 2 billion in funding over the five years of the framework, cost-shared between federal, provincial, and territorial governments, for flexible non-BRM programming to be implemented by provincial and territorial governments. Additionally, the framework provides federal funding of CAD 1 billion for the five-year period for three new federal programmes focused on strategic areas:

- **AgriInnovation** focuses on investments to expand the sector's capacity to develop and commercialise new products and technologies (Box 6.1).
- **AgriMarketing** helps the industry improve its capacity to adopt assurance systems, such as food safety and traceability, to meet consumer and market demands. It also supports industry in maintaining and seizing new markets for their products through branding and promotional activities. This programme consists of a combination of government initiatives and contribution funding for industry-led projects.
- **AgriCompetitiveness** targets investments to farmers and the agri-food industry to help strengthen the food and agriculture industry's capacity to adapt and be profitable in domestic and global markets. It comprises a combination of government initiatives and contribution funding for industry-led projects.

Box 6.1. AgriInnovation

The federal-only **AgriInnovation** Program of GF2 addresses the three stages of the innovation continuum: from research, to technology transfer, to the commercialisation and adoption of innovation. It contains three streams of innovation initiatives:

- The AAFC-led **Research Acceleration Innovation stream** addresses emerging science-based requirements of the sector through research development and knowledge transfer activities to identify and mitigate risks to production, keep pace with sustainability considerations, improve productivity and capture market opportunities. It targets far-from-adoption, cross-cutting research.
- The Industry-led **Research and Development stream** supports pre-commercialisation research, development and knowledge transfer for innovative agriculture, agri-food and agri-based products and processes. The Stream may provide financial support to approved applicants, and/or support in the form of collaborative assistance given by AAFC research scientists and experts for knowledge transfer. It provides support to two types of projects: Agri-Science Clusters and Agri-Science Projects
  - **Agri-Science Cluster** support aims to mobilise and coordinate a critical mass of scientific expertise in industry, academia and government. Funding is available to not-for-profit and for-profit applicants (the latter under certain conditions); partners can include AAFC researchers/resources (under a Collaborative Research Agreement). It is national in scope, industry-led, and addresses components of the sector's applied science plan under a single application. Maximum funding, in the form of a non-repayable contribution, is CAD 20 million over five years and requires industry contribution.
  - **Agri-Science Projects** are less comprehensive, but available for a single research project or a small set of projects. Their scope may be national, regional or local, and for profit and not-for-profit organisations are eligible. Maximum funding, in the form of a non-repayable contribution agreement, is CAD 5 million and requires industry contribution.
- The Industry-led **Commercialisation and Adoption stream** aims to facilitate the demonstration, commercialisation and adoption of innovative agri-based products, technologies, processes or services. This stream provides support to approved industry-led pre-commercial demonstration, commercial or adoption projects.

These federal initiatives are complemented by cost-shared programmes with provinces and territories, which are designed to reflect the innovation requirements unique to different provinces and territories to address the broader innovation objective of the country.

Source: AgriInnovation Program, http://www.agr.gc.ca/eng/?id=1354301302625.

Under the previous five-year policy framework, a number of policies and programmes, which expired at the end of March 2014, played a similar role in helping the industry to adapt and adopt new technology or practices, with a similar budget. They included:

- The Agricultural Flexibility Fund (AgriFlexibility),[1] a CAD 500 million five-year plan, which supported farm investment.
- The Agri-Processing Initiative (API), which provided repayable contributions to encourage increased investment in, and adoption of, innovative technologies and processes in agri-processing industries (co-operatives and for-profit companies incorporated in Canada), with a focus on new capital equipment and a budget of CAD 500 million over the five years.
- The Canadian Agricultural Adaptation Program (CAAP), which provided funding to industry-led small-scale projects. Recipients included farmers, cooperatives, marketing boards and companies. The programme budget was CAD 163 million over the five years.

Prior to the introduction of AgriInnovation, a number of agricultural programmes specifically targeted the creation, adoption and commercialisation of innovation in the sector, such as the Agricultural Innovation Program (AIP) in place between November 2011 and March 2013. The Agri-Opportunities Program (January 2007-March 2011) also provided repayable contributions towards capital and other costs to enable and accelerate the commercialisation of agricultural, agri-food and agri-based products, processes and services.

A number of federal and provincial initiatives support the development of bio-based industrial products (Box 6.2 and Table 7.A1.1).

GF2 intends a shift away from reactive income support towards programmes that protect producers from market and natural disasters, to include more proactive and strategic programming. It continues to allow flexibility for provinces and territories to design and deliver programmes outside of risk management that respond to regional priorities in support of shared national outcomes. Provinces can also determine the level of resources to be expended in the overall programme area of support within the agreed limits of the Framework Agreement.

A number of federal and provincial programmes facilitate access to credit for farmers, producer organisations or co-operatives (Box 6.3). Some programmes can in part contribute to developing operations and upgrading facilities, with positive impacts on innovation, but others are mainly to help cash flow.

Under the *Agricultural Products Marketing Act (APMA)*, the Federal Government may grant provincial entities, including boards and agencies, authority to "regulate the marketing of [any] agricultural product in interprovincial and export trade." The APMA grants provincial entities the power to enact regulations and instruments. In some cases, these powers include the authority to set production quotas and prices (i.e. supply management). The APMA also grants provincial entities the power to set levies on the interprovincial movement or export of agricultural goods. Provincial boards and agencies have enacted marketing regulations on storage and transportation; grading and quality; revenue pooling; maintenance of books, records, and marketing information; registration of farms; licensing of producers, wholesalers, processors, and truckers; and price setting. A wide range of products are covered, including mushrooms, potatoes, wheat, apples, asparagus, beans, berries, flue-cured tobacco, grapes, onions, soya beans, pork, maple syrup, pulses, and flax.

Box 6.2. Support for the development of bio-based industrial products

The Government of Canada has created specific programmes to encourage the bio-based sector, such as the Eco-Energy for Biofuels Initiative. Broader programmes are open to the bio-products sector and complement specific initiatives directed at bio-products and food-based sectors. Table 7.A1.1 presents the main federal initiatives encouraging the development of bio-based industrial products using:

- Targeted financial support to R&D, such as Agri-Innovation (Box 6.1), the Sustainable Development (SD) Tech Fund to support late development of clean air, water and land technology solutions, or the Eco-Energy Initiative.
- Support to capital investment for technological development, adoption and scale, such as Avrio Ventures (third section of Chapter 4); the Clean Energy Fund or investments in Forest Industry Transformation.
- Regulation with a commitment to develop a clear and predictable regulatory framework (Chapter 4).
- Policy to encourage the development of the bio-based industry from production to utilisation.
  - At the producer level, this includes the Canadian Biomass Network, the Industrial Bioproduct Value Chain Committee and the Cellulosic Biofuel Network;
  - At the industry level, the Canadian Renewable Fuel Strategy includes incorporation mandates (5% in gasoline and 2% in diesel); various biofuel and biomass initiatives, which provide support that is declining over time. Significant support now focuses on next generation biofuels; and the provision of information about bio-products in different areas (mapping tool).

In most provinces, policy strategies support the development of bioenergy and biogas production and consumption, by improving related regulation, demonstrating solutions, providing support, and establishing standards.

Provincial regulations include renewable fuel mandate, i.e. the requirement to use a certain percentage of renewable content in gasoline and in diesel (respectively 5-5% in British Columbia, 5-2 in Alberta; 7.5-2 in Saskatchewan, 8.5-8.5 in Manitoba, 5-2 in Ontario, 5-0 in Quebec, and 5-2 in New Brunswick).

Provincial financial incentives support include:

- Investment on sustainable infrastructure projects, in particular in the area of was management and energy or new and renewable energy (British Columbia); construction of transportation biofuel production facilities (Saskatchewan); biomass to energy conversion systems (Manitoba); innovative technologies such as renewable energy generation facilities, biotechnology (Ontario); or bioenergy (Quebec);
- The development of markets or value chains for biomass products (triticale and forestry in Alberta, bioproducts, renewable fuels and co-products in Ontario, biomass and biogas in PEI, wood in Quebec);
- The production of bioenergy products by providing biofuel and electricity producers a credit per litre or kWh (Alberta, Saskatchewan, Manitoba, Quebec);
- R&D to develop renewable bio-based feedstocks (Alberta); bio-products (Manitoba); the ethanol industry (Ontario); or innovation in general (New Brunswick); and
- R&D through tax credit (Saskatchewan).

Box 6.3. Agricultural credit programmes

The **Advance Payments Program** (APP) is a loan guarantee programme under which the Federal Government, *inter alia*, guarantees cash advances of up to CAD 400 000 provided by participating producer organisations to producers, based on the value of the eligible product (including livestock). These guarantees help the producer organisation borrow money from financial institutions at lower interest rates and issue producers a cash advance on the anticipated value of the farm product that is being produced and/or that is in storage. Loans are interest-free up to CAD 100 000 and repayable within 18 months.

The **Canadian Agricultural Loans Act (CALA)** programme of June 2009, replacing the previous Farm Improvement and Marketing Co-operative Loans Act (FIMCLA) programme, is a loan guarantee programme with expanded eligibility to start-up farmers, agricultural co-operatives and for inter-generational farm transfers. The maximum loan amount is CAD 500 000. Farmers can use these loans to establish, improve, and develop farms; while agricultural co-operatives may also access loans to process, distribute, or market the products of farming.

Provincial governments provide farming organisations with agricultural loan and credit guarantees. For example:

- Operating Credit Guarantees (OCG) for Agriculture is a programme run by Manitoba's Agricultural Services Organization (MASC) to assist producers in obtaining lines of credit from participating lending institutions. The OCG guarantees loans to be used for general farm expenditures, living expenses, farm improvements, current year's principal and interest payments on existing loans, and limited capital purchases. Under the OCG programme, MASC provides participating lending institutions with a 25% guarantee on an operating loan made to a farmer.
- The province of Alberta through its Agriculture Financial Services Corporation also offers a variety of similar services and credit guarantees to its eligible producers.

Under the **Price Pooling Program**, the Federal Government enters into an agreement with a marketing agency to facilitate the marketing of agricultural products under a cooperative plan. The agreement provides a price guarantee for products sold, allows marketing agencies to make initial payment to producers for products delivered and covers eligible marketing costs, to a fixed maximum. The price guarantee is set at a percentage (currently 65%) of the expected average wholesale price of the product. The guarantee triggers when the market price falls below the guarantee price. Once the entire agricultural product is sold, the actual average wholesale price is determined. If the calculated value is less than the eligible initial payment plus eligible marketing costs, the programme allows for a payment for the shortfall by the federal government. From 2011 to 2013, Price Pooling Program has had agreements with three to five marketing agencies per year and with a total guarantee amount of approximately CAD 34 to 45 million. According to Canadian authorities, no government expenditures have been incurred under the Price Pooling Program since 1997 (WTO, 2011). Both the APP and PPP are under the Agricultural Marketing Programs Act (AMPA).

Canada's approach to agri-environmental issues in agriculture includes regulations, voluntary measures and financial incentives for the adoption of environmentally-friendly practices. Provinces implement specific, sometimes local regulatory requirements that restrict agricultural practices (Box 6.4).

One issue with regulation on farm practices for innovation is that command and control regulatory approaches may prevent the adoption of innovative approaches. However, they can be adapted to local circumstances to allow or stimulate innovation. For example:

- The province of Prince Edward Island's Environmental Property Tax Credit Program requires that applicants be in compliance with the Environmental Protection Act as it pertains to buffer zone legislation. The regulations have been adjusted over time to reflect local conditions, such as the slope of land surrounding riparian buffer strips.
- Prince Edward Island regulations on potato growing practices include bans on farming on land with over 11% slope, rotations shorter than three years, and cultivating within 10 meters of a watercourse.
- New regulations governing vineyard waste management in the Niagara Region of Ontario require waste treatment facilities on site, which can be expensive. In order to comply in a cost-effective way, one winery has adapted a previously-constructed treatment wetland to pre-treat the winery waste. Constructed wetlands have been used to treat various waste streams, such as municipal wastewater and coal and metal mine drainage, but not for winery waste treatment in Ontario. Other small wineries in Ontario may also choose to voluntarily follow this innovative approach, which also provides a natural habitat for wildlife.

There are also examples where expectation of future regulations stimulates innovation even before regulations are in place. For example, the fertiliser company Agrium is using nanotechnology for fertilisers to release nutrients under specific conditions to reduce emissions of nitrogen-containing greenhouse gases. These technologies were developed prior to any regulations being put in place, but in anticipation that the new technologies would facilitate compliance with forthcoming regulations. Manufacturers of manure spreading technology have developed splash plates and injectors in order to diminish the odour, partly with the expectation that regulations on manure spreading would be expanded.

Box 6.4. The agri-environmental policy approach

Agri-Environmental programming at the federal level

The federal government encourages the adoption of innovative environmental practices mainly through cost-shared funding of farm-level programmes administered by provincial and territorial governments. There are two programmes (cost-shared between federal and provincial governments) that strive to advance environmentally sustainable agriculture: The Environmental Farm Plans (EFP) programs and the Environmental Stewardship Incentive programs. These programs are designed on a provincial/territorial basis and delivered through provincial agriculture departments or local third-party agriculture organizations. EFPs consist of an environmental assessment of farm management practices, and an action plan that details identified risks, and actions or practices to mitigate those risks. The Environmental Stewardship Incentive Programs provide cost-shared financial assistance to farms with an EFP to adopt specific beneficial management practices (BMPs), such as nutrient management, manure storage and soil erosion controls. These BMPs have environmental benefits within the regional context in which they are implemented, such as reductions in nutrient loading to water bodies.

In British Columbia and Ontario, the EFP is a no-charge, confidential and voluntary process, which helps farmers identify environmental strengths and risks on their farms, and actions to improve the environmental performance of their farm. In Quebec, the agri-environmental programmes are also achieved through EFP, with higher rates of adoption because one component of the EFP, the agri-environmental fertilisation plan is compulsory. As explained in a recent case study carried out in the context of OECD Green Growth work on support for the adoption of environmentally friendly practices in British Columbia, Ontario and Quebec (OECD, 2015), agri-environmental programmes often include knowledge transfer components.

Livestock and nutrient management regulations at the provincial level

Increasingly, Canadian provinces are mandating nutrient management plans through regulatory changes. Buffer strips around water courses and groundwater sources have become a common requirement to limit nutrient leaching. Under municipal by-laws, the location of manure storage, as well as setback distances from neighbouring properties or streams, may be regulated.

A number of provincial governments have in recent years introduced a range of measures to control environmental pollution from livestock operations. For example:

- The *Nutrient Management Act* in the province of Ontario sets out regulatory requirements for certain nutrient management practices and requires farmers to document these practices to reduce risk of water contamination by agricultural sources. The practices regulated include the management of manure (e.g. storage and application), application of non-agricultural materials (e.g. sewage bio-solids and vegetable processing wastes) and the treatment of manure and other materials in on-farm anaerobic digesters.

- Through its *Livestock Manure Mortalities Management Regulation* pursuant to the *Environment Act* – the province of Manitoba prescribes various requirements at the provincial level for the use, management and storage of livestock manure and mortalities in agricultural operations so that livestock are handled in an environmentally-sound manner. Pursuant to this general purpose, a permit is required for the construction, modification or expansion of a manure storage facility. Specific constraints such as maximum livestock population, fencing restrictions, restrictions to drainage and water work, apply on crown land.

- The province of Quebec's *Agricultural Operations Regulation* seeks to address the problem of diffuse pollution caused by agricultural activity, particularly by achieving a proper balance of phosphorous in the soil. It includes norms for livestock buildings and manure management, and restrictions on land use to limit water pollution.

Institutional changes

Historically, Western Canadian wheat and barley growers were required to sell their grain to the Canadian Wheat Board. In August 2012, the **Canadian Wheat Board** (CWB) monopsony ended, and it was transformed into a voluntary marketing organisation. This means that:

- Farmers are no longer restricted in delivering what the CWB requests in terms of wheat and barley, creating innovation opportunities for new varieties.

- They may process their own grain or enter into contracts with processers themselves, creating processing innovation opportunities.

- They may sell and/or export to the buyer of their choice, which may lead to shipping, logistics, or handling, etc., innovation opportunities.

In August 2012, a temporary five-year arrangement was introduced to authorise a "point of sale deduction" on wheat and barley deliveries to licensed facilities in Western Canada, in order to replace funding for research, market development and technical assistance that was previously provided by the Canadian Wheat Board under their single-desk structure. The funding is allocated to three recipients, the Western Grains Research Foundation, the Canadian International Grains Institute, and the Canadian Malting Barley Technical Centre, who use the funds to conduct research, market development and technical assistance activities in the wheat and barley industry.

Trade agricultural policy

Most import restrictions and export measures in agricultural markets are linked to domestic market price support arrangements, in particular for supply-managed commodities. For example, the dairy products market is protected by tariff quotas, prohibitive out-of-quota tariffs, and export subsidies. The applied MFN tariffs on dairy products, which averaged 228.5% in 2012, are the highest among all major product groups. In its latest notification on export subsidies to the WTO, Canada notified "producer financed subsidies" for four product categories (skimmed milk powder, cheese, other milk products, and incorporated products).[2] In addition, the Canadian Dairy Commission (CDC) also has State trading enterprises (STE) privileges in the implementation of Canada's tariff-quota commitment for butter (Table AIV.1). Import permits for the butter tariff quota have been allocated exclusively to the CDC with the requirement that these imports be directed to first-stage processors and further processors. With the exception of a few products in some provinces (e.g. fluid milk in the Atlantic Provinces), the majority of dairy products are traded freely between provinces (WTO, 2011).

Under export measures, the WTO Review of Trade Policy also mentions the federal *AgriMarketing* programme, which provides matching funding to activities to enhance the marketing capacity and competitiveness of the Canadian agriculture, agri-food, fish and seafood subsectors.

Simple average MFN import tariffs are relatively low for most products in Canada, and tariff quotas are generally filled except for products where Canada is a competitive exporter. However, because of high tariffs for some products, the simple average of applied MFN tariff for WTO agriculture sectors is relatively high (Figure 4.3).

In addition to the North American Free Trade Agreement (NAFTA) with Mexico and the United States, Canada is engaged in several bilateral trade agreements (with Panama, Jordan, Colombia, Peru, Costa Rica, Chile and Israel; and has recently signed one with Honduras. They usually cover agricultural products. In October 2013, Canada and the European Union reached a political agreement on the key elements of a Comprehensive Economic and Trade Agreement (CETA), which will remove over 99% of tariffs between the two economies and will affect trade of agricultural products, notably beef and cheese. The Canada-Korea Free Trade Agreement signed in March 2014 will result in the elimination of tariffs on 86.8% of agricultural tariff lines and will thus provide increased market access for Canada's key agricultural exports, including beef, pork, canola and grains. Canada is negotiating agreements with more countries or groups of countries, in Latin America, and Asia (e.g. India, Japan). It is, in particular, part of the Trans-Pacific Partnership Negotiations.

Level and composition of agricultural support to producers

OECD indicators of support to agriculture measure the extent to which: 1) the government supports individual producers' receipts (Producer Support Estimate as a percentage of gross farm receipts, %PSE); 2) it uses market-distorting instruments such as Market Price Support (MPS) to do so; and 3) it spends on providing general services to the sector (General Services Support Estimate, GSSE), as opposed to support individual producers. The classification of policy measures in the PSE and GSSE can also help identify to some extent which support is targeted to the adoption of innovation and sustainable practices.

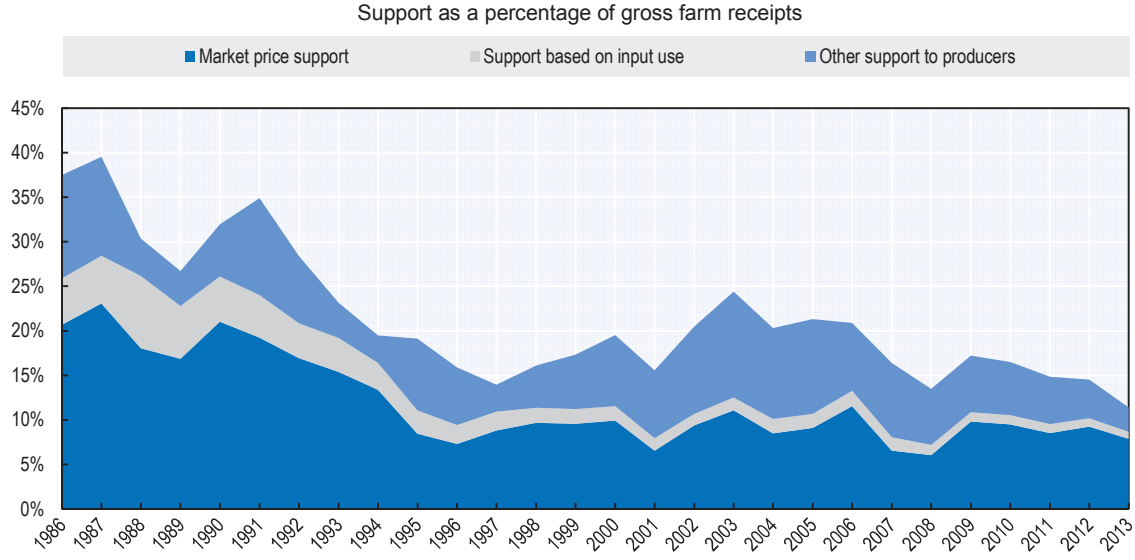
Major policy instruments in Canada that generate support to agricultural producers are variable in nature, depending on climatic and market conditions (Figure 6.1). Overall, support levels as a percentage of gross farm receipts have ranged between 12% and 18% in most years since the mid-1990s and have been consistently below the OECD average (Figure 6.3). For most commodities, prices received by producers are aligned with world market prices, but the domestic price of supply-managed commodities is well above world levels: in 2010-12, prices received by milk producers were double world price levels and those received by poultry and egg producers were a third higher.

Overall, MPS typically accounts for 50-60% of total support to producers (OECD, 2014, Table A.5). The remainder is dominated by budgetary payments, which for the most part compensate for farm income losses, and are often paid per hectare. Support based on input use is mainly to support innovation (investment support and provision of services) and also for risk management. It accounted for about 7% of the PSE in recent years (OECD, 2014, Table A.5). In addition, Canada does not impose any constraints on payments received by producers, or grant significant payments for the adoption of agri-environmental practices (OECD, 2014, Figure 2.9).

The share of most distortive forms of support – MPS and support based on output and unconstrained variable input use – is higher than the OECD average (Figure 6.2). The three supply-managed sectors - dairy, poultry and eggs - are the most distorted and least performing of all sectors OECD, 2014, Chapter 4).

For other commodities, support for risk management increased farmers capacity to invest but did not create specific incentives to adjust and innovate. Farmers did innovate mainly to respond to market incentives. Direct government incentives to innovation were limited, and their increasing importance in the current policy framework is not yet reflected in PSE indicators, which cover the period up to 2013.

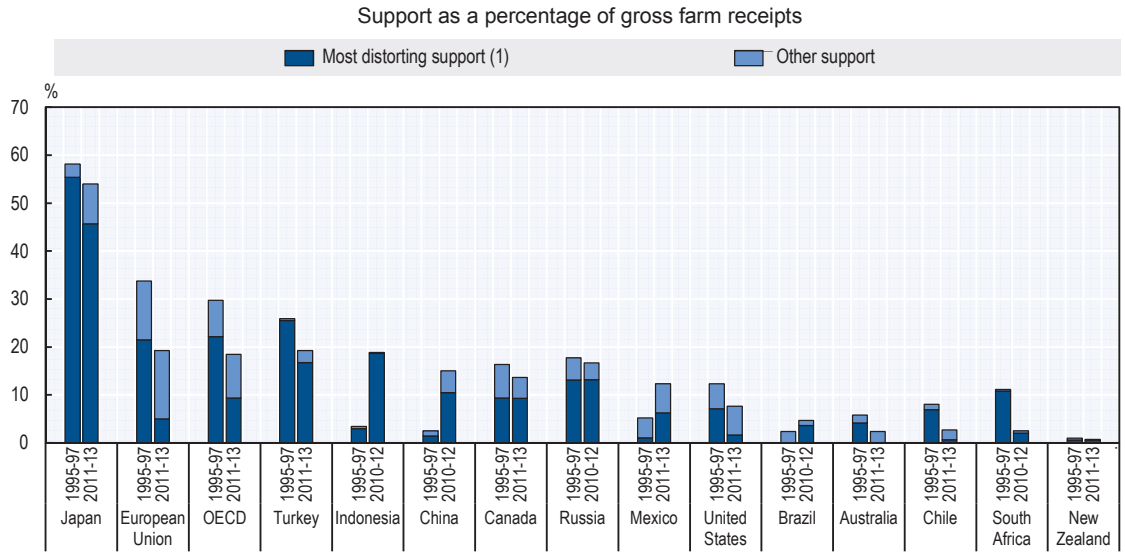
Figure 6.1. Evolution of support to Canadian producers, 1986-2013



Source: OECD (2014), "Producer and Consumer Support Estimates: Agricultural support estimates 2014", *OECD Agriculture Statistics* (database).
DOI: http://dx.doi.org/10.1787/data-00705-en.

StatLink http://dx.doi.org/10.1787/888933250504

Figure 6.2. Level and composition of support to producers across selected countries, 1995-97, 2011-13



European Union: 27 member states in 2011-13 and 15 member states in 1995-97.

1. Most production and trade distorting support includes support based on output and variable input use without input constraints.

Source: OECD (2014), "Producer and Consumer Support Estimates: Agricultural support estimates 2014", *OECD Agriculture Statistics* (database).
DOI: http://dx.doi.org/10.1787/data-00705-en.

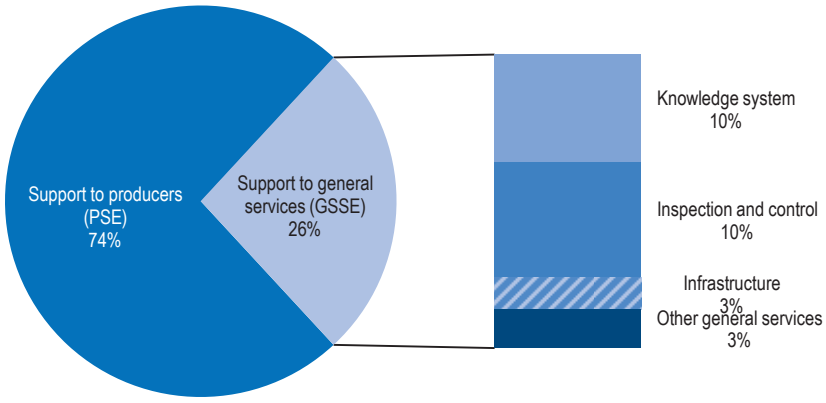
StatLink http://dx.doi.org/10.1787/888933250513

Total support to the agricultural sector

In addition to policies that support agricultural producers, governments also support general services to the sector, such as agricultural R&D, education, extension, inspection and control, and infrastructure investments, which all have a positive long-term impact on agricultural innovation and productivity growth. General services also include marketing and promotion of agricultural products and public stockholding. In this report, government action in providing general services is considered in sections corresponding to the general policy action. For example, government role in agricultural R&D and extension is reviewed in Chapter 7 on the agricultural innovation system, and agricultural education is part of the third section of Chapter 5 on education policy. Government expenditures on these services are accounted for in OECD support indicators in the GSSE. Their importance in total support to agriculture versus support to individual producers reflects the policy emphasis on providing long-term benefits to the sector.

In Canada, support to general services accounts for a quarter of total support to agriculture (Figure 6.3), a share close to the OECD average and only higher in countries with very low producer support levels (Figure 6.4). This reflects the historical focus of agricultural policies towards market and income support.

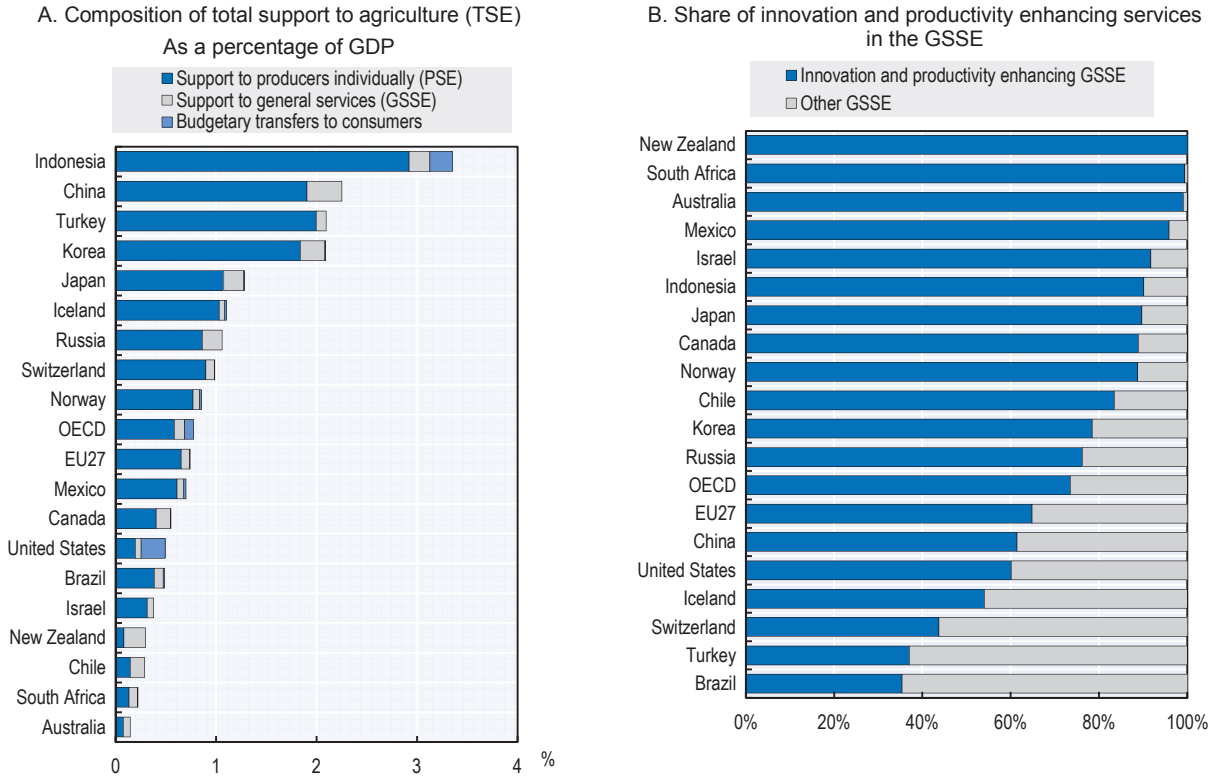
Figure 6.3. Composition of support to agriculture in Canada, 2011-13



1. Support to agriculture, as measured by the OECD Total Support Estimate (TSE), is the sum of support to agricultural producers PSE), support to general services to the sector (GSSE) and budget transfers to consumers, which are zero in Canada.
Source: OECD (2014), "Producer and Consumer Support Estimates: Agricultural support estimates 2014", *OECD Agriculture Statistics* (database).
DOI: http://dx.doi.org/10.1787/data-00705-en.

StatLink http://dx.doi.org/10.1787/888933250526

Figure 6.4. Composition of support to agriculture across selected countries, 2011-13



EU27: European Union with 27 member states.
Innovation and productivity enhancing GSSE includes Agricultural knowledge and innovation systems, Inspection and control, Development and maintenance of infrastructure without Farm restructuring. Data for Brazil, China, Indonesia, Russian Federation and South Africa represent 2010-12.
Source: OECD (2014), "Producer and Consumer Support Estimates: Agricultural support estimates 2014", *OECD Agriculture Statistics* (database).
DOI: http://dx.doi.org/10.1787/data-00705-en.

StatLink http://dx.doi.org/10.1787/888933250534

Among general services, most is enhancing innovation and productivity and thus supporting long-term competitiveness (Figure 6.4). Over the period, public expenditure on investments in infrastructure development for agriculture, often funded at provincial level, has increased faster than inflation. This is a positive development as investments in infrastructure improve the enabling environment for innovation, but the share of those expenditures in relation to GDP is low. The share of support for innovation-related activities such as agricultural R&D, education and extension in GDP is higher in Canada than in the average of OECD countries, but government expenditure in these areas has decreased in real terms (OECD, 2014). As explained in Chapter 7, this partly reflects the growing role of non-government actors and funding in these activities, and the relative disengagement of the government in some areas like extension services.

Notes

1. http://actionplan.gc.ca/en/initiative/agricultural-flexibility-fund.
2. [G/AG/N/CAN/92] cited in WTO (2011).

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Chapter 7

The Canadian Agricultural Innovation System

This chapter outlines the role of a well-functioning agricultural innovation system in ensuring good use of public funds, and higher responsiveness to the needs of 'innovation consumers' through improved collaboration between public and private participants, including across national borders. A well-functioning agricultural innovation system is key to improving the economic, environmental and social performance of the food and agriculture sector. The long-term positive impact of agricultural R&D on productivity growth is well established, and technologies and practices can help improve the sustainability of natural resource use.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

General innovation profile

Agriculture innovation is increasingly dependent on general innovation, through developments in ICT, biotechnology and nanotechnology, but also marketing innovation. 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.

Industry Canada, the federal department for industry, is responsible for Canada's Federal Science and Technology Strategy. Under the Economic Plan released in 2006 (Advantage Canada), a science and technology strategy was introduced. [1] It sets broad government direction and has been used as a tool to establish and lead to the development of innovation and collaboration priorities (e.g. an Entrepreneurial Advantage, a Knowledge Advantage, and a People Advantage). In late 2012, the Minister of State for Science and Technology was mandated to update the Science and Technology Strategy.

The National Research Council of Canada (NRC),[2] which reports to Industry Canada, is the Government of Canada's premier organisation for R&D, working with clients and partners and providing innovation support, strategic research, scientific and technical services. The NRC's **Industrial Research Assistance Program** (IRAP) provides support to small and medium-sized enterprises in Canada in the development and commercialisation of technologies. Industry Canada also has as an advisory body, the *Science, Technology and Innovation Council (STIC)*, which provides advice and benchmarking reports every two years. However, very little of the benchmarking data is broken down by sector, such as for the agricultural sector.

There are a number of granting agencies such as the National Sciences and Engineering Research Council of Canada (NSERC), the Social Sciences and Humanities Research Council of Canada (SHRCC) and the Canadian Institutes of Health Research (CIHR) which provide public funds to support research and development, and innovation in targeted areas. Each of these organisations sets priorities consistent with the Government general strategy. Provincial governments have a similar budget setting process and are able to fund universities and colleges within their jurisdiction to concentrate on provincial agricultural innovation priorities.

Agricultural innovation stakeholders may participate in government innovation programmes not specifically targeted to agriculture. These are usually considered competitively-allocated, given any sector can compete for the programmes and funding, or can access the services. Certain policy-driven programmes are dedicated, for example, to space research or ICT and are exclusive to those sectors. Agricultural innovation systems have cross-linkages to other sectors (e.g. health, environment, energy, etc.). There is consequently a relatively high degree of complexity when positioned in the general innovation system.

In its third and most recent report, STIC tracks progress on science, technology and innovation (STI) since 2008 and identifies five key indicators as strategic areas for improvement:

- Business Enterprise Expenditure on R&D (BERD) as a share of GDP.
- Business investment in Information and Communications Technologies.
- Higher education expenditures on R&D (HERD) as a share of GDP.
- Science and engineering doctoral degrees granted per 100 000 population.
- Share of human resources in science and technology.

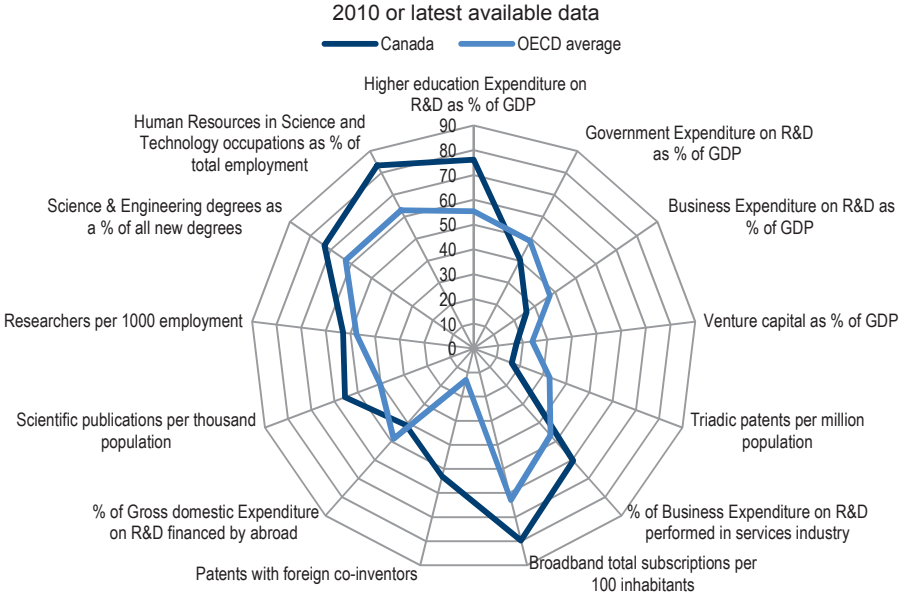
Investigating Canada's innovation profile, the 2012 OECD Economic Survey of Canada (OECD, 2012, Chapter 1) found that the public supply of knowledge is rich, as measured by two key indicators: scientific articles per capita (quality adjusted for journal ranking) and spending on higher education R&D in proportion to GDP, which is fourth highest in the OECD (Figure 7.1). The public

education system has likewise apparently kept up with the needs of the knowledge economy. The workforce displays a high share of human resources in science and technology. Science and engineering degrees, as well as the number of researchers, are slightly above their respective OECD averages. Innovation policy as a whole is still mainly viewed through a traditional S&T lens, centred on the universities, though this is slowly changing in line with growing recognition of a commercialisation gap between academic and applied research. Overall, the Global Innovation Index ranks Canada's innovation capacity favourably and as consistent with its high per capita GDP. According to the Global Innovation Index 2014, Canada ranks 12th, with 92% of the maximum score (Cornell University, INSEAD, and WIPO, 2014). Yet Canada ranks much lower in innovation efficiency, indicating an overall poor return in terms of innovation output for the corresponding input.

Business expenditure on R&D (BERD) and patenting, which are positively correlated, are two areas where Canada does not perform well compared to other OECD countries. This might seem surprising, given both the quality of its human capital and the level of fiscal support given to business innovation, the third highest in the OECD. No other country among a group of high R&D spenders (EC, 2009) displays such a large divergence between human resources and research infrastructure, and firm R&D and patenting activity. It should nevertheless be noted that Canada performs well compared to other OECD countries for the incidence of innovation, as measured by innovation surveys (OECD, 2009).

The imbalance between world class academic research and lacklustre business R&D has led policy makers to re-examine the linkages between academia and business. The recent Review of Federal Support to R&D – Expert Panel Report, also known as the Jenkins report (Government of Canada, 2011), recommended that the National Research Council (NRC) – which governs the main public research institutes – be reconfigured to be more focused on demand-driven applied research better able to serve the needs of businesses. This refocusing has already gotten underway, and in its new budget the federal government has committed to carrying it further. The relatively high level of broadband penetration, thanks to strong public support, has also provided critical infrastructure for enhancing the spill-over benefits of public and private innovation (Figure 7.1).

Figure 7.1. Science and innovation profile of Canada



Source: OECD (2012), *OECD Economic Surveys: Canada, 2012*,
DOI: http://dx.doi.org/10.1787/eco_surveys-can-2012-en.

Overview of agricultural innovation system's actors and respective roles

Agricultural innovation systems 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. They are commonly categorised as government, research, industry, academia, other organisations, such as non-profit organisations, and markets.

Table 7.1 provides an overview of the key players in the Canadian agricultural innovation system and their main roles, while Figure 7.2 puts the above roles in the context of the innovation continuum. Different players within a category can have quite distinct roles: federal and provincial levels of government for example, universities and colleges, or large multinational enterprises versus small local ones.

Table 7.1. Key players in the Canadian Agricultural Innovation System

Categories	Key players	Main roles
Government	• Federal • Provincial • Local (municipalities)	Strategy, governance, information; Enablers (performer and funder of R&D); and Economic stimulators
Research	• Research institutes	Knowledge generators (performer of R&D)
Academia	• Universities • Colleges	Developers of talent; and Knowledge generators
Industry	• Farms (corporate, family) • Firms (food processors, SMEs, MNEs, new ventures) • Input Industries[1]	Innovators: Funders, performers, marketers, adopters, implementers.
Other organisations	• Innovation Intermediaries • Associations[2]	Facilitators[3]
Markets	• Consumers, representatives	Information on demand

SME: small to medium-sized enterprise; MNE: multinational enterprise.

1. Suppliers of innovation in areas such as farm inputs, equipment, packaging materials, etc.

2. Trade and sector-based representative associations (canola, pulses, etc.) are prevalent in the agricultural sector.

3. Governments also may facilitate; however, the organisations lobby and inform federal and provincial governments, work with academia, and engage the industry. Although government roles such as networking and acting as a catalyst for collaboration resemble facilitation, they are seen as being included under the Enablers role.

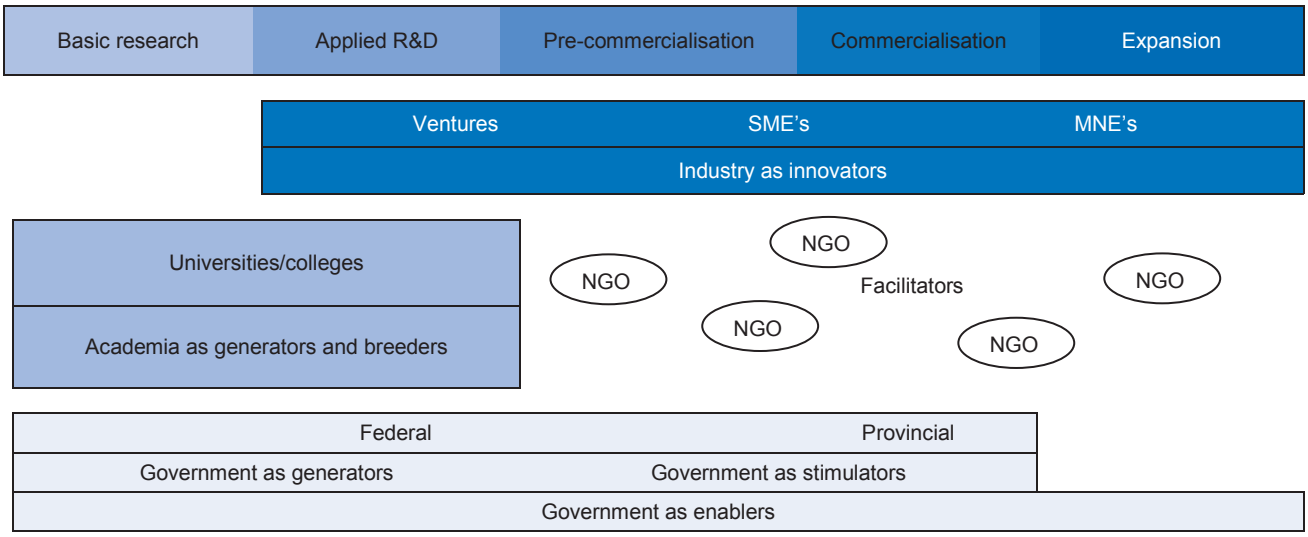
Source: Agriculture and Agri-Food Canada (AAFC).

In Canada, **industry**, as the primary "innovator", plays a key role in generating new ideas, technologies, processes, organisational and marketing methods, bringing them to market through commercialisation, and adopting or implementing them, with all other players performing important supporting roles. Industry can be involved in all stages and functions along the innovation continuum, although it typically involves less pure (basic) research and more of an application of innovation towards business objectives. Innovation also occurs in industry that does not necessarily draw from science, but entails new business models, organisational practices, processes and marketing methods arising from non-science disciplines.

Canadian **farmers** are adopting new and innovative practices such as no-till or precision farming and are continuously improving their seed (or breed) quality and varieties. Food processing industries include a large range of enterprises from multinational enterprises (MNE) to SMEs. MNEs in Canada diffuse innovation globally more quickly, often have in-house R&D capabilities, and tend to be concerned more about regulatory barriers to innovation. On the other end, SMEs tend to be more

concerned about financing and growth. Input industries are a highly-used source of innovation in the agriculture and food sector, which ranges from new pesticides or fertiliser technologies at the farm level, to new packaging at the food processing level.

Figure 7.2. The role of innovation actors along the innovation continuum



SME: Small to medium-sized enterprise; MNE: multinational enterprise; NGO: Non-Governmental Organisation.
Source: Agriculture and Agri-Food Canada (AAFC).

Biotechnology is an R&D-intense component of the agricultural sector and is somewhat unique from other sectors. In general, it takes 10-15 years and approximately CAD 1.5 billion to commercialise a biotechnology product. 80% of Canadian biotechnology companies are privately owned. The majority of the sector is made up of SMEs: in 2005 roughly three-quarters of biotechnology companies had less than 50 employees (van Beuzekom and Arundel, 2009, quoted by Genome Canada, 2011).

Government has played a leading role in providing an enabling environment for innovation and supporting innovation through funding and performing research and development (R&D), training and extension, through its policies, programmes and investments, especially in areas of public good where the private sector has less incentive to invest. There are three main levels of government, federal, provincial and local (municipal). Both innovation and agriculture are shared jurisdictions between federal and provincial governments, although at an aggregate level, the federal government would seem to have a larger role in innovation than the provinces. Table 7.2 delineates some high-level differences between the roles of the provincial and federal governments. Most federal contributions are in R&D (researcher salaries, and research and innovation programmes), whereas provincial contributions are spread between research, extension and education (Figure 7.5).

In agriculture, the government has been a performer of R&D for over 125 years. AAFC has science and technology transfer capacity distributed across the country in a network of 19 research centres, farms and labs, and outreach offices (Annex 7.A3). The organisational structure aligns with three agriculture ecosystems: Coastal, Prairie/Boreal Plain, and Mixedwood Plain (Figure 7.11), allowing delivery of national research, development and technology transfer to be tailored to regional needs. As a result, the federal government performs a relatively higher proportion of R&D than at the broader economy-wide level (across all sectors).

Table 7.2. Differences between federal and provincial government: Roles in innovation

Government	Federal	Provincial
Working with other levels of government	• Outward focus on multinational research and innovation, bilateral, international bodies of governance and grand challenges. • Inward focus on provincial relations.	• Inward focus on local (municipal) and regional innovation clusters and provincial economic priorities. • Some provincial work with international partners in areas of specialised interest.
Interaction with sector and NGOs	• Deals with national NGO's and tends towards sub-sectors with greatest national impact.	• Relatively closer to Provincial NGO's and sub-sectors relevant to provincial interests.
Innovation programming	• Typical five-year window evolves with Growing Forward frameworks.	• Many rely on federal-provincial joint funding. • Different provincial approaches. • Smaller provinces may not have critical mass for certain types of programming.
Research capacity	• AAFC has a network of research centres across Canada. • Provides funding and participates in R&D partnerships with industry, provincial governments, academia and the international scientific community.	• Varies: research is often performed by University MoUs or by co-funding specialised Research Institutes. • Research Levies are mandated in certain Provinces.

Source: Agriculture and Agri-Food Canada (AAFC).

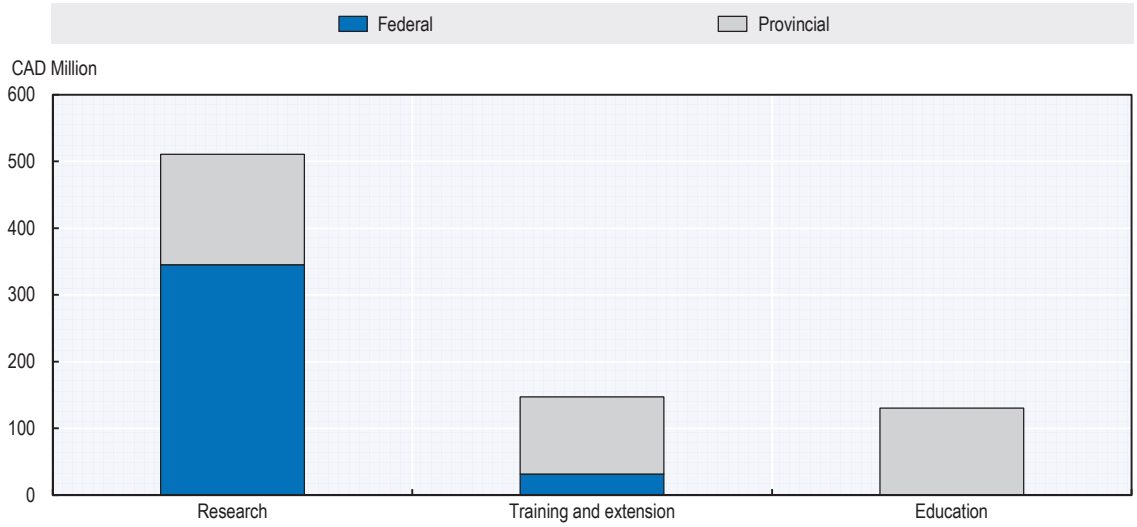
More recently, the federal government has increased funding for industry-driven R&D, and has placed an emphasis on improved commercial performance, in the context of its overall innovation programming.

Provincial governments vary in terms of the amount of R&D performed, although it is typically much less than at the federal level, with consolidation (Alberta) or the use of third parties (Ontario) being observed. The provincial ministry of agriculture in Ontario (OMAFRA) discontinued the majority of its in-house R&D many years ago during a significant downsizing effort, and now works through a Memorandum of Understanding (MoU) with the University of Guelph to perform R&D (Figure 7.3). This is similar in the province of Quebec, using its local universities (Laval and McGill) for agricultural research.[3]

Education of farmers, agribusiness professionals, agronomists, scientists and technicians in agricultural, biosciences, food, nutrition and veterinary sciences is primarily performed by colleges and universities within academia.[4] The Canadian Faculties of Agriculture and Veterinary Medicine (CFAVM) is an association that represents the 13 major universities and colleges with agricultural or veterinary-based programmes. Education is increasingly student-tuition funded, with support from provincial governments. This may be supplemented with various federal programmes (education is a provincial jurisdiction).

The amount of R&D generated by Canadian universities is comparatively high as Canada has one of the highest higher education expenditures on R&D (HERD) per capita in the OECD (Figure 5.6). The first role of academia is to develop highly qualified people (HQP). In the process of doing so, they are also performers of R&D in those fields that reflect developments in the economy or societal preoccupations; therefore research is not necessarily linked to public sector priorities. R&D in universities is funded from various sources. Canadian universities vary with respect to commercialising their R&D, but largely, academia recognises the role of commercialisation rests in the private sector. Academia's main functions with respect to supporting commercialisation are effective technology transfer and spin-offs, where new ventures leave the world of academia and enter the private sector.

Figure 7.3. Agricultural Innovation System: Federal and provincial contributions, 2008-13



Source: AAFC Government Expenditures Database, http://www.agr.gc.ca/eng/about-us/publications/economic-publications/alphabetical-listing/farm-income-financial-conditions-and-government-assistance-data-book-2013/?id=1392131614380.

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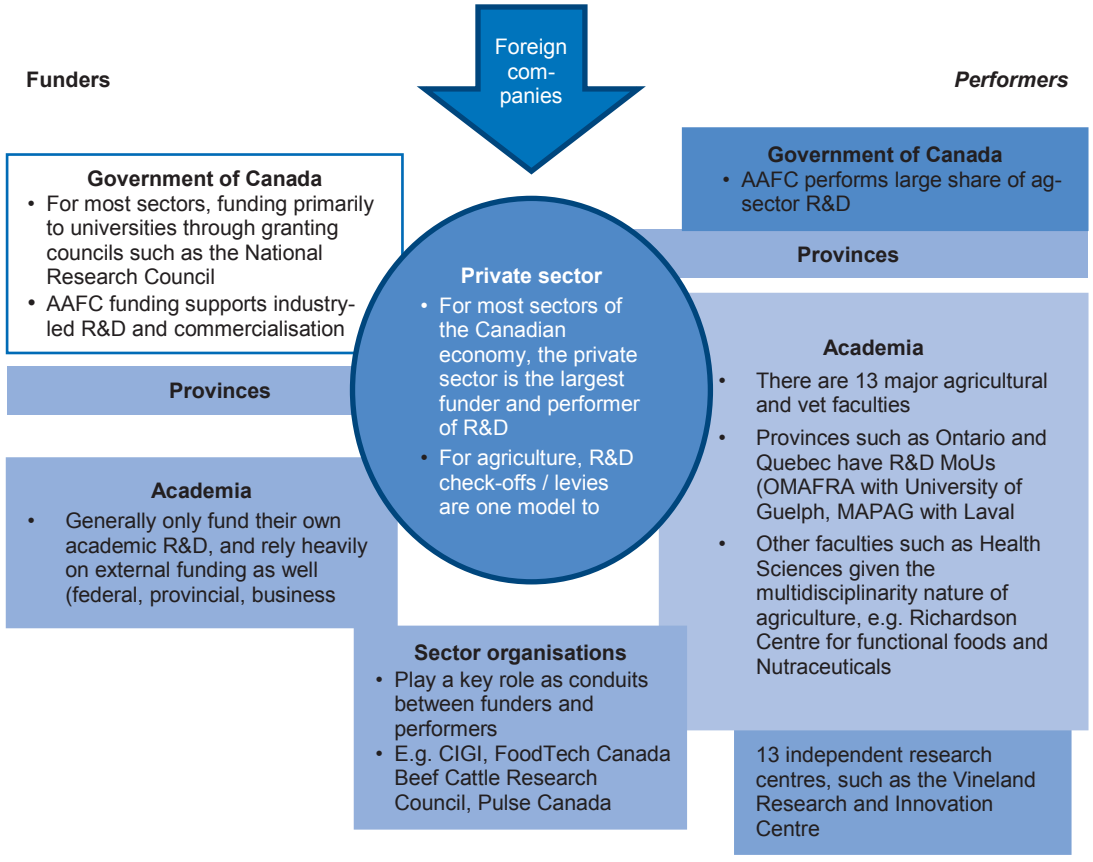
Figure 7.4. R&D funders and performers in Canada



CIGI: Canadian International Grain Institute.
Source: Agriculture and Agri-Food Canada (AAFC), http://www.agr.gc.ca/eng/home/?id=1395690825741.

In summary, Figure 7.4 outlines the diversity of funders and performers of R&D in Canada.

Many different types of **organisations** (non-government, typically non-profit) also play a role in agricultural innovation in Canada, usually playing the role of facilitator by filling a gap where other players are absent.[5] They are most often mission-based. Innovation intermediaries are those organisations that most directly facilitate innovation as their primary mandate, and operate in a given space along the innovation continuum, usually where there is a gap unfilled by the other players. These innovation intermediaries include research parks, accelerators, incubators, and marketing services. Trade associations usually represent a sub-sector within agriculture (e.g. the Canola Council of Canada or Canada Grains Council) and may have innovation as only one aspect of their overall mandate (such as managing the collective funding and allocation of R&D projects). Interest groups and non-governmental organisations (NGO) are typically mission-based, and as such can play an indirect role by challenging the status quo (e.g. health NGOs fund-raising for health R&D). However, some NGOs can also have as a mission to sway public opinion for or against new technologies. The relatively lower amount of resources available to NGOs suggests a role of facilitator, as they would often rely on influencing, utilising or providing services to other players. Although the breadth and overlap of the different organisations makes defining sub-categories difficult, it is clear that NGOs operate differently from trade associations and that innovation intermediaries play a key role.

Governance of innovation system

Governance ensures that government priorities are coordinated and communicated clearly, that progress is monitored and that policy outcomes and impacts are evaluated against objectives. The integration of the agricultural system in the governance of general innovation ensures better use of public funds, and increased efficiency of innovation systems through the pooling of complementary expertise and resources.

Priorities and coordination

For example, AAFC's strategic direction and priority setting for research, development and knowledge transfer activities is informed by the over-arching Federal Science and Technology (S&T) Strategy earlier. AAFC also participates in federal governance structures related to innovation, which typically are led by Industry Canada.

As with other federal science-based departments and agencies, AAFC's role in innovation is generally to:

- Inform regulatory and policy decisions.
- Produce far-from-adoption applied science with broad stakeholder application.
- Support innovation to improve economic prosperity.

As agriculture is a shared federal-provincial jurisdiction, co-ordination between AAFC and provincial agriculture ministries takes places at different levels[6] (Figure 7.5). Consultative mechanisms ensure exchange of information between innovation stakeholders. R&D agreements between provincial government and agriculture faculties are formalised through Memoranda of Understanding (MoU).

Producers and private sector companies influence the direction of public research in a number of ways. Within the Canadian political process, individual producers, producer organisations and private companies advocate for scientific research (and other issues) through their federal and provincial political representatives. Parliamentary committees exist in both the House of Commons (Committee on Agriculture and Agri-Food) and the Senate (Committee on Agriculture and Forestry) to address

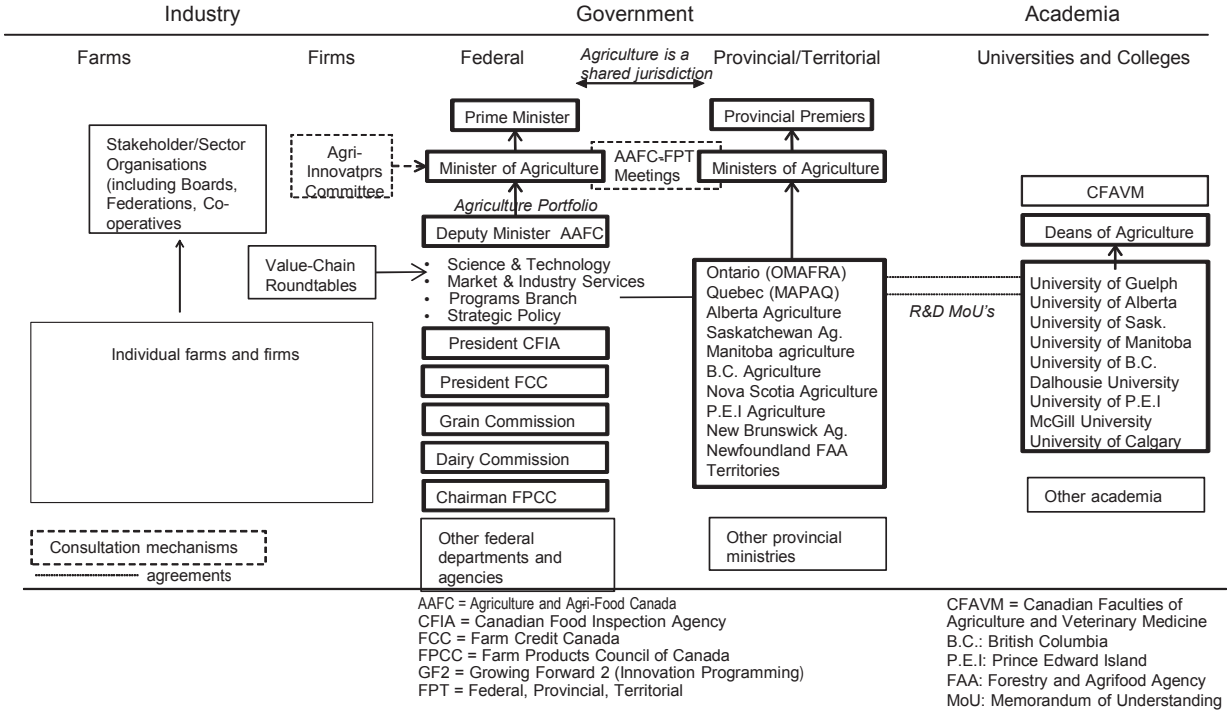
matters related to agricultural science and innovation, and these committees often seek the views of industry as a means of informing the direction of the government.

Industry representatives are also frequently invited to participate in government committees, working groups and other fora designed to address both scientific/technical as well as policy issues related to public research. An example is the Prairie Grain Development Committee (PGDC), a forum for the exchange of information relevant to the development of improved cultivars of grain crops for the Western Canadian prairies. The PGDC also advises regulatory agencies regarding legislation and regulations governing grain breeding, cultivar production, and sector development. Crop-specific committees within the PGDC include a mix of government, academia and industry participation.

Various consultative mechanisms exist in provinces to help define R&D priorities. For example, the Ontario Research Advisory Network (ORAN) is a network of advisory bodies comprised of individuals with expertise from a broad range of sectors that provides long-term, strategic guidance for agricultural programme development, and identifies emerging research priorities.

Adoption of innovation is also an agricultural policy objective, but it would be important to ensure stronger policy coherence between agriculture and innovation so that agricultural policy measures facilitate the adoption of innovation, and innovation policy contributes to long-term objectives to improve the profitability, competitiveness and sustainability of the food and agriculture sector.

Figure 7.5. Governance of Canadian Agricultural Innovation System



Source: Agriculture and Agri-Food Canada (AAFC).

Evaluation

At the national level, each federal government department is responsible for the evaluation of its own innovation programme, and evaluation of national science and technology performance does not contain information by sector. Evaluation procedures of AAFC programmes are described in Annex 7.A2.

Information for the evaluation of agricultural innovation programmes and systems is obtained through Memoranda to Cabinet, Treasury Board Submissions, Results-Based Management Accountability Frameworks (RMAFs),[7] Performance Measurement Strategies, and programme promotional information. AAFC's Office of Audit and Evaluation (OAE) collects data on financial and budget allocation information, application submission criteria and performance information from different parts of AAFC.

Before any proposed policy or programme is approved by the government, a Performance Measurement Strategy (which outlines the objectives of the programme, and defines the programme activities, outputs and expected outcomes) is developed. These strategies ensure that credible and reliable programme performance data are collected to support evaluations. To support this strategy, performance indicators are identified for each recipient of programme funding. Recipients report periodically on those indicators and at the end of the project, report globally on innovation project findings.

The input indicators available include budget allocations through a number of AAFC innovation programmes, such as those mentioned in Chapter 6.

The output indicators available include:

- Number of innovations created (products, processes or practices).
- Number of patents and copyrights.
- Number of peer review publications.
- Number of knowledge transfer activities and networks (i.e. public-private partnerships).

National agricultural innovation programmes and systems at AAFC are benchmarked by identifying sets of indicators through performance measurement strategies. In accordance with the Policy on Transfer Payments, the preparation of a performance measurement strategy is required for all transfer payment programmes. Program managers are responsible for developing and implementing ongoing performance measurement strategies for all new and ongoing direct programmes spending, including ongoing programmes of grants and contributions. Managers are also responsible for ensuring that credible and reliable performance data is being collected to effectively support evaluation. AAFC evaluations may also use secondary data sources for benchmarking national programmes by comparing these to provincial/territorial and international agricultural innovation programmes.

Macro-economic and social impacts are not a specific requirement of these evaluations, but have become increasingly important in recent years, as the government is making the effort to link programme effectiveness to broader national objectives.

AAFC has recently been putting more emphasis on developing indicators to measure innovation performance. With the increased focus on innovation programmes and outcomes, there is a greater need for reliable measurement, along with a need from industry to know how it is performing relative to other economies and to other sectors in the Canadian economy (benchmarking).

In 2012, the government created the **Agri-Innovators Committee (AIC)** for the purpose of receiving expert advice on how to advance innovation in the sector and to help ensure that government investments in innovation generate the results and returns needed by farmers. The AIC was comprised of representatives from across Canada and from an array of agricultural sectors (beef, livestock and genetics, pork, poultry, processors, food processing, pulses, grains and canola) and a broad range of expertise and skills. The work of the Committee was completed as of March 2014, and a final report was provided to the Minister of Agriculture and Agri-Food with recommendations and advice in the following four key areas: regulatory reform; investment climate conducive to innovation and competiveness needs; public-private collaborations; and entrepreneurial culture (see main recommendations in Box 7.1).

Box 7.1. Agri-Innovators Committee recommendations

Committee deliberations on the four themes below led to the following conclusions:

"To realize the sector's full growth potential, we need to maximize innovation capacity across the entire value chain. While many stakeholders have a role to play in advancing innovation in the sector, industry must drive innovation with governments as supporting players.

The main long-term innovation challenge facing the Canadian food and agriculture sector is chronic underinvestment in research and development (R&D). To address this issue, concerted action must be taken on the four themes identified in this report.

Regulatory reform

Simply removing regulations is not the solution to achieving regulatory reform. A continuous process of modernisation is required that is aligned domestically and internationally. Regulatory modernisation initiatives are critical to enable Canada to signal that it is "open for business".

An investment climate conducive to innovation and competitiveness

A pro-business investment environment is a key driver to support industry-led innovation. Overall, economic considerations such as access to capital, labour, markets and technology, along with competitive taxation rates, are important for creating the conditions that encourage increased investment.

Public-private collaborations

To have the greatest impact, governments, universities and private sector partnerships are required to drive innovation along the value chain and across the innovation continuum (from research to commercialisation).

Entrepreneurial culture

There is a changing philosophy among early adopters, with a shift in mind-set from a "production focus" to understanding markets and consumer demand. The challenge for the sector is to fully embrace this philosophy. In addition, Agri-Innovators Committee members recognised that the motivation and ability to seize new opportunities depends to a large degree on industry's ability to raise awareness of agricultural opportunities in order to attract entrepreneurs, investors and highly qualified people who can assist in positioning Canada as a global innovation leader."

The following six overarching and inter-related recommendations were provided:

1. Canada needs a competitive business environment to become a destination of choice for investment, especially in R&D and value-added processing.
2. A "fast-to-market" mind-set among governments, academia and industry is critical to compete in global markets.
3. A modern science-based regulatory environment is a key component of a competitive business environment that enables access to appropriate inputs and maximises global market access opportunities. Alignment across various jurisdictions within Canada is necessary.
4. Better coordination, collaboration, and leveraging of resources, as well as a customer-driven focus are achievable through R&D partnerships and clusters involving government, academia and industry.
5. Benchmarking is an important tool for understanding our current capacities and assessing them against those of our competitors (e.g., adoption of new products, practices, processes and technologies) as well as for ensuring more productive use of existing and future resources.
6. Building awareness of the opportunities in the agriculture and agri-food sector as well as explaining the role of modern agricultural technologies, and Canada's robust approval processes for food and novel production techniques will be critical to support an innovative sector."

Source: AAFC (2014a), Agri-Innovators Committee Report to the Minister of Agriculture and Agri-Food. Available at: http://www.agr.gc.ca/eng/science-and-innovation/agri-innovators-committee/summary-of-the-agri-innovators-committee-final-report/?id=1373984119650.

Investing in innovation

The public sector continues to be the main source of funding for agriculture R&D, whether performed in public or private organisations. A variety of funding mechanisms are used, including direct government spending on researcher salaries and/or projects, public-private partnerships (PPPs), and various forms of tax incentives. Business investment in R&D is normally driven by market demand, but governments also provide different kinds of incentives. Some, like R&D tax rebates, apply to the economy in general, while others are agriculture specific. Producer organisations and other non-governmental organisations also provide R&D funding. 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.

Investment in public R&D

Priorities for public research on agriculture

Within AAFC, the focus of activities is on the application of science to agri-based production systems, under three pillars that emphasise the department's role in supporting the sector's economic prosperity: providing science that enhances the sector's resiliency; fostering new areas of opportunity for the sector; and, supporting sector competitiveness (Table 7.3).

Table 7.3. AAFC's Science and Technology Branch Strategic Direction

Pillar 1: Providing science that enhances the sector's resiliency	Pillar 2: Fostering new areas of opportunity for the sector	Pillar 3: Supporting sector competitiveness
Addresses challenges to the resource base/sector's capability to produce: • Upstream research – fundamental disciplines. • AAFC is major provider and assumes a leadership role.	Addresses new and non-traditional commercial opportunities for the sector: • AAFC leads in upstream research through to technology transfer and application for activities with public and broad stakeholder benefits. • Moves into a supportive role as research moves downstream, for activities that will generate commercial benefits to private firms.	Addresses existing sector's ability to respond to market demands: • AAFC capacity is maintained to: – Leverage research resources to address key challenges and opportunities; – Provide expertise that industry can access through collaboration.
For example: • Maintaining the collections of invertebrate, plant, fungi and animal genetic resources to identify invasive species/new pests. • Investigating the interactions of agricultural production with water, air, soils and climate. • Investigating crops and livestock biological mechanisms that may offer protection against threats and challenges.	For example: • Developing bioenergy, bioindustrial chemicals and bio-based materials derived from crops and livestock • Supporting development of novel food and non-food products.	For example: • Developing improved production traits (e.g. resistance to specific pests, diseases or weeds; yield enhancement). • Strategies to reduce risk to food value chain (pathogens, infectious agents). • Production practices that improve productivity, sustainability and profitability. • Practices that facilitate compliance with environmental regulations and enable sector participation in markets for environmental goods and services. • Understanding critical factors influencing product quality. • Finding alternatives to the use of antibiotics in livestock production.

The high level direction of the pillars is elaborated through a series of sector science strategies that set priorities for AAFC's science activities over the medium term, providing the basis for detailed work planning.[8] The strategies outline the department's objectives and focus areas for scientific research, development and knowledge transfer, provide a framework for scientists to propose areas of work, and describe the role of AAFC's science capacity in relation to, and in collaboration with other organisations in academia, government and industry.

Seven of the strategies are commodity-focused, encompassing science activity for: Forages and Beef; Cereals and Pulses; Oilseeds; Horticulture; Dairy, Swine, Poultry, and Other Livestock; Bioproducts; and Agri-Food. Two other strategies capture cross-cutting agricultural challenges: Agro-Ecosystem Productivity and Health; and Biodiversity and Bio-resources. In each area, collaboration occurs across government, industry, academia and the broader science community to guide AAFC research, development and knowledge transfer activities.

A key theme of the current federal S&T Strategy is the need to generate greater participation by non-government players in the science and technology arena, by pursuing active business-led initiatives that focus resources on better meeting private sector needs. AAFC also emphasises partnership approaches to leverage its resources and capacity with that of other players in the system: other federal and provincial departments and agencies, industry organisations and academic institutions, both in Canada and abroad.

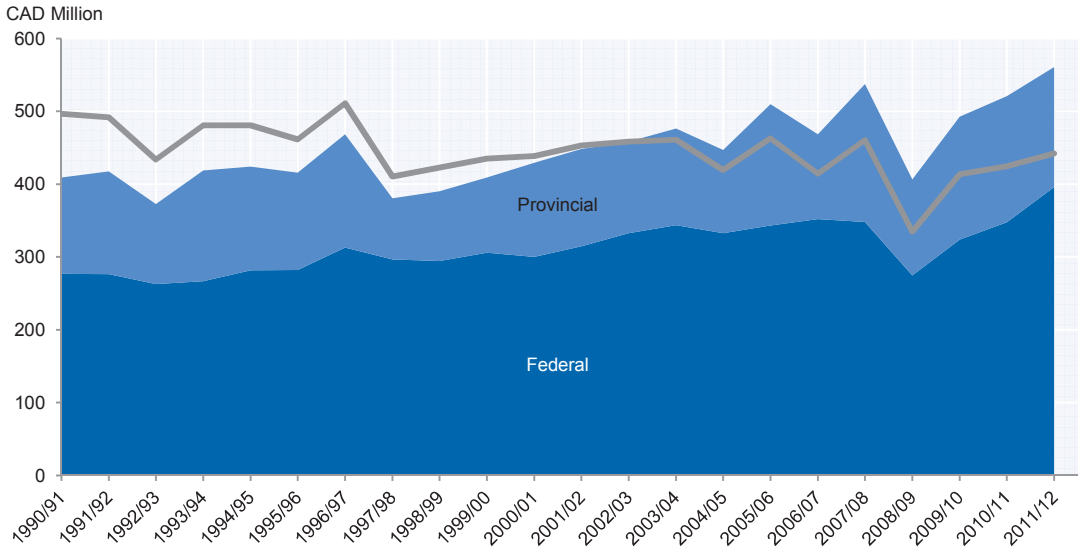
In provinces, the research agenda is generally closely linked to industry needs. Provincial priorities are directly linked to increasing farm profitability, resilience and sustainable use of resources, as well as improving product chains in terms of developing new products (including bioproducts) and processing technologies, and increasing value-added, and food safety and quality. For example, the bio-food sector is one of the seven strategic areas in the Quebec research and innovation policy plan. Manitoba established and developed research centres and networks in the area of agri-food, health and medicine (e.g. functional food and nutraceuticals).

Trends in public R&D expenditures

Over the last decade, public expenditures (combined provincial and federal) on food and agriculture R&D increased, from CAD 400 million in 2000 to CAD 561 million in 2011, but in real terms (2002 CAD), they are on a slightly downward slope (Figure 7.6). A stronger decline in 2008-09 occurred at the end of the Agricultural Policy Framework, but rose after new initiatives were put in place through Growing Forward (2008-2013). The federal share of total R&D expenditures has accounted for an average of 70%, with provincial public expenditures accounting for the remaining 30%. Most provinces report they maintained or increased slightly funding to agriculture R&D.

Compared with countries like the United States, Australia or the Netherlands, the decline in public expenditure on agricultural R&D in real terms has started earlier in Canada (Figure 7.7). However, Canadian agricultural research intensity – Canada's public R&D expenditure on agriculture in relation to the agricultural value-added –remains higher than in the United States, Australia or Brazil, and much higher than research intensity the whole economy (Figure 7.8.B), although it is also on a downward trend (Figure 7.8.A).

Figure 7.6. Trends in public expenditures on agricultural research in Canada, 1990-91 to 2011-12



Real government expenditures on R&D in agriculture and agri-food have been deflated to 2002 dollars.

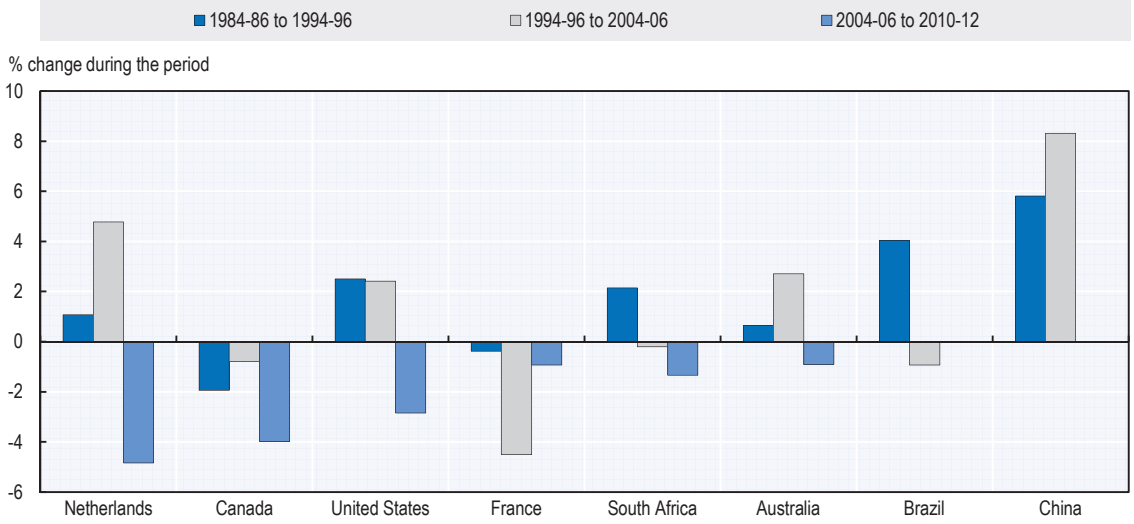
2011-12 figures are estimated.

Source: Agriculture and Agri-Food Canada (AAFC) (2014), *An Overview of the Canadian Agriculture and Agri-Food System 2014*, available at: http://www.agr.gc.ca/eng/about-us/publications/economic-publications/alphabetical-listing/an-overview-of-the-canadian-agriculture-and-agri-food-system-2014/?id=1396889920372.

StatLink http://dx.doi.org/10.1787/888933250566

Figure 7.7. Percentage change in real public expenditures on R&D between periods, 1984-86 to 2010-12

Government budget appropriations or outlays for R&D (GBAORD) in Million 2005 Dollars - Constant prices and PPPs



Data for South Africa 2010-12 are for 2009; data for Canada 2010-12 are 2010-11.

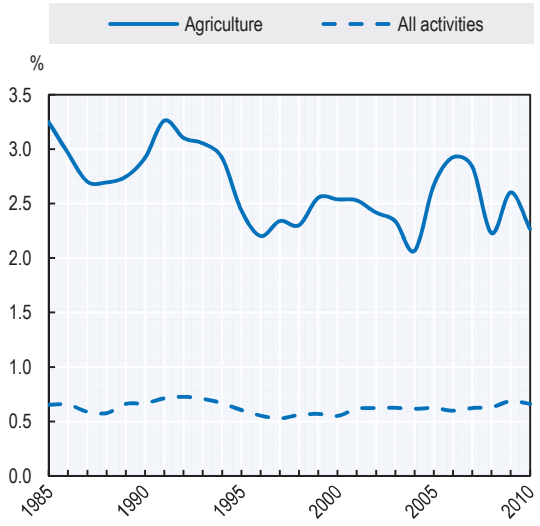
PPP: Purchasing Power Parity.

Source: OECD Research and Development Statistics, 2014; ASTI (Agricultural Science and Technology Indicators) IFPRI, 2014.

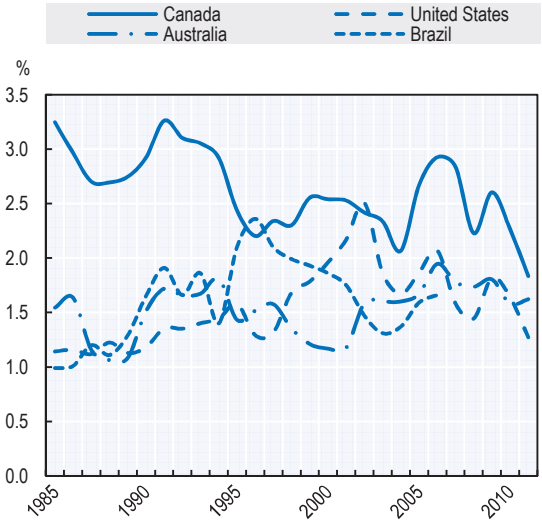
StatLink http://dx.doi.org/10.1787/888933250572

Figure 7.8. Public expenditures on R&D as a share of value-added, 1985-2010

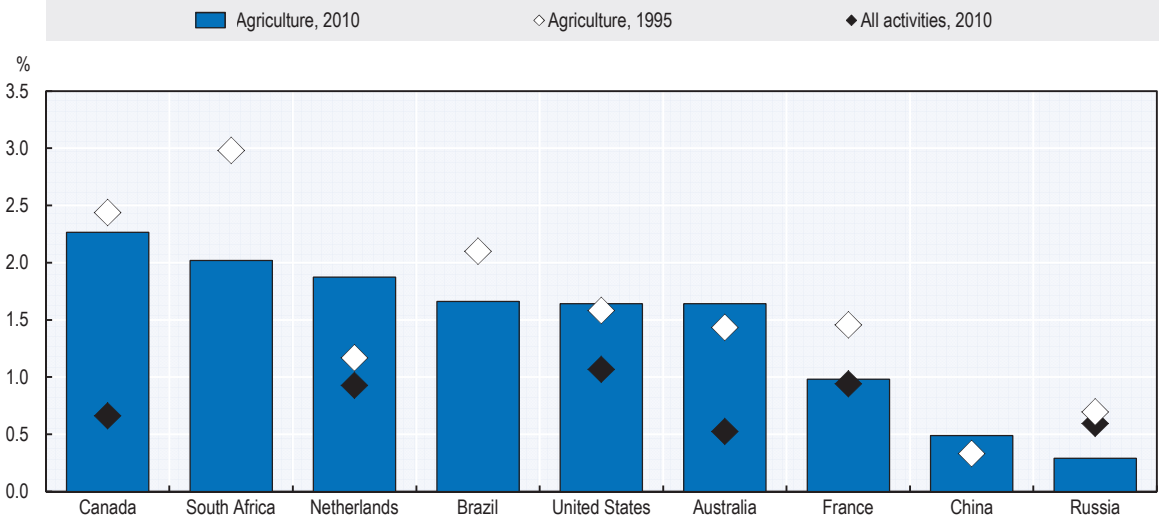
A. Agriculture and economy-wide R&D intensity in Canada



B. Agriculture R&D intensity in selected countries



C. Agriculture and economy-wide R&D intensity in selected countries



In 2006 classification changed from ISIC rev3 to rev4.

For 2011, Canada national agricultural GVA is an adjusted aggregate of regional values.

For OECD countries, public expenditure on R&D is Government budget appropriations or outlays for R&D from OECD R&D Statistics, and value-added of agriculture is from OECD Gross Domestic Product statistics. For non-OECD countries, agricultural R&D intensity from ASTI (Agricultural Science and Technology Indicators) is used.

Source: OECD Research and Development Statistics, 2014; ASTI (Agricultural Science and Technology Indicators) IFPRI, 2014.

StatLink http://dx.doi.org/10.1787/888933250583

Composition of public expenditures on food and agriculture R&D

Approximately two-thirds of AAFC R&D funding is from institutional sources; the other third from time-limited and targeted funding sources. With regard to provincial expenditures on agriculture R&D, the share of institutional versus project-based funding varies by province. For example, institutional funding accounted for 26% of the total in Manitoba, 29% in Saskatchewan, and 68% in Quebec.

With respect to basic versus applied R&D, it is a difficult exercise to categorise AAFC research projects and other R&D activity in a way that aligns with the OECD categorisation scheme (Frascati manual, OECD, 2002). Provinces tend to fund mainly applied research.

When considering AAFC three pillars (Table 7.3), a 2011 estimate found that approximately 30% of the R&D budget is in the first pillar – providing science that enhances the sector's resiliency. A smaller percentage of R&D, roughly 10%, was in the second pillar – fostering new areas of opportunity for the sector. The remaining 60% was aligned to the third pillar – supporting sector competitiveness. Much of AAFC's more upstream, fundamental R&D, however, is aligned with the first pillar.

Almost all of AAFC R&D activities performed in AAFC research centres and laboratories are considered to be applied science, in the sense that the Department is focused on using its science assets to solve the challenges of Canadian agriculture. Research teams are engaged, at any given time, in a range of projects that span the continuum from more basic, upstream research to near-market projects where AAFC scientists are collaborating with academia and industry. Incentives to collaboration, such as Agri-Sciences Clusters, alliances, networks and Public-Private Partnerships (PPPs) are discussed in the section on knowledge flows.

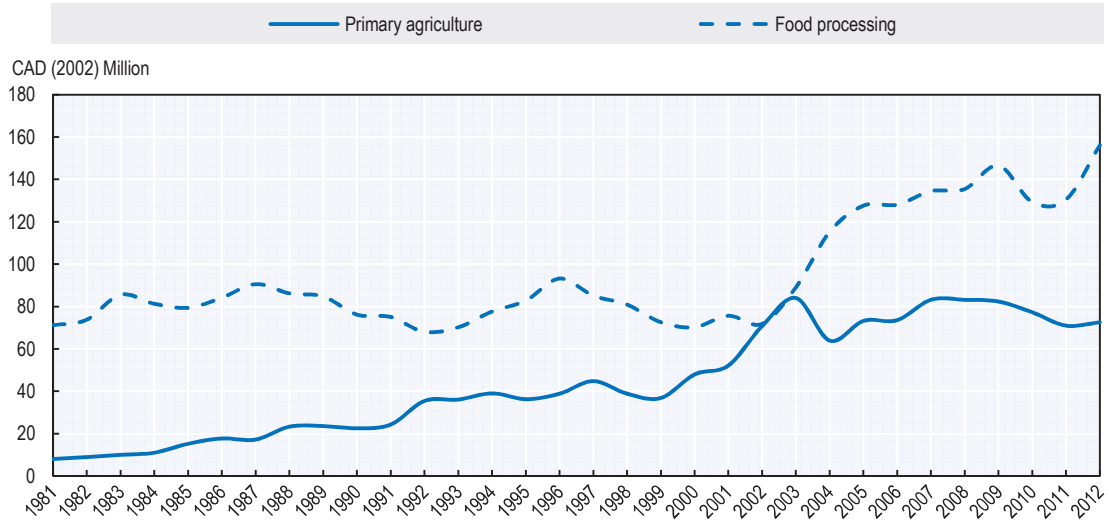
Non-government R&D expenditures

In Canada, governments generally represent the largest funding source for agricultural R&D. However, non-government entities make significant investments in R&D and innovation in some areas of agriculture such as certain crop types with strong IP protection. Public-private partnerships exist, but this is a potential area for increased consideration.

In Canada, the picture of R&D expenditures in agriculture is incomplete. At the national economy-wide level, Statistics Canada collects this data from private businesses, the private non-profit sector, provincial research organisations, provincial governments, the federal government and from higher education institutions.[9] However, the national level R&D expenditures are not broken down by industrial classification systems. Therefore, total expenditures on agriculture R&D all the way from private industry to higher education institutes are not available, making it difficult to calculate agriculture R&D spending as a percentage of GDP. The Business Expenditures on R&D (BERD) reported for agriculture is available for primary agricultural operations[10] only and does not include business spending on R&D in other related industries: seed developers, chemical companies, machinery companies, contract service providers and biological and life science (such as biotechnology) companies. It should be noted, however, that it is in these sectors that most private agricultural R&D is taking place.

Private sector R&D investments (BERD)[11] in Canadian agriculture have grown steadily since the 1980s, when intellectual property rights (IPR) protection on new crop varieties was introduced. Figure 7.9 shows that in real terms, private sector spending on primary agriculture increased substantially between 1998 and 2002, but has slowed to CAD 70 million in 2011, down from a peak of CAD 84 million in 2002. In current terms, total private R&D expenditures in agriculture in 2011 amounted to CAD 92 million. While provinces report a long-term increase in private expenditure on agriculture R&D, some mention stagnation or even a decrease in the last five years related to the economic downturn.

Figure 7.9. Real private sector R&D expenditures in primary agriculture and food processing, 1980-2011



2009-11 figures are preliminary. This includes all R&D expenditures (intramural) made by private industry regardless whether the sources of funds were self-financed.
Source: Statistics Canada and AAFC calculations.

StatLink http://dx.doi.org/10.1787/888933250592

The food processing industry has benefited from innovations in food safety and preservation processes (e.g. HACCP systems and flash freezing) as well as inventory control (i.e. "just-in-time" inventory). Products are also continually being improved with the use of new ingredients and innovative packaging, as food processors benefit from innovations taking place in other industries in the supply chain. Real private R&D expenditures in the food processing industry are almost double that in primary agriculture. They are estimated to have reached CAD 156 million in 2011, following the steady upward growth since 2000. R&D spending averaged CAD 79 million per year between 1980 and 2000 (Figure 7.9).

Intellectual Property Rights (IPRs) are an important mechanism to generate R&D and innovation funding. The use of IPRs allows plant breeders to collect royalties on certified seed, which can be reinvested into plant breeding research programmes. IP protection used by the agricultural sector in Canada is discussed in the section on knowledge flows.

In Canada, mandatory levy, or check-off, systems are used to financially support both marketing and research activities for a variety of farm products. Both check-offs and levies have allowed producers to finance and benefit from private investments in commodity R&D. However, the use of producer check-offs to raise funds for R&D varies across provinces and agricultural commodities. Such variation is due largely to differences in value-added opportunities, rates of industry growth, and size of the check-off (Alston, Gray and Bolek, 2012). The majority of check-off systems in Canada are implemented and managed provincially through legislation that provides for the collection of producer paid levies.

Examples of check-off programmes in Canada include:

- **Saskatchewan Pulse Growers Check-off:** every buyer, processor, broker, assembler, exporter or marketer of pulses who acquires Saskatchewan-grown pulses from a grower is required under provincial and federal legislation to deduct a mandatory, non-refundable pulse check-off. A check-off of 1% of the gross value of sale (plus Goods and Services Tax) is deducted at the first point of sale or distribution when a Saskatchewan grower sells a pulse crop (peas, lentils, chickpeas, beans, faba beans, soybeans, etc.). The legislation applies to all pulses, regardless of how they were produced (i.e. conventional, organic, or other). The Saskatchewan Pulse

Growers then invests the check-off funds in research and development, market promotion, communications, and general operations of the organisation.

- **National Beef Check-off:** A mandatory levy of CAD 1 per head is collected on cattle sales throughout Canada to fund research and marketing activities on behalf of the entire industry. When producers market their cattle, it is collected by provincial organisations through existing systems such as auction markets, order buyers, brand inspectors and others who handle cattle sales. The goal of the national beef check-off is twofold: to increase sales of domestic and export beef, and to find better and more efficient methods of producing beef and beef cattle. The national check-off generates over CAD 8 million annually and is a critical source of revenue to fund initiatives that will advance the industry and build strong markets for Canadian cattle and beef.

Endowment funds are an additional source of R&D investment money from non-public sources. For example, the Western Grains Research Foundation (WGRF) operates a CAD 90 million endowment fund that invests in a wide variety of crop research activities. It is a farmer funded and directed non-profit organisation investing primarily in wheat and barley variety development to benefit Western Canadian farmers. The principal of the endowment fund is invested and the earnings are used to fund research projects. To date, the WGRF has supported a wealth of innovation across Western Canada and provided over CAD 26 million in funding for over 230 projects across a number of different crop types.

Public incentives to private investment in agricultural R&D

In Canada, there are a variety of mechanisms used by the government to support private investment in agricultural R&D, including tax provisions, credit, and competitive grants.

Tax provisions[12]

In addition to the Scientific Research and Experimental Development (SR&ED) Tax Incentive Program described in the third section of Chapter 4, farming corporations can use a special mechanism that enables them to earn SR&ED tax credits on contributions made to agricultural organisations that fund eligible research and development. It is common practice for farmers to fund agricultural research through a third-party payment mechanism. These producer organisations act as agents through which member farmers can finance eligible research investments. The SR&ED tax credits are then distributed back to individual farmers. These organisations must be Canada Revenue Agency (CRA)-approved associations that finance qualifying SR&ED activities of benefit to the individual contributors, as well as to the agricultural industry as a whole.

Farm Credit Canada

Farm Credit Canada (FCC)[13] is Canada's leading agriculture lender whose mandate is "advancing the business of agriculture" (Box 4.3). It provides specialised and personalised business and financial services to small and medium-sized businesses that are related to farming. It also provides insurance, software, learning programmes and other business services to producers, agribusinesses, such as suppliers and processors, and agri-food operations. The FCC also assists farm businesses with the development of their respective business plans, including future research and development efforts, lists of any patents or intellectual property owned by the farm.

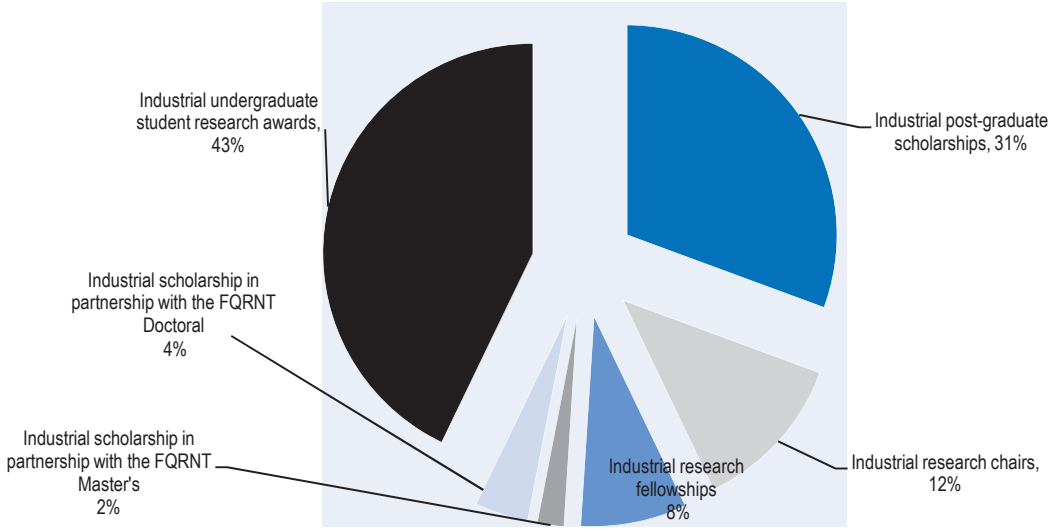
Competitive grants/research chairs

There are a number of Federal Government granting agencies providing research funding to universities, colleges and the private sector, including the Canadian Health Institutes for Research (CIHR) CAD 720 million in 2011-12) and the Social Sciences and Humanities Research Council of Canada (SSHRC) (CAD 167 million in 2013).

The Natural Sciences and Engineering Research Council (NSERC)[14] is a federal agency, which provides new funding for initiatives to support science, technology and the growth of innovative firms.[15] Agriculture and food-related research are linked to all four target areas (i.e., Environmental Science and Technologies, Information and Communications Technologies, Manufacturing and Natural Resources and Energy), and it is not considered as a standalone priority. NSERC offers a Collaborative Research and Development programme intended to give companies operating from a Canadian base access to the knowledge, expertise and educational resources available at domestic post-secondary institutions. It also strives to offer opportunities for mutually beneficial collaborations that result in industrial or economic benefits to Canada. Direct project costs are shared by the industrial partner(s) and NSERC. Projects can range from one to five years in duration, but most awards are for two or three years. These projects can be at any point in the R&D spectrum that is consistent with a university's research, training, and technology transfer mandate.

Although agricultural institutions are eligible for research grants from a number of funding agencies, it appears that NSERC may be the most relevant to the sector. Figure 7.10 provides a breakdown of agriculture-related funding from the organisation. Through NSERC's Industrial Research Chair Program, the dairy industry (for example) has three research chairs involving partnerships with the organisation. In addition to the research chairs, agriculture has benefitted from NSERC partnerships related to research networks. In addition to a dairy network[16], there are others with relevance for agriculture (green crops, biomaterials, pollination).[17]

Figure 7.10. Breakdown of agriculture-related, industry-led projects funded by the Natural Sciences and Engineering Research Council (NSERC), by NSERC programme, 2009-10



FQRNT: Fonds Québécois de la Recherche sur la Nature et les Technologies.
Source: Agriculture and Agri-Food Canada (AAFC).

StatLink http://dx.doi.org/10.1787/888933250608

Genome Canada

Genome Canada is a not-for-profit organisation that invests in genomics research to generate economic and social benefits for Canadians. Through six regional Genome centres across Canada, it connects ideas and people across public and private sectors to find new uses and applications for genomics. It invests in large scale science and technology to fuel innovation and it translates discoveries into applications to maximise impact and return on investment. Genomics research is intended to discover new opportunities in diverse areas such as health, fisheries, forestry, agriculture and the environment. Agriculture is one of the areas provided with funding. Genome Prairie for

example is currently funding research on wheat genome sequencing, carinata for biodiesel, total utilisation of flax, and turning waste into value-added resources.

Genome Canada was initially funded by the Federal Government with an investment of CAD 160 million in 2000-01. In 2012, over CAD 2 billion was invested in genomics, with Genome Canada providing about 43% of the funding. The remaining 57% was secured from partners, including provincial entities (19%), international initiatives (20%) private sources (8%), and institutional organisations (4%) as well as other federal funders (6%). Funding thus far has resulted in 4 500 research publications, 24 companies created or enhanced, 10 000 highly-skilled full-time workers employed, and 350 patent applications and 24 license agreements.[18]

Canadian Foundation for Innovation (CFI)

The Canadian Foundation for Innovation was founded in 1997 by the Federal Government to build capacity to undertake world class research and technology development in Canada. It initially started with CAD 800 million in funding, and now offers CAD 500 million. Through a rigorous, competitive and independent review process, it funds research infrastructure by providing competitive grants to institutions such as universities and colleges, hospitals, and other research organisations to cover the cost of state-of-the-art equipment, laboratories, databases, specimens, scientific collections, computer hardware and software, communications linkages, and buildings necessary to conduct leading edge research. It helps institutions attract, retain, and train the top researchers from around the globe and aims to foster collaboration among the academic, private, public and non-profit sectors on a range of projects and across many disciplines, including food and agriculture. They are being established to support business innovation and private sector R&D.[19]

Agricultural programmes

Two programmes within AgriInnovation are geared towards encouraging industry-led innovation and investment: Agri-Science Cluster and Agri-Science Projects described in Box 6.1. In addition, a number of federal and provincial agricultural loan and credit guarantees programmes support investment in farms or cooperatives (Box 6.3).

Economic Action Plan / Federal Budget 2013

The federal government, through its Economic Action Plan 2013,[20] has allocated R&D and innovation funds for which the agricultural sector may be eligible. For example, the federal government has proposed multi-year funding of CAD 165 million for genomics research, including support for new large-scale research competitions and participation by Canadian researchers in national and international partnership initiatives. Genome Canada, a not-for-profit corporation dedicated to accelerating the development of Canadian research capacity in genomics, would benefit from this funding.

Procurement and pull mechanisms used to fund research

The Canadian Innovation Commercialization Program (CICP)[21] is a new procurement programme, originally a CAD 40 million pilot by Public Works and Government Services Canada, where government is the first-buyer of an innovation. Budget 2012 made the CICP programme permanent; however, there have been very few projects thus far that relate to agriculture.

2002-04 data suggests that a large number of firms in the food manufacturing sector specifically use conventional sources such as banks, for funding projects related to innovation (Table 7.4). In terms of government programmes, the most uptake in the early 2000s was from the R&D tax credit.

Table 7.4. Sources of innovation funding in food manufacturing firms, 2002-04

Main sources of external capital funding for innovation, food, beverage, tobacco innovative plants, 2002-2004		Use of government support and programs, food, beverage, tobacco innovative plants, 2002-2004			
	% of plants		% of plants		
			Federal	Provincial	Did not use
Conventional sources (i.e. banks)	37.1	R&D tax credits (i.e. SR&ED)	43.6	28.4	52.2
Canadian based venture capital	7.6	Government information	19.4	17.4	77.6
Private placement	5.5	Government R&D grants (i.e. IRAP)	10.7	6.9	86.2
Angel investors/family	5.1	Other government support programmes	4.2	0.6	95.3
Collaborative arrangements, alliances	3.5	Government support for training	3.7	12.4	85.2
Foreign-based venture capital	0.8	Government technology support and assistance programmes	2.8	3.7	95.0
Initial Public Offering (IPO)	0.4	Government venture capital support	0.4	2.6	96.9

Source: Statistics Canada, Survey of Innovation 2005.

StatLink http://dx.doi.org/10.1787/888933250722

Knowledge infrastructure

Institutions

AAFC has 19 research centres across the country (Figure 7.11). A list and description of AAFC research centres is provided in Annex 7.A3.

Provincial governments support regional research centres, and universities and colleges. In Manitoba for example, support to research includes the establishment and/or development of the Richardson Centre for Functional Foods and Nutraceuticals (RCFFN), the Composite Innovation Centre, the Manitoba Agri-Health Research Network (MAHRN) and the Canadian Centre for Agri-food Research in Health and Medicine (CCARM), the expansion of the Food Development Centre (FDC), and the on-going support towards the provincial Diversification Centres, Prairie Agricultural Machinery Institute (PAMI), University of Manitoba and Food Development Centre. In Ontario, innovation partners supported by the provincial government are the Agri-Tech Commercialization Centre (ATCC), the Vineland Research and Innovation Centre, the Livestock Research Innovation Corporation (LRIC) and the University of Guelph.

Figure 7.11. AAFC Science and technology branch ecozones and locations

Source: Agriculture and Agri-Food Canada (AAFC).

Infrastructure for knowledge sharing

Two major AAFC programmes help safeguard the biodiversity of Canadian crops by protecting and preserving Canadian agricultural genetic resources. The **Plant Gene Resources of Canada** (PGRC) and the **Canadian National Collection** both provide identification services and genetic material to Canadian and international scientists (Box 7.2). This material is essential for research into biodiversity and taxonomy, which contributes to agriculture through, for example, assisting in early detection of invasive species; and supporting accurate diagnostics of pests and pathogens.

Information in PGRC and National Collections is freely accessible to the public and shared through the **Canadian Biodiversity Information Facility (CBIF)**, which was created in 2003 to act as the national portal and coordinating platform for federal biodiversity data supplied by contributing federal organisations. It serves the purpose of ensuring that federal data shares common standards as well as facilitating access to it. Equally it functions within a national and global portal network to facilitate access to important biodiversity data held outside of the federal government but essential to the interests of Canada.

This facility was in response to Canada's membership commitment to the Global Biodiversity Information Facility (GBIF); an OECD mega-science initiative aimed at establishing global standards of accessibility for biodiversity data. AAFC has had a leadership role in its creation.

Box 7.2. Canadian gene resources and national collections

Plant Gene Resources of Canada (PGRC)

AAFC identifies, collects, preserves and encourages the utilisation of crops grown in Canada through the PGRC Canadian Genetic Resource Program. It is headquartered at the Saskatoon Research Centre in Saskatchewan, and at several collection nodes across Canada. The roles of the PGRC include plant and seed preservation; and animal germplasm conservation.

The PGRC is responsible for over 1 000 species of plants and preserves over 113 000 seed samples in their Seed Genebank. The Centre's Canadian Genetic Resource programmes acquire and preserve native Canadian plants of economic importance or those at risk of loss in biodiversity. On Canada's behalf, PGRC has formal responsibility for principal world germplasm collections of barley and oats. In addition, it preserves backup or duplicate world collections of pearl millet, oilseed and crucifers in case the primary collection should be destroyed. The programme also has a collection of over 3 500 tree fruit and small fruit crops at the Canadian Clonal Genebank housed at the Greenhouse and Processing Crops Research Centre (Harrow, Ontario). Although Canada might not commercially grow all the collected varieties, each is distinct and the genetic information these plants contain may become a valuable resource in the future as scientists look to the past as they develop new varieties. In addition, scientists at the Potato Research Centre (Fredericton, New Brunswick) maintain a collection of over 130 heirloom and modern Canadian-bred potato varieties.

PGRC also houses the Canadian Animal Genetic Resources (CAGR) Program, a new, joint initiative between AAFC and the University of Saskatchewan. Created in 2005, this programme ensures the long-term conservation of genetic diversity of Canadian animal and poultry breeds through germplasm cryopreservation.

Canadian national collections

The Canadian National Collections are kept in the Eastern Cereal and Oilseed Research Centre (Ottawa, Ontario). AAFC science expertise includes a team of researchers involved in taxonomy - the science of classification of species. AAFC scientific expertise is used to make authoritative identifications of native and foreign plants, insects, nematodes, fungi. National Collections play an important role in the development of new crops, bioproducts and biotechnologies capable of sustaining, in the long-term, the quality and yields of Canadian agriculture

Within the Canadian National Collections, there are a number of working reference collections:

- Canadian National Collection of Insects, Arachnids and Nematodes: Considered one of the best of its kind in the world in terms of size, species representation and level of curation, the collection contains approximately 16 million specimens.
- National Vascular Plant Herbarium: Properly called a herbarium, it includes 1.5 million irreplaceable specimens protected in a climate-controlled environment. When adequately protected from moisture and pests, dried specimens can last in the herbarium for hundreds of years. This resource allows identification of plants from anywhere in Canada and supports research on plant classification worldwide.
- Glomeromycota in vitro Collection: This collection is a premier collection of arbuscular mycorrhizal (AM) fungi which are specific types of microorganisms that live in association with plants. It is the first international culture collection of its kind with 150 specimens and was established as part of an international scientific collaboration between AAFC, the Canadian Collection of Fungal Cultures and the Mycothèque de l'Université catholique de Louvain.
- National Mycological Herbarium: This collection contains 350 thousand specimens.
- Canadian Collection of Fungal Cultures: This collection contains 16 000 living fungal strains.

PGRC uses its website[22] to communicate all plant germplasm and germplasm information, such as passport data and characterisation data. Also, scientific journals are used to communicate research findings or characterisation and evaluation data of the PGRC germplasm. Sharing PGRC germplasm and associated information is done in accordance with international genebank standards and as directed by the International Treaty on Plant Genetic Resources.

Similarly, the Canadian Animal Genetic Resources (CAGR) Program provides physical and phenotypic data corresponding to DNA and germplasm maintained in the genebank. The CAGR is developing a website for dissemination of information on the animal germplasm held at the genebank.

The results of AAFC research are regularly published in peer-reviewed journals, communicated to stakeholders, shared with international research partners and promoted to media and to Canadians through a variety of communications channels including: media events; participation by scientists in

events that highlight their work; corporate and regional exhibits; videos; and print material such as fact sheets and newsletters. Collaboration with other science-based government departments and intergovernmental communities such as the Science and Technology Cluster (science.gc.ca) also occurs. In addition, AAFC has been a major contributor to the Government of Canada's Open Data Portal[23], a part of the federal Open Government initiative to create greater transparency and accountability, increase citizen engagement, and drive innovation and economic opportunities. Over 1 700 AAFC datasets for agriculture have been made available at the Portal, including numerous sets related to geospatial and genomics data.

The Department's public website provides scientific information tailored to a range of audiences – the general public, users of research, and the scientific community. Also included on the site are descriptions of over 4 000 research projects, research centres and profiles of AAFC scientists.[24] Innovation Express,[25] a magazine of "what's new" in science and innovation from across AAFC, is distributed online. The department also regularly communicates news about scientific research through social media channels.

Fostering knowledge flows: The role of networks and markets

Intellectual property rights (IPRs), knowledge networks, and knowledge markets are of growing importance in fostering innovation, which increasingly requires collaboration and exchanges.

Intellectual Property Rights (IPR) rules

Historically most Canadian agricultural research has been carried out in public institutions, either at federal government experimental farms or publicly funded university research farms and/or laboratories. The output from this research, whether new varieties of existing crops (e.g. Marquis wheat), entirely new crops (e.g. canola), or improvements in livestock breeding techniques, was deemed to be a "public good" and was therefore given freely to producers without the imposition of any form of IP protection. The establishment of IPRs for many products of agricultural research has increased the incentive to undertake more private agricultural research.

In Canada, there are two main types of Intellectual Property (IP) protection used by the agricultural sector: patents and Plant Breeders' Rights (PBRs) (VALGEN, 2012).

Patents are granted by the Canadian Intellectual Property Office (CIPO) and are governed by the *Patent Act*. Once granted, patents are in effect for a period of up to 20 years after the initial patent deposit date and give exclusive rights to the inventor, prohibiting others from manufacturing, using or selling the protected product without the permission of the patent holder. Patents granted by the CIPO are only valid in Canada. Canadian patent applications are assessed against three criteria: novelty, utility and non-obviousness.

Patents may be obtained for either products or processes; in Canada, patents pertaining to agricultural products may cover plant transformation techniques, plant hybridisation methods, genes and chemical seed treatments applied to the exterior of seed. Novel testing methods for determining the presence of transgenes may also be protected. Patents are widely employed in pharmaceuticals, medical instruments and chemicals.

Agricultural crops with patented traits or genes are typically also grown under contracts between purchasers of the agricultural technology (producers) and the company offering the product for sale. These contracts usually prohibit the purchaser from replanting the product of the purchased seed in subsequent years, or using the seed for research purposes without first obtaining written authorisation from the seed developer.

With animals, although the use of patents is not as widespread as with plants, their use is growing. For example, patents protect the DNA "snips" or genetic sequences (similar to the plant traits noted above) that are used, for example, by cattle breeders to determine if bulls possess genetic defects. The user pays a royalty to the patent holder for the use of the "snip" test.

Plant Breeders' Rights (PBRs) offer exclusive rights to the breeder for the production and sale of the propagating material of the protected variety, including its repeated use in the commercial production of hybrid seed. Canada's current PBR legislation, the *Plant Breeders Rights Act,*[26] was enacted in 1990 and conforms to the Convention of the International Union for the Protection of New Varieties of Plants (UPOV78).[27] Proposed legislation in the Agricultural Growth Act, which would enable Canada to comply with the UPOV91 convention, is being discussed by Parliament. UPOV91 offers strengthened protection and improves plant breeders' ability to recover their initial costs of variety breeding and development. It also improves the ability to generate the funds necessary for further re-investment. At present, 77% of all UPOV members benefit from the UPOV91 framework including most of Canada's trading partners (European Union, United States, Japan, Korea, and Australia).

PBRs are obtained through the Canadian Food Inspection Agency (CFIA)'s Plant Breeders' Rights Office. All plant species are eligible for protection in Canada; however, PBRs tend to be utilised by plant breeders for crops where patents are not available.

PBRs are also granted by national governments, but unlike patents, are reserved solely for new plant varieties, offering exclusive rights to the breeder for the production and sale of the propagating material of the protected variety, including the repeated use of the protected variety in the commercial production of hybrid seed.

There are three main mandatory exemptions which set the PBR IP regime apart from patents and balance the interests of the breeder, the farmer and the public in general – breeder's exemption,[28] research exemption[29] and private non-commercial exemption.[30] The PBR breeder's exemption and the research exemption are specifically designed to encourage the sharing of PBR-protected plant varieties for the purpose of advancing scientific study and knowledge, as well as creating new plant varieties for the benefit of society as a whole.

The UPOV PBR regime also contains an optional explicit exemption in the 1991 Convention (mandatory and implicit in the 1978 Convention), known as the "farmer's privilege", which allows a farmer to save the seed produced from a protected variety for subsequent replanting in future years on his/her own holdings.

As patents, PBRs are valid only in the country in which the application was made. In Canada, they last for up to 18 years from the issue date of the certificate.

With regard to sharing of IPRs, public research institutions retain their freedom to work with their own germplasm. Thus when germplasm developed by public research institutions is provided to a private company for breeding and commercialisation, either a licensing agreement or another legal agreement would be used to dictate the terms around the use of the germplasm, including whether or not the finished variety could or should be patented.

Once a public research institution has registered a variety (or even has PBR), but does not have a plant cell, trait or gene patent, the seed can be used by anyone for breeding. Whether a public plant breeder makes breeder seed available to an entity wanting to use it for breeding is another matter. For the most part, when a public research institute provides germplasm to a private company, it dictates the terms on the use through a Material Transfer Agreement (MTA). Such terms can prohibit the company from filing a patent on the public germplasm or on any material developed from it. Most companies request breeder seed directly from the public research institution and agreements are put in place permitting the company to make crosses and commercialise selections. Exchanges between academic institutions have become formalised as well. If a private company or any other entity were to breach the terms of a MTA or a licensing agreement, the recourse would be determined by the court of law.

Trade secrets are information that companies keep secret to give them an advantage over their competitors. In an agricultural context, they are most commonly used in the food processing and manufacturing sectors. For example, the formula for Coca-Cola is one of the most familiar trade

secrets. However, they are also used in some hybrid crops such as corn and canola, as the value to the company or breeder is not to disclose the parental lines (inbred) used, thereby preventing a competitor from replicating the same hybrid cross. Trade secrets are not protected by legislation (e.g. there is no Trade Secrets Act) in the way that trademarks, patents or plant breeders' rights are. Protection for trade secrets is done by non-disclosure agreements or other conditions of employment, where the information must be kept confidential.

Trademarks are words, names, symbols, devices and images that are used to identify any goods. Goods are physical commodities used in interstate commerce, and can be natural, manufactured, or produced. Trademarks are used in agriculture to protect brand names of products or technologies related to their branding and marketing (e.g. Monsanto's RoundUp Ready).

The use of **geographical indications**, though modest in Canada, could be considered a form of trademark protection (e.g. *agneau de Charlevoix*). It could be argued that the application of the Animal Pedigree Act in Canada is a form of IP protection. The bylaws of breed associations formed under the act allow a degree of control to owners for the reproduction of the certified breed of their animals.

Historically in agriculture, patents have been used mainly on genetically engineered (GE) varieties of three field crops; corn, soybean and canola. It is expected that private companies will continue to opt for patents over PBR protection in cases where stronger forms of IP protection are more desirable for protecting their investment.

However, patents have also been granted recently on selected novel soybean varieties obtained from conventional breeding. As a result, it is expected that more breeders of agricultural crops will select for patent protection over PBRs, where applicable and cost effective. Patents also prohibit the activity of saving seed, as well as conducting research or breeding without the expressed authorisation of the patent rights holder. It should be mentioned that the typical 'clientele' for patents and PBRs tends to differ somewhat. In Canada, PBRs continue to be widely used as the primary intellectual property protection tool in the horticulture and ornamental sectors and in field crops other than canola, corn, and soybeans (e.g. cereals such as wheat and barley, pulses and specialty crops). Food processors and manufacturers in Canada typically make use of IP tools (e.g. patents on manufacturing processes, trademarks on their brand identification, trade secrets on their food and beverage formulations) in the same manner other industrial sectors would.

Intellectual Property protection

IP protection is relatively high in Canada; patent protection in particular has increased significantly in the early 1990s and has been stable since (Figure 7.12). On the other hand, Plant Variety Protection as calculated by Campi and Nuvolari (2013) is relatively lower than in Australia or the United States.

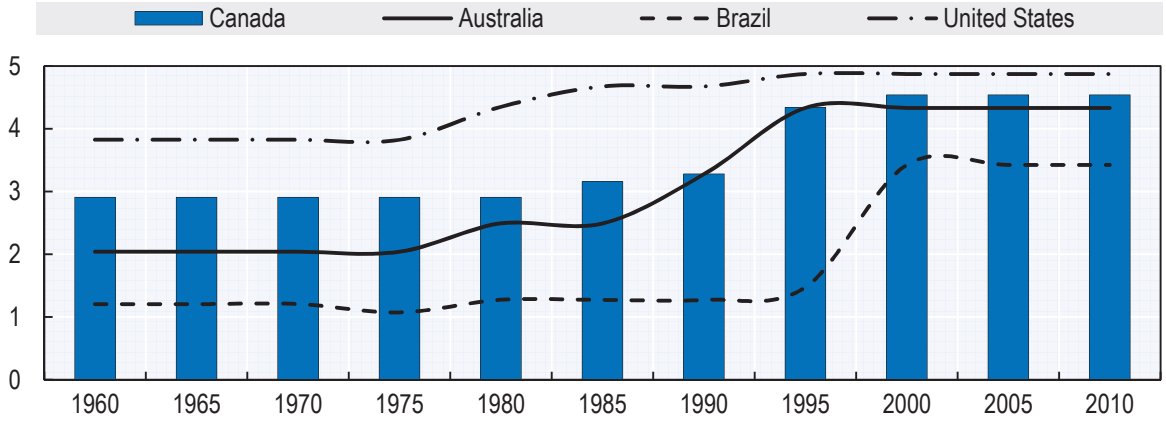
Impact of Intellectual Property protection on private sector investment in new plant varieties and on farmers' access to foreign varieties

At present, approximately 95% of private sector crop research and breeding funding in Canada is targeted towards only three crops (canola, corn, soybeans) that have strong forms of intellectual property protection either in the form of patentable traits and/or the crop hybridisation does not permit for successful saving and replanting of seed. Of the total private sector funding available for research and breeding, only 2-3% is earmarked for wheat.

As required by law, a report on the impacts of the *Plant Breeders' Rights Act* was prepared for review by the Parliament of Canada and presented in 2002. The main findings of the review were that, after ten years of PBR in Canada, there had been an increase in investment in plant breeding and an improvement in access to foreign varieties in both sectors. Plant breeders' rights appeared to have had a positive impact on the availability of improved varieties for producers.[31]

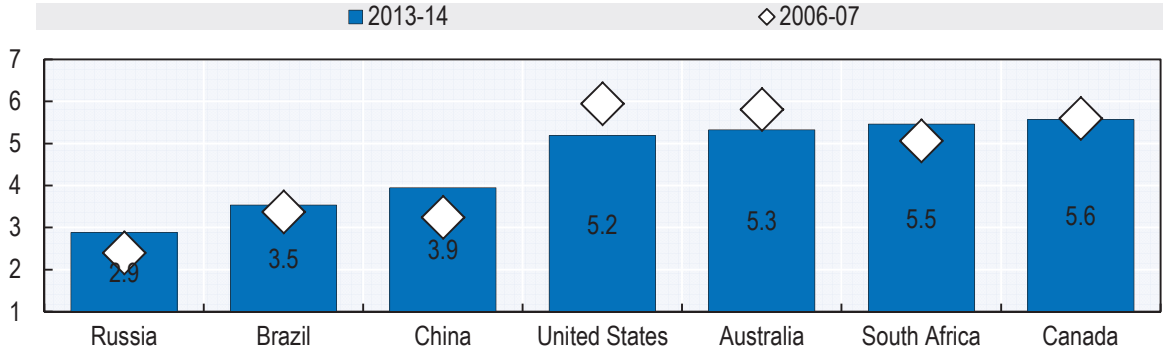
Figure 7.12. Intellectual Property Protection

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



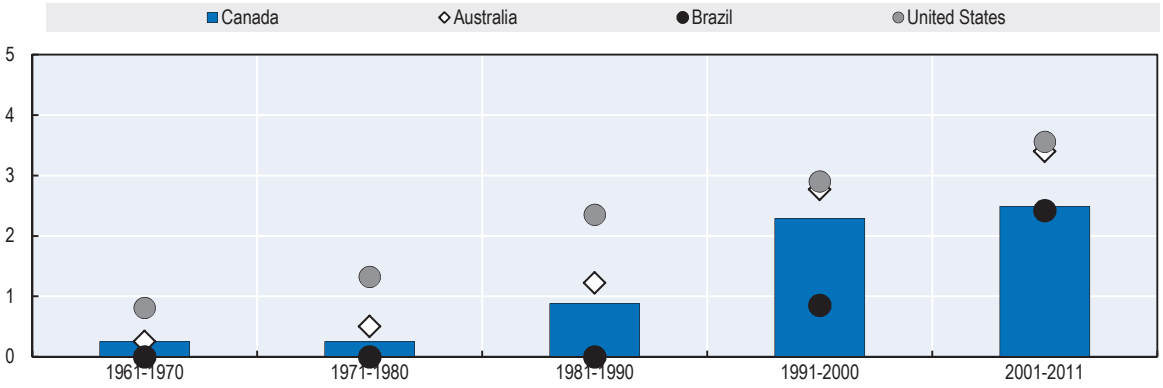
Sum of indices for duration, enforcement, loss of rights, membership and coverage.
Source: Unpublished update to the series from Park, W.G. (2008), "International Patent Protection: 1960-2005", *Research Policy*, No. 37, 761-766.

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



Source: World Economic Forum (2013), *The Global Competitiveness Report 2013-2014*, Full data Edition, Geneva 2013.
http://reports.weforum.org/the-global-competitiveness-report-2013-2014/#.

C. Plant Variety Protection Index
Score 1-4 (best)



Source: Campi, Mercedes; Nuvolari, Alessandro (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.

StatLink http://dx.doi.org/10.1787/888933250619

Delaying the adoption of UPOV91 compared to trading partners has been a barrier to increased levels of investment in the domestic plant breeding programmes of some crops over the past ten years. As well, many foreign breeders have not sought PBR protection nor introduced their varieties into Canada, as the IP regime does not conform to UPOV91. This is seen by a decreasing trend in the annual number of PBR applications since 2006, while other UPOV91 countries are continuing to observe increases. As a result, Canadian farmers are at a competitive disadvantage compared to other countries where clearer protection of the intellectual property of plant breeders provides greater incentives to develop of more productive and higher yielding varieties. In response to this issue, legislation is currently being discussed to reinforce plant breeders' rights, including the adoption of UPOV91.

An area of specific concern for private investment is the cereal sector. At present, over 70% of the wheat varieties available in the Canadian marketplace are derived from public breeding entities (federal government, provincial governments, and universities). In 2012, the International Seed Federation (ISF) conducted a cross jurisdictional study examining royalty collection systems in wheat. Canada ranked as having the lowest remuneration rate in the study, with only 18-20% of the total seed planted having some form of royalty payment. The largest factors cited for the poor performance being the absence of any remuneration system on farm-saved seed, a lack of conformity with UPOV91, and high levels of illegal sales ("brown bagging").

By comparison, other countries that have successfully moved to UPOV91 and implemented farm saved seed remuneration mechanisms have seen increases in private sector investment in wheat, with more varieties available in the marketplace and significant yield gains over time (e.g. Australia, United Kingdom, France). For example, Australia spends CAD 80 million annually on wheat research and breeding, almost exclusively derived from private sector investment. By comparison, Canada spends CAD 25 million annually, which is almost exclusively funded by the public sector.

Public sector research management of Intellectual Property

AAFC's **Office of Intellectual Property and Commercialisation (OIPC)** is responsible and accountable for the development and administration of all processes and procedures regarding the identification, protection and deployment of AAFC's intellectual property (Box 7.3).

Box 7.3. The Office of Intellectual Property and Commercialisation (OIPC)

Under the broad responsibility for managing intellectual property generated by AAFC, OIPC fulfils several functions, including:

- Negotiating and preparing various agreements to facilitate research collaboration: collaborative research agreements, confidentiality agreements, material transfer agreements and research support agreements.
- Negotiating and preparing licence agreements for AAFC technologies and plant varieties.
- Managing knowledge capture, including invention disclosures.
- Identifying collaborators.
- Developing IP protection strategies.
- Preparing IP and business risk assessments.
- Managing patents, copyright, trademarks and official marks.
- Obtaining and maintaining protection of AAFC plant varieties under the *Plant Breeders' Rights Act*;.
- Obtaining variety registration and seed certification for AAFC crops under Canada`s *Seeds Act*;.
- Building business relationships with industry;
- Marketing AAFC inventions and plant varieties, and managing royalty payments on AAFC licences.

Source: http://www.agr.gc.ca/eng/programmes-and-services/list-of-programmes-and-services/?id=1296842751916 or http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1296842751916&lang=eng.

AAFC has a variety of technologies and intellectual property available for commercialisation.[32] Some **licensing opportunities** are competitive and time-sensitive. The department uses the Request for Proposals process to identify technologies that are available for a specific time only. Terms may include commercial exclusivity. If a license is not executed from the Request for Proposals, the technology may continue to be available as a generally available technology. Technologies may also be made available on a non-exclusive basis; such licensing opportunities are included with generally available technologies.

In 2013, AAFC held about 600 **Commercialisation License Agreements** with more than 200 companies. For example, AAFC grants sole rights to seed companies to market crop varieties developed by the department's plant breeders. Other intellectual property such as patents or copyrights developed by AAFC researchers can also be licensed to interested parties.

Institutions to promote sharing of IP across jurisdictions

Canada's *Plant Breeders' Rights Act* facilitates IP sharing, as it allows for exemptions to the holder's exclusive rights for the purposes of conducting research and breeding new plant varieties. This ensures that PBR protected varieties are readily accessible for researchers and plant breeders without requiring authorisation from the rights holder.

Box 7.4. IP management by the University of Waterloo

In general, IP created in the course of teaching and research at the University of Waterloo belongs to the researcher/inventor. Researchers can also choose to have their patents processed by the university, in which case the university retains all patents rights. How often this occurs is not clear, and the policy does not provide a rationale; for universities, retaining ownership of a researcher's patent does not affect their ability to process the patent. Ownership of IP resulting from collaborations with non-university sponsors – including check-off funded producer groups – is determined in separate agreements with the sponsor. In many of these cases, the university maintains IP ownership, but the sponsor maintains an exclusive license. Since funding in these cases comes from outside the university, there is no conflict with the university's inventor ownership policy.

While an inventor-ownership IP policy can be an effective incentive for university researchers, it may not be the central reason for the University of Waterloo's success. Perhaps as important is its academic strength in technical disciplines, a university-wide emphasis on entrepreneurship, and its placement at the centre of a well-recognised high-growth ICT cluster.

Source: AAFC (2014c), *The Role of Intellectual Property in Agricultural Innovation in Canada: An Evolving Landscape* (Agriculture and Agri-Food Canada Report).

There is also a general trend in other areas towards formally establishing technology transfer offices and making them more prominent. Most universities in Canada operate under an inventor-ownership model, where faculty researchers are free to commercialise their inventions at no cost; this is in contrast to the United States for example, where most universities operate under a university-ownership system. The University of Waterloo provides an example of this inventor-ownership model, with its synergistic cooperative education programme, its focus on entrepreneurship as part of its technical disciplines, as well as its policy on intellectual property (Box 7.4). Waterloo is home to more than 700 technology companies today, including Blackberry and Open Text (Council of Canadian Academies, 2009). The University of Manitoba announced in 2014 that it will make new technology from in-house research available to partners with no financial commitments required until the company starts making money from the technology.

Intermediaries can also be important in filling the gap between commercialisers and research institutions. NGOs and NPOs play a key intermediary role in knowledge "translation", for both IP and non-IP knowledge. Ensuring the appropriate use of NGOs/NPOs as brokers for public and academic IP (and non-IP) management can lead to improved adoption and commercialisation. Many countries use intermediary institutes (e.g. 60 *Fraunhofer* Institutes in Germany) who work with researchers to translate and apply knowledge into intellectual property and to identify business partners for commercialisation. In Canada, the Centre for Drug Research and Development (CDRD), a national

not-for-profit research centre, seeks out IP, de-risks discoveries stemming from publicly-funded health research, and transforms them into viable investment opportunities for the private sector – thereby bridging the commercialisation gap between academia and industry.

Public sector's role in providing advice/recommendations to private firms on navigating the IPR system

The Canadian Intellectual Property Office's IP Toolkit[33] helps direct individuals and firms through information about Intellectual Property (IP). It contains general information, instructional modules, links and highlighted glossary terms that answer most IP questions asked by businesses and entrepreneurs. Firms can find out what IP is and why it is useful, how it fits as part of a business strategy, and how to apply for and use it effectively.

In the case of plant varieties, Canada's Plant Breeders' Rights Office[34] discloses information on their website about applying for and navigating the process of obtaining plant variety protection. In addition, a list of staff contacts is available on the website if applicants, agents, breeders, or the general public have questions about the process and/or relevant policies.

Facilitating knowledge flows and linkages within national agricultural innovation system

Reinforcing the linkages among participants in the agricultural innovation system (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.

Facilitating knowledge transfer and adoption at the farm level

Particular attention can be paid to training, extension and advisory services to facilitate the successful adoption of innovation. The potential benefits of innovations are only realised if implementation is effective. Given the large number of farmers, extension services are particularly important for facilitating access to technology and knowledge, in addition to more effective participation in innovation networks.

Knowledge transfer in Canada has been provided in the past through provincial extension agents, who worked closely with producers. The extension service was complemented by formal and informal training offered by post-secondary agricultural institutions, either at the degree or diploma level. As universities were also research institutes, individual researchers provided results directly to producers. Similarly, government researchers, whether federal or provincial, also provided outreach on their results. During the last twenty years, however, the use of provincial extension agents and researcher publications as the main extension mechanism has changed and has been supplemented by industry-led groups and private companies.

Interaction of federal scientific and technical staff with the private sector is an important mechanism to promote knowledge transfer and adoption. Scientists, technicians, and management staff at the research centres interact directly with the sector to promote knowledge transfer and innovation. AAFC employees have networks of formal and informal relationships throughout industry, as well as with provincial governments and academia. These networks extend beyond Canada's borders to participation in international scientific collaborations, researcher exchange programmes and other avenues.

Public research institutions are supplementing their own outreach by working with industry distribution channels. In addition, the technology transfer mechanism used depends on the knowledge to be transferred and the characteristics of the target recipient. Technology transfer mechanisms include: direct transfer from regional specialists; transfer through industry organisations or delivery agents; toll-free call centres that provide professional and technical advice; detailed technical manuals

to inform users on issues and to guide on adoption; demonstration farms or sites to share and transfer knowledge and technologies; website information on all aspects of production/processing; field days, seminars, radio clips and articles for publication in local and regional newspapers; trade shows (e.g. London Poultry Show, Royal Winter Fair, Canadian Western Agribition, Crop Production Week, Banff Pork Seminar, etc.); agriculture science clusters; "Coffee row" – Farmers chatting informally; and Food Technology Centres (e.g. the Guelph Food Technology Centre provides up-to-date knowledge on food safety, product development and sustainability issues to the food and beverage industry).

More specifically related to AAFC's science functions, dedicated outreach staff are employed across the country to help facilitate the transfer of science-based solutions. Outreach staff provide a connection to regional innovation networks that include other federal departments and agencies, provincial extension officers, agricultural producer organisations, private companies and NGOs. They facilitate ongoing partnerships and collaborations, help translate scientific knowledge to locally relevant application, and provide an important feedback loop into strategy formulation at the national level.

Agricultural training and extension services

Agricultural training and extension services[35] are critical to facilitate farmers' access to improved technology and knowledge, and to enable producers to adapt to changing circumstances and solutions. The importance of these services is revealed by the willingness to pay for them, either collectively or individually. Extension services can also facilitate farmer participation in innovation networks.

Training for agri-food professionals within the areas of innovation is generally funded by traditional ministries (education, science, agriculture) and provided by various players, including educational institutions, enterprises, trade unions or employers' associations, and innovation intermediaries[36] who often specialise in certain agricultural fields or in specific extension activities. Examples of specialised innovation intermediaries active in training include:

- **Guelph Food Technology Centre** (GFTC):[37] predominantly fee-for-service training paid by the organisation seeking the training. Each year, more than 3 600 professionals are trained, representing 500 agri-food companies from 26 countries. Over 150 courses are delivered annually in 8 languages, making GFTC an international training leader.
- **Canadian International Grains Institute** (CIGI)[38] For 40 years, CIGI has worked with the agricultural community worldwide in the promotion and utilisation of Canadian field crops. CIGI delivers customised training programmes and technical expertise, and provides ongoing specialised technical support to customers around the world. CIGI is a one-stop shop for technical expertise and facilities housed under one roof. Since 1972, more than 35 000 people representing the grain, oilseed, pulse and special crops industries from 115 countries have participated in CIGI programmes and seminars. CIGI is funded by farmers, AAFC and industry partners.

AAFC's Renewal surveys (AAFC, 2008, p. 14) indicate that farmers are active in seeking out training. In 2007, seven in ten Canadian producers (69%) reported taking some type of farm-related training in the past five years, with the most popular types being related to environmental management (48%), agricultural production (39%), and food safety and quality (26%) (Figure 7.13). Participation for all assessed types of farm-related training increased; however, the most sizeable increases were for training in environmental management (48% up from 31% in 2004).

Extension services in Canada, generally available to all farmers, are differentiated not by income group or region, but by topics such as business development, risk management, food safety, skills development, etc. Government extension services are led by provincial governments, but have significantly been reduced over the last few decades (Gill, 1996). The decline of the public extension system in Canada is the result of several factors, including: the changing rural sector; the challenge of

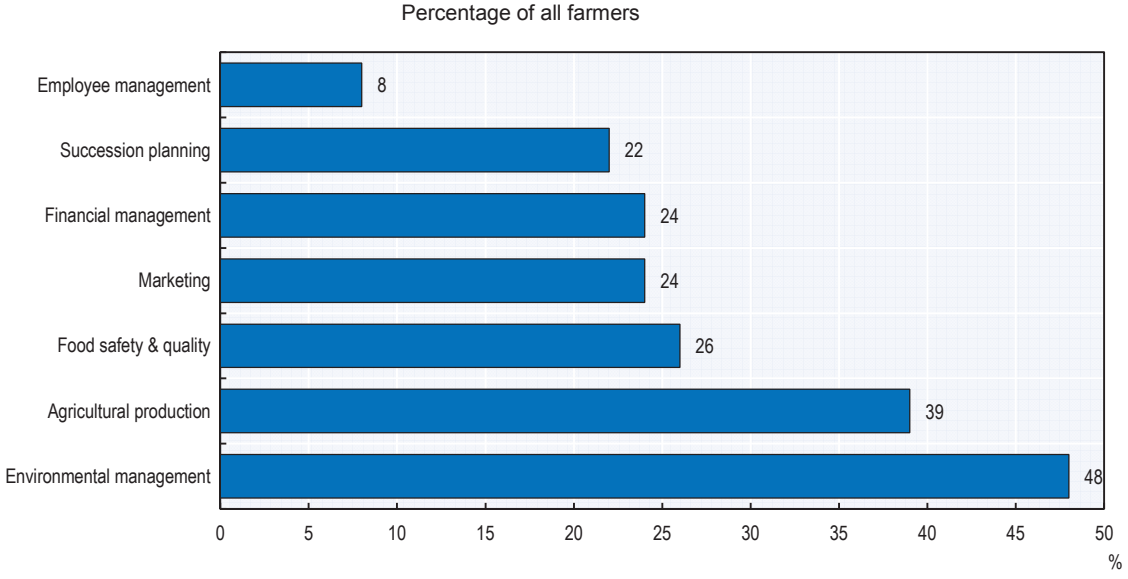
documenting the economic benefits of extension; the changing nature of the farming business; developments in technology and communication; and the evolution of the university system (Milburn et al., 2011). The increasing involvement of industry in knowledge transfer is influenced by funding and programme cuts to government extension services.

Private companies now train professionals to provide customer services focused on sales of inputs and equipment (e.g. agronomists to help farmers decide on proper timing of herbicide application). Many of these same companies host field days or on-site demonstrations, conduct research trials, put on seminars, sponsor trade shows, etc. Cooperatives in various segments of the agriculture sector also play a role, where members of the cooperative are offered extension-like services for mutually beneficial farm practices.

Many producer organisations such as the Canola Council of Canada[39] and Canadian Cattlemen's Association[40] offer information through their websites and print publications (e.g. agronomics, disease management, results of variety trials, tillage technology, environmental practices, new production/processing approaches/equipment and marketing options). Social media tools such as FarmOn[41] and podcasts by the Canadian Cattlemen's Association allow producers to seek advice and share information on new products and practices in real time. Demonstration on farms or sites, field days, seminars, radio clips, articles for publication in local and regional newspapers, and trade shows are also essential in facilitating knowledge flows for the sector. Academia can also provide extension with specialised workshops. For example the Canadian Beef School[42] is conducted from the Olds College (Alberta) animal science programme.

There are regional differences in the supply of extension services. In Quebec, about half of all agricultural advisors work in private enterprises or cooperatives that are active in the input sector or financial services. Others include 1) farm advisory groups or clubs; 2) private consultants or consulting firms; and 3) para-public organisations (Gaboury-Bonhomme, 2011). While in Quebec, the provincial government has withdrawn from funding and providing extension services, the Ministry of Agriculture in Saskatchewan, has strongly invested in this area. Within the Regional Services Branch, ten offices located throughout the province and within the Ministry's Agricultural Knowledge Centre offer extension services to producers.

Figure 7.13. Share of farmers receiving farm-related training, 2007



Source: National Renewal Survey, 2007, commissioned by AAFC.

StatLink http://dx.doi.org/10.1787/888933250625

Box 7.5. Improving business and management skills

Successive agricultural policy frameworks included funding for the development of farmers' skills and knowledge. Under the first policy framework (2003-2008), programmes were delivered directly by the Federal Government, while Growing Forward (2008-2013) transferred the delivery of these programmes to the provinces and territories, allowing for more flexibility to make the programmes increasingly responsive and adaptable to actual needs.

Under Growing Forward (2008-2013), the Business Development Program (BDP) funded activities related to agriculture business management practices and skills development (including in some instances succession planning), and provided for enhanced participation by young or new entrants. This programme was delivered through the provision of:

- Federal funding to cost-shared provincial initiatives (60-40) (programme design and development shifted to the provinces and territories); and
- Federal-only support to national organisations: Farm Management Canada; Canadian 4H Council (4H), which focuses on enhancing the skills of youth; Canadian Young Farmers' Forum (CYFF) that connects leading young agriculture producers across Canada, including through best management practices (BMP) workshops; Canadian Agricultural Safety Association (CASA), which provides leadership and direction for agricultural health and safety; and Canada's Outstanding Young Farmers' Program (COYFP), which recognises excellence in young farmers, enables the exchange of ideas, and raises awareness of good farm business management practices.

Under Growing Forward 2 (2013-2018), the AgriCompetitiveness programme concentrates on activities that increase the sector's ability to adapt and sustain itself on a national scale, while activities under the Cost-Shared Programme focus on addressing regional circumstances to increase the adaptability of the sector.

Under the AgriCompetitiveness programme, the Stream B Fostering Business Development initiative supports projects designed to enhance skills, tools and knowledge of entrepreneurs in the industry through: activities that allow agri-businesses to transition, adapt, and improve their profitability and resilience; by nurturing entrepreneurial capacity through the development of both young and established farmers; farm safety initiatives; business skills; and individual and industry leadership. Contribution funding may also be provided to not-for-profit organisations that operate nationally, whose proposed projects are national in scope, and which support and complement the objectives of the Growing Forward 2 cost-shared Adaptability and Industry Capacity (AIC) programme.

The Cost-Shared Adaptability and Industry Capacity programme specifically targets regional needs and circumstances. Eligible programmes and initiatives provide producers and agri-businesses with the knowledge, tools and skills needed to understand their financial situation of their business, to assess opportunities, and to respond to changes.

Provincial and Territorial Programs (including cost-shared programmes under Growing Forward) are listed in Annex 7.A4. Some major provincial government programmes are:

- In Manitoba, the provincial ministry provides grants to the Agricultural Societies Program. Corporations recognised as an Agricultural Society in Manitoba can apply for financial and leadership development assistance to conduct educational, community and leadership development activities, including fairs and exhibitions.
- In Nova Scotia, the provincial agriculture ministry provides extension services through the Crown (provincially-owned) corporation, Perennia.
- In Quebec, the provincial agriculture ministry provides extension services related to farm business management and agri-environmental initiatives to producers through a network of advisors.
- The Ontario Farm Innovation Program (OFIP) aims to increase the development, adaptation, assessment and adoption of innovations to help agricultural producers respond to changing demands.
- In Saskatchewan, the Agriculture Demonstration of Practices and Technologies (ADOPT) programme accelerates the transfer of knowledge to Saskatchewan farmers and ranchers. Funding is provided to help producer groups evaluate and demonstrate new agricultural practices and technologies at the local level.

Other measures promoting adoption of innovation and knowledge transfer

Past and current framework programmes include specific measures aimed at improving on-farm and firm adoption of innovation by:

- Improving business and management skills (Box 7.5 above).
- Supporting innovation and adaptation (Box 6.1).

- Facilitating access to credit (Box 6.3).
- Promoting the adoption of agri-environmental practices (Box 6.4).

The AAFC Pest Management Centre's Pesticide Risk Reduction Program provides a platform to deliver assistance to support research, development and transfer of reduced-risk pest control solutions. These activities take place within the context of pesticide risk reduction strategies developed in consultation and collaboration with stakeholders. This process not only helps the programme deliver pest management solutions, but also ensures their rapid adoption by farmers. Examples of material developed to facilitate knowledge transfer include target pest identification and biology brochures, fact sheets on biological and mechanical pest control options, and integrated approaches to controlling weeds, insects and plant diseases.

Financing and funding mechanisms for commercialising innovation

The proportion of innovation funding dedicated to the commercialisation of goods has been progressively increasing within broader federal government programming, as well as within the agriculture portfolio. At the same time, pre-commercialisation support has also strengthened, although it had already been present in various forms (Niva Inc., 2009).

The unprecedented level of support for commercialisation and new instruments in the 2012 and 2013 budget was largely based on the recommendations by the Jenkins report (Government of Canada, 2011), which had built on previous diagnostic analysis by the Council of Canadian Academies (CCA, 2009). The nature of the policy shift can be simplified as a shifting of support from indirect general support for R&D towards more direct, targeted and downstream support. This was exemplified by streamlining the general tax credit for R&D (SR&ED), and increasing pre-commercialisation direct support through the NRC's Industrial Research Assistance Program (IRAP),[43] as well as offering new procurement and venture capital initiatives. The majority of these national programming initiatives are open to support the agricultural sector where applicable, although uptake varies from programme to programme.

Incentives for collaboration within Agricultural Innovation System

The main economic, social, environmental and regulatory factors that drive collaboration in Canada include:

- The decreasing availability of funding and the global recession.
- Few organisations have sufficient funds or personnel to work in isolation.
- Desire for intellectual interaction and collaboration.
- Need for a division of labour in more specialised or capital-intensive areas of science.
- Science-based, regulatory approval processes may involve several disciplines.
- Government encouragement of international and cross-sectoral collaboration.

Government scientists work with a variety of agricultural research parties, in Canada and globally, enabling them to participate in, monitor and learn from cutting-edge work across disciplines. In addition, agricultural colleges and universities collaborate with government, other countries and private companies. Food processors collaborate with food and raw product suppliers for product innovation. Collaborations can be scientific endeavours with industry or larger, more strategic initiatives with industry, university and other institutions. Collaborations in Canada serve as a knowledge transfer vehicle and bring together several disciplines to address complex issues.

AAFC has a Collaborative Policy Framework for reviewing proposals from the perspectives of scientific merit and management criteria to determine if it is an appropriate role of government and whether the specific collaborative efforts leverage and build capacity.

The general innovation system includes institutions and mechanisms, such as the NRC and its programmes, which facilitate collaboration between innovation stakeholders and support the commercialisation of innovation, including in the food and agriculture sector.

The **Networks of Centres of Excellence (NCE)**[44] provide opportunities for Canadian researchers and students to work with sector partners in a variety of research areas and accelerate the exchange of knowledge and transfer of technological innovations (OECD, 2011). They offer programmes that:

- Mobilise multi-disciplinary research capacity from across Canada to accelerate the creation of new knowledge in a specific research area.
- Create large-scale, academic-led research networks.
- Engage partners from multiple academic institutions, industry, government and not-for-profit organisations.
- Train the next generation of HQP.
- Work with end-users to facilitate the application of knowledge.
- Increase collaboration between researchers in Canada and abroad.

The NCE Secretariat manages four national programmes.

NCE Program (includes the NCE Knowledge Mobilisation and the Canada-India Research Centre of Excellence initiatives): Finds solutions to social, economic or health issues via a collaborative approach and a wide range of research expertise. The programme supports large-scale, multi-disciplinary led research networks. Partners from industry, government and not-for-profit organisations contribute additional expertise and contribute around CAD 90 million per year of cash and in-kind support.

- **Centres of Excellence for Commercialisation and Research (CECR)**: Matches clusters of research **expertise** with industry to share the knowledge and resources that bring innovations to market faster. Centres advance research and facilitate commercialisation within four priority areas: the environment; natural resources and energy; health and life sciences; and information and communications technologies.
- **Business-Led Networks of Centres of Excellence (BL-NCE)**: Funds large-scale collaborative research networks that bring a wide range of expertise to bear on specific challenges identified by an **industrial** sector. BL-NCEs are led by a not-for-profit consortium of industrial partners and networks to enhance private sector innovation by blending with academic expertise. BL-NCEs increase private sector investments in Canadian research, support training of skilled researchers, and accelerate the transfer of ideas from the laboratory into solutions needed by the industry.
- **Industrial Research and Development Internship (IRDI)**: Helps meet Canada's need for training highly skilled workers. IRDI gives graduate students and post-doctoral fellows opportunities to gain industry experience by solving private-sector challenges. Industry partners benefit from hosting highly skilled interns with specialised research knowledge. The IRDI programme increases the science and technology capacity of businesses, while creating new opportunities for HQP. The programme supports collaborative projects in various academic disciplines that involve graduate students and postdoctoral fellows, their supervising professors, and industry partners.

In addition, the Canadian agriculture system has a number of institutional arrangements that foster collaboration and cooperation to increase knowledge flows and dissemination among key stakeholders in the sector.

Canada's **Agri-Science Clusters**[45] are industry-led initiatives (e.g. institutional arrangements) in which institutions from industry, academia and government collaborate to bring together a critical mass of scientific and technical resources/expertise to accelerate innovation in agriculture and the value-added industries.

Government plays a supporting role for cluster activity in the form of non-repayable funds (Growing Forward 2 funding), and through collaborative technical expertise of federal scientists and technology transfer personnel. Other funding is sourced from industry (e.g. farm-level check-offs, industry NPO funds), although funding sources differ by cluster.

Clusters engage in a targeted approach using both applied and pre-commercialisation science to address gaps and accelerate innovation. A collaborative approach is used at all stages – from gap identification and expertise engagement through to knowledge/technology transfer:

- Gap identification: The cluster lead, guided by *value-chain strategic plans*, engages stakeholders and the science community to identify key knowledge/information gaps in achieving their strategic objectives.
- Developing solutions: The lead organisation invites proposals from the science community to address identified gaps. It is responsible for the project – selection, supervision, and communication of results.
- Accelerated adoption: The cluster's technology transfer and commercialisation strategy is engaged to ensure an efficient adoption of new practices and/or technologies and the effective communication of new information created by these research efforts.

As of December 2014, twelve clusters organised along commodity lines have been funded:

- Beef Cattle Industry Science Cluster.[46]
- Cluster for Dairy: Innovation in Nutrition/Health and Sustainable Development.[47]
- Canadian Swine Research and Development Cluster.[48]
- Canadian Poultry Science Cluster for Sustaining Industry Competitiveness and Addressing Societal Issues.[49]
- Canola/Flax Agri-Science Cluster.[50]
- Pulse Science Cluster.[51]
- Canadian Wheat Breeding Research Cluster.[52]
- Canadian Agri-Science Cluster for Horticulture. [53]
- Canadian Ornamental Horticulture Research and Innovation Cluster.[54]
- Improving Competitiveness and Profitability of Canadian Agriculture with an Organic Science Cluster.[55]
- Canadian Field Crop Research Alliance.[56]
- Bioindustrial Innovation Canada.[57]

In addition to Clusters programmes, there are several mechanisms in place for funding Public-Private Partnerships (PPPs), including federal and provincial government programmes, formal agreements between public and private players (e.g. MoU), and private sector donations and endowments.

Launched in December 2012, the **Global Institute for Food Security** is an example of an agricultural PPP funded by private sector endowment. Housed at the University of Saskatchewan, this initiative received a commitment of CAD 35 million from the Potash Corporation of Saskatchewan Inc., and is one of the largest corporate donations for university research in Canada. The province of Saskatchewan has also committed a CAD 15 million endowment over the next seven years to support this project.

Another example of a successful PPP is the **Canadian Wheat Alliance**, which is an 11-year commitment among AAFC, the University of Saskatchewan, the Province of Saskatchewan and the National Research Council to support and advance research aimed at improving the profitability of Canadian wheat producers. The Canadian Wheat Alliance will align their complementary areas in high priority research areas including variety development. It was established in April 2013 with an initial investment of CAD 97 million dollars over five years by the federal and provincial governments and the University of Saskatchewan.[58]

Collaboration between public and private agricultural research is encouraged through the use of complex models such as public-private-producer partnerships (P4s) and clusters, which often result from industry experts recognising the deficiencies of existing business models and coming together to create networks among industry, producer associations and government to better coordinate R&D priority setting exercises. There are several examples of P4s including the Saskatchewan Pulse Growers,[59] the Western Grain Research Foundation, Vineland Research and Innovation Centre,[60] and the *Centre de développement du porc du Quebec*.

AAFC's **Pest Management Centre** (PMC) is an example of collaboration between growers, governments and the private sector. The PMC's Minor Use Pesticides Program (MUPP) works with commodity organisations, manufacturers, the provinces, the regulator (Health Canada's Pest Management Regulatory Agency) and the US Department of Agriculture's Interregional Project #4 (IR-4) to identify and prioritise the top crop/pest issues and to match them with potential solutions. The MUPP then conducts field trials on grower-selected priorities to determine product efficacy, crop tolerance and residue levels before drafting regulatory submissions to the Pest Management Regulatory Agency (PMRA) for review and decision.

Canada's twelve **Value Chain Round Tables** (VCRTs) are mechanisms for cooperation across the supply chains at the national level. Launched in 2003, the VCRTs bring together key industry leaders from across the value chain – input suppliers, producers, processors, food service industries, retailers, traders and associations (geographical regions and sector diversity are also considered) – with federal and provincial government policy makers. VCRTs have become central vehicles for:

- Identifying sector strengths and weakness.
- Capitalising on domestic and international market opportunities.
- Sharing information and building trust across commodity sectors.
- Identifying research, policy, regulatory and technical requirements.
- Creating shared visions and cooperative long-term strategies.
- Responding to crises.

Canada's VCRTs represent the beef, food processing, grains, horticulture, organic, pork, pulses, seafood, seeds, sheep, and special crops. In addition, an Industrial Bioproducts Value Chain Committee was formed in February 2013.

Strengthening international co-operation on agricultural innovation

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. This allows countries with limited research capacity to focus their scarce resources on local specificities.

Efforts regarding exchange of staff

Canada strives for an open, transparent and efficient set of policies and programmes that promote the movement of knowledge workers, both within the science research community and for business. Canada follows many international conventions and norms when it comes to facilitating the movement of business or commercial travellers (category that most agricultural innovation system workers would fall into when crossing borders). One of the tools used to facilitate business travel:

- The ATA[61] Carnet is widely used by the business community for the temporary importation of a multitude of goods into countries worldwide. The document covers commercial samples, professional equipment, and goods for presentation or use at trade fairs, shows and exhibitions.
- Currently 71 countries are part of the programme, with more joining every year. Many foreign authorities view the ATA Carnet as the only acceptable document for duty- and tax-free temporary importation of goods.
- Armed with the ATA Carnet, business people can make advance customs arrangements at a predetermined cost, visit several countries, use the ATA Carnet for several trips during its one-year validity, and return to the home country with no problems or delays.
- The World Customs Organization administers the international customs conventions under which the ATA Carnet system operates, and the International Chamber of Commerce World Chambers Federation administers the ATA system.

Canada also has a policy that allows multi-national companies to bring in expert staff from other parts of the world to work in their Canadian operations as required, at least on a temporary basis. There is also a relatively open and transparent process for foreign academic and scientific knowledge workers to come and work in Canada for varying lengths of time. The North American Free Trade Agreement (NAFTA) makes specific provisions for the movement of knowledge workers (generally those with university-level education) from the United States and Mexico to work in Canada, and vice versa.

Canadian universities have diverse workforces and international training opportunities, with Canadians academics, post-graduate students and students working overseas and offering opportunities to host similar experts domestically. All of Canada's agricultural and veterinarian colleges and universities take advantage of these opportunities.

AAFC plays a major role in agricultural science research and technology development, and has numerous MoUs and agreements with many countries and internationally recognised research institutions that facilitate the movement of experts into and out of Canada.

The International Development Research Centre (IDRC) is a Canadian crown corporation that supports local research to help developing countries use science and technology to improve food quality, health, job creation, etc. IDRC also encourages sharing this knowledge with policymakers, other researchers, and communities around the world. To accomplish its goals in generating and applying new knowledge to meet the challenges faced by low-income countries, training and exchange of highly qualified personnel are critical.

Canada's **Temporary Foreign Worker Program (TFWP)** enables employers in Canada to hire foreign nationals on a temporary basis to meet short-term skill and labour needs when Canadians or permanent residents are not available (Box 4.4).

Access to highly qualified personnel and exchange of staff takes place through the following programmes and mechanisms:

- Visiting Fellowships Program of the National Science and Engineering Research Council (NSERC)[62]: young scientists and engineers work for 1-3 years with research groups in Canadian government laboratories and research institutions.
- Foreign Research Participant Program for International Students, Scientists and Experts: facilitates exchanges in which international participants conduct research on approved Canadian research projects at AAFC for mutual benefit.
- Foreign Research Exchange Programs for Canadian Scientists and Experts: work transfers or secondments provide AAFC scientists with the opportunity to work with leading scientists and laboratories using cutting-edge technologies and resources, and to develop networks and promote Canadian objectives.
- Alumni networks for International Students, Scientists and Experts: maintain contact with these experts who may serve as "ambassadors" for ongoing cooperation.
- Joint research calls, for example with the European Union, United States and New Zealand under an agreement of the Joint Programming Initiative – Agriculture, Food Security and Climate Change (JPI-FACCE).
- The Visiting Experts Programme of the Food and Agriculture Organization of the United Nations[63] (FAO) provides a framework for Canadian scholars and researchers to contribute their expertise to issues related to hunger and food security.

Mechanisms to encourage international co-operation

Canada is a founding member and has remained a top donor to the Consultative Group on International Agricultural Research (CGIAR)[64] for over 40 years.

AAFC is a member of an International Platform for Coordinating the IPR Issues (PIPRA)[65] was founded in 2004 with a vision to reduce the barriers to innovation by sharing IPR information, improving commercialisation strategies, etc. PIPRA is an international collaboration of universities, foundations, public entities, and non-profit research institutions which makes agricultural technologies more easily available for both developing and developed countries. PIPRA has developed a plant transformation vector (commonly known as pPIPRA) with maximum freedom-to-operate. The vector user will know with whom to negotiate in order to have the legal rights to access any previous research results. With a pro bono attorney network,[66] PIPRA provides intellectual property rights and commercialisation strategy services to its members.

Canadian and US regulators co-operate on pest management and pesticide use issues through AAFC's Pest Management Centre (PMC)'s Minor Use Pesticides Program (MUPP) and the US Department of Agriculture's IR-4[67] Project. In addition to the activities mentioned above, the PMC and IR-4 conduct joint projects on similar crop and pest problems with the goal of achieving safe and effective new use solutions simultaneously in both countries. Regulators on both sides of the border are conducting joint reviews of many of these projects. The entire cooperative effort saves time and resources, and often results in harmonised Maximum Residue Limits which prevents trade barriers.

AAFC is also engaged in a number of international science-based networks listed in Box 7.6.

Box 7.6. AAFC participation in international science-based networks

- Governing Body of the *FAO International Treaty on Plant Genetic Resources for Food and Agriculture* – Canada is a party to this legally-binding international agreement (http://www.planttreaty.org/).
- *Commission on Genetic Resources* for Food and Agriculture of the United Nations Food and Agriculture Organization (FAO – http://www.fao.org/nr/cgrfa/en/).
- FAO *Global Initiative on Plant Breeding* (http://km.fao.org/gipb/).
- FAO *Global Soil Partnership* (http://www.fao.org/globalsoilpartnership/en/).
- *Forum for the Americas on Agricultural Research and Technology Development* (FORAGRO – http://www.iica.int/foragro/) of the Inter-American Institute for Cooperation in Agriculture (IICA).
- IICA *Cooperative Program in Agricultural Research and Technology for the Northern Region* (PROCINORTE – http://www.procinorte.net/Pages/Default.aspx), research network with USA and Mexico.
- *Convention on Biological Diversity*; Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA – http://www.cbd.int/sbstta).
- *Intergovernmental Platform on Biodiversity and Ecosystem Services* (IPBES – http://www.ipbes.net/).
- *Commission for Agro-meteorology* of the World Meteorological Organization (WMO – http://www.wmo.int/pages/prog/wcp/agm/cagm/cagm_en.php).
- Global Forum on Agricultural Research (GFAR – http://www.egfar.org/).
- G20 *Wheat Research Initiative* (IRIWI – http://www.wheatinitiative.org/) and International Wheat Yield Network (WYN).
- G8 *Open Data Initiative* (https://sites.google.com/site/g8opendataconference/home).
- *Cooperative Research Program* (CRP – http://www.oecd.org/agriculture.crp) of the Organisation for Economic Cooperation and Development (OECD).
- *Agriculture Technical Cooperation Working Group* (ATCWG – http://www.apec.org/Groups/SOM-Steering-Committee-on-Economic-and-Technical-Cooperation/Working-Groups/Agricultural-Technical-Cooperation.aspx) of the Asia-Pacific Economic Cooperation (APEC).
- Other international agricultural Research Centres (e.g. AVRDC (Asian Vegetable Research and Development Centre), CATIE (Centro agronómico tropical de investigación), ICIPE (International Centre of Insect Physiology and Ecology), GlobalHort, INBAR (International Network for Bamboo and Rattan).
- CABI International Bioscience (http://www.cabi.org/).
- *International Dairy Federation for Dairy Research* (IDF: http://www.fil-idf.org/Public/ColumnsPage.php?ID=23077).
- *Group on Earth Observations* (GEO – http://www.earthobservations.org/index.shtml) Agricultural Monitoring (GLAM)
- GEO Joint Experiment of Crop Assessment and Monitoring (JECAM: http://jecam.org/).
- GEO Global Drought Monitoring Initiative (GDM).
- International Panel on Climate Change (IPCC: http://www.ipcc.ch/).
- *Global Research Alliance on Agricultural Greenhouse Gases* (GRA: http://www.globalresearchalliance.org/).
- Joint Programming Initiative - Agriculture, Food Security and Climate Change (JPI-FACCE – http://www.faccejpi.com/).
- International Knowledge-Based Bio-Economy Forum (KBBE).

International technology transfer

The private market is the main vehicle importing new technology and making it available to Canadian farmers and to up-stream and downstream industries. The Government has programmes, such as the International Research Assistance Program, to help adapt technology to actual requirements. Some of AAFC's partners have preferred formal mechanisms, such as MoUs, which list priority areas, the forms of cooperation and intellectual property considerations. Through the use of MoUs, AAFC seeks to share knowledge and best practices with its international partners (e.g. China, India, Indonesia) in an effort to advance issues of mutual interest, such as animal development and production, plant development and production, sustainable agriculture (water and soil management, use of pesticides and chemicals, quality and safety of products), and processing technologies.

The main mechanisms that AAFC uses to facilitate technology transfer include:

- The Foreign Research Participant Program provides an opportunity for international participants who meet the screening criteria to participate in science and technology projects that are consistent with AAFC priorities. The participants are hosted at AAFC research centres.
- Memorandum of Understanding: A partnership mechanism between AAFC and foreign government organisations or agencies that identifies common objectives, priority areas to pursue in a cooperative context, and the policy framework for that cooperation. While it formalises the relationship among partners, an MoU is not an international legal instrument and therefore it is not legally binding.
- Academic Exchange Agreement: A partnership between AAFC and a foreign university or research centre working in the agricultural or agri-food field. It seeks to foster academic and scientific cooperation, knowledge sharing and research activities of common interest. An academic exchange agreement is implemented through student and visiting researcher exchanges, joint research activities or scientific documentation exchanges, etc.
- Collaborative / Cooperative Arrangement: A partnership mechanism through which AAFC establishes a cooperation strategy with a public or private agency. It sets out specific objectives and priority areas that are intended to be the subject of close collaboration. A collaborative arrangement involves no legal or financial constraint.
- Letter of Intent: A document in which AAFC and international (public or private) organisations express the shared desire to work towards establishing a partnership or continue a partnership that generates mutually beneficial activities. That intent could result in the signing of an umbrella MoU, an Academic Exchange Agreement or a Collaborative/Cooperative Arrangement. A Letter of Intent creates no obligation on the part of the parties in question.

Knowledge for innovation, such as ideas or management systems that may be imbedded in more intangible ways, also flows freely, sometimes supported by government activities. Seminars, workshops, and other information exchanges are used as vehicles for the transfer of knowledge, best practices and technology. Examples include a five-day risk assessment and management workshop held in Canada for high level officials from China's Ministry of Agriculture, and a three-day conference held in China on genetic evaluation of dairy cattle. In addition, joint projects and research are also used as a means to transfer knowledge and technology through practical application. For example, the Live Swine and Dairy Cattle projects proposed under the MoU between AAFC and India's Ministry of Agriculture aim to transfer Canadian expertise in these areas to contribute to the programme of increasing protein production in India.

Normally there is a mix of domestic and international knowledge available, allowing the private sector to adopt whatever combination might work best in their particular situations. Canadian industry makes extensive use of modern information technology to seek out new knowledge or technology (i.e. internet) and will obtain the information they need to make investment decisions, including

traveling internationally. Many sector organisations also play a role in seeking out and bringing new technology and knowledge to their members.

Measuring the performance of the Agricultural Innovation System

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. Surveys can also provide a picture of the variety of innovators and innovations created by the public and private sectors, and adopted by farms and firms.

R&D outcomes

The number of patents in a country is a proxy for R&D outcomes. It is not a comprehensive indicator of the performance 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 (2013c). According to agricultural patent applications filed under the Patent Co-operation Treaty (PCT), which protects inventions in all signatory countries, Canada is the tenth largest contributor to the total of world agriculture patents covering specific agricultural inputs, agricultural sciences and food processing innovations (Figure 7.A5.1). The share of agriculture-related patents in Canada's total number of patents is higher than the share of the corresponding sectors in GDP (Table 7.5). Most patents are in food processing rather than agricultural science.

Data on agricultural publications and citations confirm and strengthen the image of a relatively strong Canadian contribution to agriculture innovation at the world level and in comparison with the importance of the sector for the economy (Figure 7.A5.3 and 7.A5.4). Agricultural sciences dominate bibliographic references on agriculture, while most agriculture patents are related to food processing. Canada's share of agricultural science publications and citations in the total world output has decreased in the last 15 years (Figure 7.14). This reflects the strong increase in contributions by BRIICS countries,[68] as the number of agriculture publications increased by close to 3% per year between 1996 and 2012 (compared to around 28% in the BRIICS and around 5% in the OECD area).

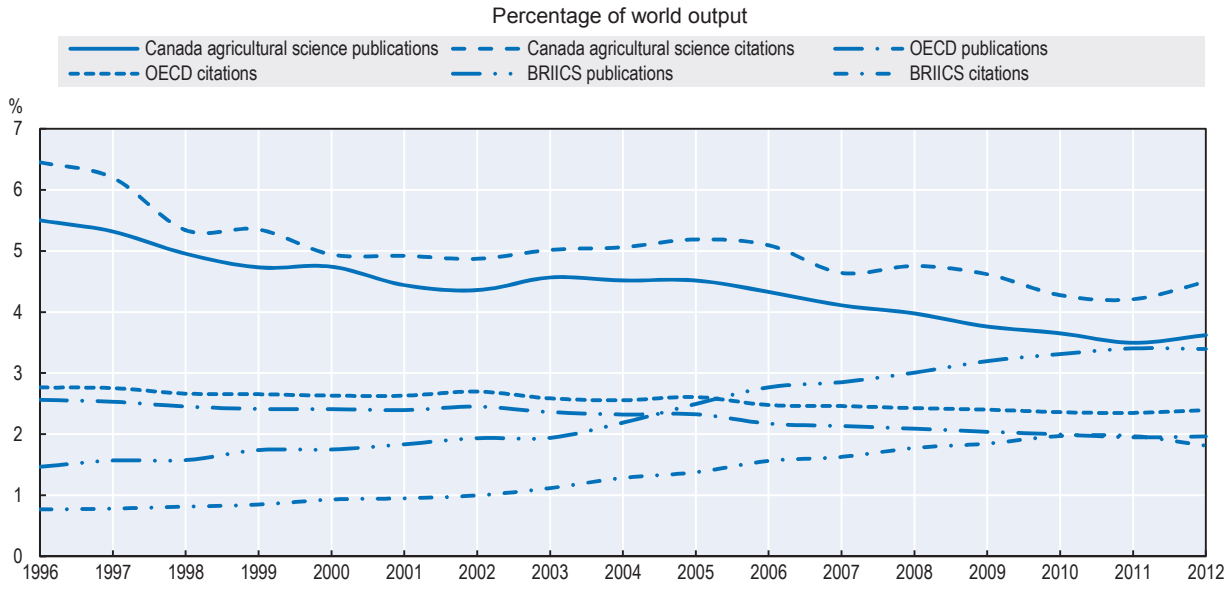
Table 7.5. R&D outcomes, 2006-11

	Australia	Brazil	Canada	United States	OECD average	OECD total
Agri-food specialisation: agri-food as a share of country's total (%)						
Patents	7.4	11.0	6.0	6.8	5.6	
Publications	10.6	19.4	8.7	6.7	9.4	
Citations	10.8	15.5	8.3	6.3	11.9	
Country's contribution to world agri-food output (%)						
Patents	0.5	0.2	0.6	10.8	0.7	27.9
Publications	3.3	4.7	3.7	18.3	2.0	68.9
Citations	2.9	1.2	4.1	27.2	..	48.4

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

StatLink http://dx.doi.org/10.1787/888933250737

Figure 7.14. Evolution of scientific output and impact in agricultural sciences, 1996-2012



Agricultural science includes Scopus journal classifications: agronomy and crop science, animal science and zoology, aquatic science, ecology/evolution/behaviour systematics, forestry, horticulture, insect science, plant science and soil science, and miscellaneous agriculture/biological sciences.

Source: SCImago. (2007). *SJR — SCImago Journal & Country Rank*, Retrieved 19 March 2014, from http://www.scimagojr.com.

StatLink http://dx.doi.org/10.1787/888933250632

R&D collaboration

About 30% of Canadian agriculture patents have a foreign co-inventor, and those account for a larger share of the world's total than wholly Canadian agricultural patents (Table 7.6 and Figure 7.A5.2), indicating that Canadian agricultural innovators are more engaged in cross-country cooperation than the average of developed and emerging economies. As for other countries, collaboration rates are higher for publications than for patents. At about 50%, the Canadian collaboration rate is much higher than in the United States, but is lower than in many European countries (Figure 7.A5.3). While government policy may influence collaboration, it is strongly linked to the size of the country, with innovators in smaller countries more likely to collaborate internationally when they have a certain level of research capacity (Figure 7.A5.5).

Table 7.6. R&D co-operation, 2006-11

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

	Australia	Brazil	Canada	United States	OECD average
Patents	23.1	29.7	29.7	14.3	11.8
Publications	47.3	22.3	48.9	36.4	50.8

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

Rate of adoption of new techniques and methods within the agricultural sector

Data around farm-level adoption of new techniques and methods in the Canadian sector is limited. General information from the Census of Agriculture and other related surveys shows that cropping practices and certain types of crop and machinery (no till) have been adopted widely over many decades, and that business practices have changed with the times (AAFC, 2011). Statistics Canada has

also produced a *Survey of Innovation and Business Strategy* in both 2009 and 2012, which touch on adoption of new techniques and methods in the processing level.

In addition to information from Statistics Canada, other research can fill some data gaps. For example, Farm Credit Canada administers a self-selected Vision Panel, and regional or provincial research centres provide insight into trends in the sector, as well as the factors that contribute to the farm-level capacity to innovate (Farm Credit Canada, 2009).

A recent survey administered by the University of Saskatchewan to farmers in Saskatchewan, Alberta, and Manitoba examined the adoption rates of different innovations at the farm level. The survey covered a wide range of innovation types:

- *Product innovations*: New crop types and/or cultivars, new livestock breeds and/or types.
- *Process innovations*: Irrigation and water management practices, changes in weed, pest and disease management practices, change in soil management practices and fertiliser application, use of new cropping equipment, livestock health, handling and/or feeding practices, etc.
- *Organisational innovations:* Use of incentives to attract employees, new members with additional expertise on the farm management team.
- Marketing innovations.

Preliminary results illustrate that farmers in the Canadian prairies are more likely to adopt new crop types, make changes in weed, pest and disease management practices, change soil management practices and introduce new approaches to marketing the farms' production (60%) compared with other innovative activities (ranging from 20% for adopting new livestock types and breeds, as well as water management practices, to 30% for adopting livestock health and feeding practices).

Results also show that innovators are those farmers who operate larger farms, employ more workers, have more social capital, belong to more informal networks, talk with more people, value continuous learning, attend workshops, etc.

Evidence from surveys show that business management programmes helped producers and agri-businesses advance their business goals, improve profitability and invest where needed in order to produce and market agricultural products safely and to manage the natural resource base sustainably. Conducted in 2004, 2007 and 2012, the National Renewal Survey (NRS) (a survey initiative commissioned by AAFC) sought to better understand a variety of business management practices and activities of Canadian producers over time. In the 2012 NRS, results indicated that more producers who participated in a Business Development Program (BDP) under Growing Forward in the past five years had a written plan as to who will succeed them in their business (45%) versus producers who did not participate (23%). This suggests that the BDP indirectly facilitated knowledge transfer by encouraging farmers to write succession plans.

Notes

1. The 2007 Strategy is available at www.ic.gc.ca/eic/site/icgc.nsf/eng/h_00856.html; the 2009 progress report at www.ic.gc.ca/eic/site/icgc.nsf/eng/h_04709.html.
2. National Research Council: www.nrc-cnrc.gc.ca/eng/index.html.
3. There are three agriculture faculties in Quebec at Laval, McGill and Montréal universities.
4. A general distinction is that universities tend to engage in more basic/pure research whereas colleges are more downstream in the areas of applied R&D.

5. A complete listing of Canadian agriculture stakeholders (e.g. associations) can be found at a public site called AgriGuide (www.agriguide.ca) and an AAFC interactive site AgriConnexions, which includes agriculture-related universities.
6. See beginning of Chapter 5 for a brief description of the Federal-Provincial-Territorial coordination process.
7. For the 2011/12 RMAF, see: http://tbs-sct.gc.ca/maf-crg/assessments-evaluations/2011/agr/agr-eng.asp.
8. An overview of the Sector Science Strategies is available at: www.agr.gc.ca/eng/about-us/planning-and-reporting/overview-of-science-and-technology-branch-sector-science-strategies/?id=1405554689843.
9. Specific Statistics Canada survey numbers available upon request. These data are available in the OECD R&D statistics database.
10. North American Classification System (NAICS) 111 for agriculture and 112 for animals.
11. Available from: www.statcan.gc.ca/pub/88-202-x/2012000/t006-eng.htm
12. Deloitte, Global Survey of R&D Tax Incentives, updated September 2012: www.deloitte.com/assets/Dcom-Canada/Local%20Assets/Documents/Tax/EN/2012/ca_en_tax_Global_SurveyR&D_Tax_incentives_September_2012.PDF .
13. Farm Credit Canada's website: www.fcc.ca/.
14. NSERC website: www.nserc-crsng.gc.ca.
15. Since 2006, the Government of Canada has provided more than CAD 9 billion.
16. Canadian Bovine Mastitis and Milk Quality Network: www.reseaumammite.org/
17. For a list of networks, see: www.nsercpartnerships.ca/How-Comment/Networks-Reseaux/index-eng.asp
18. Genome Canada's website: www.genomecanada.ca.
19. Canadian Foundation for Innovation: www.innovation.ca.
20. Government of Canada Federal Economic Action Plan web-site: www.budget.gc.ca/2013/doc/plan/chap3-4-eng.html.
21. Overview of CICP: https://buyandsell.gc.ca/initiatives-and-programmes/canadian-innovation-commercialization-programme-cicp/overview-of-cicp.
22. Germplasm Resources Information Network-Canada or GRIN-CA; http://www.agr.gc.ca/pgrc-rpc).
23. The Government of Canada Open Data Portal is available at http://open.canada.ca/en/open-data.
24. AAFC Research Centres: www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1268946647678&lang=eng.
25. www.agr.gc.ca/innovationexpressmagazine
26. Plant Breeders Rights Act: http://laws-lois.justice.gc.ca/eng/acts/P-14.6/.
27. More information on PBRs is available on the website of the Canadian Food Inspection Agency's Plant Breeders' Rights Office website: www.inspection.gc.ca/plants/plant-breeders-rights/eng/1299169386050/1299169455265.

28. Breeder's exemption allows a protected variety to be used, without prior authorization of the PBR holder, for the purpose of breeding and developing a new variety.

29. Research exception allows a protected variety to be used, without prior authorization of the PBR holder, for the purpose of conducting research and experimentation.

30. Private non-commercial exemption allows a protected variety to be used, without prior authorization of the PBR holder, for the purpose of non-commercial use such as domestic gardening, hobby gardening, and subsistence farming.

31. Canadian Food Inspection Agency's Guide to Plant Breeders' Rights in Canada: www.inspection.gc.ca/english/plaveg/pbrpov/guidee.shtml.

32. Information on AAFC-owned intellectual property, the terms and conditions relating to commercialization licenses, and the model and template agreements AAFC uses to develop, evaluate or transfer new technologies is available on the department's web site: Technology licensing opportunities: www.agr.gc.ca/eng/science-and-innovation/technology-transfer-and-licensing/licensing-opportunities/?id=1197056926950, and Commercialization licenses: www.agr.gc.ca/eng/science-and-innovation/technology-transfer-and-licensing/commercialization-license-agreements/?id=1196972174299.

33. CIPO's IP Toolkit can be found at: www.cipo.ic.gc.ca/eic/site/cipointernet-internetopic.nsf/eng/h_wr00330.html

34. CFIA's PBR information can be found at: www.inspection.gc.ca/plants/plant-breeders-rights/eng/1299169386050/1299169455265.

35. Extension services are concerned with communication, information exchange and promotion of learning in order to build capability and change practices.

36. See Second section of Chapter 7 for information on innovation intermediaries.

37. Guelph Food Technology Centre: www.gftc.ca/courses-and-training/public-training.aspx.

38. Canadian International Grains Institute: http://cigi.ca/.

39. Canola Council of Canada: www.canolacouncil.org/.

40. Canadian Cattlemen's Association: www.cattle.ca/.

41. FarmOn web site: http://FarmOn.com/.

42. Canadian Beef School: www.oldscollege.ca/programmes/ContinuingEducation/animal-science/canadian-beef-school.htm

43. The IRAP provides support to SMEs in Canada in the development and commercialization of technologies.

44. Networks of Centres of Excellence: www.nce-rce.gc.ca/.

45. Clusters Projects: www.agr.gc.ca/eng/?id=1316118882467.

46. Beef Cattle industry Science Cluster: www.beefresearch.ca/about/funding/canadas-beef-science-cluster.cfm

47. Dairy Cluster: www.dairyfarmers.ca/

48. Canadian Swine Research & Development Cluster: www.swineinnovationporc.ca

49. Canadian Poultry Science Cluster (see 2011 pp. 6-7): www.cp-rc.ca/2010_Update/2010_annualreports.html

50. Canola/Flax Agri-Science Cluster: www.canolacouncil.org/research/strategy-partnerships/research-partnerships/canadian-agri-science-clusters-initiative/

51. Pulse Science Cluster: www.pulsecanada.com

52. Canadian Wheat Breeding Research Cluster: http://westerngrains.com/about/annual-report

53. Canadian Agri-Science Cluster for Horticulture: www.hortcouncil.ca/projects-and-programmes/agri-science-cluster.aspx.

54. Canadian Ornamental Horticulture Science Cluster: www.vinelandresearch.com/Default.asp?id=75&l=1.

55. Organic Science Cluster: http://oacc.info/OSC/osc_welcome.asp.

56. Canadian Field Crop Research Alliance: http://www.fieldcropresearch.ca/.

57. Bioindustrial Innovation Canada: www.bicsarnia.ca/.

58. Canadian Wheat Alliance: www.canadianwheatallicance.ca.

59. Saskatchewan Pulse Growers: www.saskpulse.com/research-development/overview/.

60. Vineland Research and Innovation Centre: www.vinelandresearch.com/Default.asp?id=1&l=1. Vineland's primary stakeholders are the horticulture industry and government, while its broader stakeholder community includes academia, the general public, the scientific community, Board, and Advisory Committees.

61. "ATA" is an acronym of the French and English words "Admission Temporaire/Temporary Admission."

62. www.nserc-crsng.gc.ca/Students-Etudiants/PD-NP/Laboratories-Laboratoires/index_eng.asp.

63. www.fao.org/GENINFO/partner/en/visit/.

64. CGIAR website (www.cgiar.org/).

65. Currently, more than 50 institutions from more than 15 countries around the world are members of PIPRA, including AAFC. PIPRA website (www.pipra.org).

66. A national non-profit organisation based in New York City and San Francisco. It works in close partnership with non-profit legal organisations across the United States and Canada to increase access to justice for poor people who face legal problems but lack the funds for legal assistance.

67. IR-4 is shorthand for Interregional Project #4, a US programme similar to MUPP.

68. Brazil, Russian Federation, India, Indonesia, China, South Africa.

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Annex 7.A1

Federal initiatives to support bio-based products

Table 7.A1.1. Federal initiatives to support bio-based products

Targeted financial support to R&D
• National Science and Engineering Research Council (NSERC) Forest Sector Research and Development Initiative 2009-2014 (CAD 34 million over five years) – The initiative aims to stimulate commercially relevant research related to forest biomass, harvesting and conversion.
• Agri-innovation 2013-18 (CAD 698 million over five years) – The programme aims to accelerate the creation, availability, demonstration and adoption of innovative products, processes, services and technologies in the agri-based sector. The initiative will reduce the financial risk of industry led projects, facilitate the commercialisation of innovative ideas as well as enhance growth, competitiveness and productivity in the Canadian agriculture sector. The programme focuses on industry-led streams.
• Sustainable Development Tech Fund (CAD 590 million) – Funded by Sustainable Development Technology Canada to support late stage development and pre-commercialisation demonstration of clean technology solutions including: products and processes that contribute to clean air, water and land, address climate change.
• Eco-Energy Innovation Initiative 2011-ongoing (CAD 82 million) – Advance energy technology research and development projects to test the feasibility of various technologies, address knowledge gaps and bring developed technologies to the testing phase.
• National Research Council Initiatives – Introduction of two new bioproduct research and development projects. The Industrial Biomaterials Flagship focuses on the utilisation of plant materials for end use in the automotive and aviation sector. The Elbow Carbon Conversion Flagship will develop an algae system to recycle carbon emissions.
Support to capital investment for technological development, adoption and scale
• Avrio Ventures (up to CAD 10 million over life of single company) – Offered through Farm Credit Canada and supplied by a venture capital firm that supports the commercialisation and growth stage of Canadian industrial bio-product companies. Investments are typically made to commercialise products, initiate product roll-outs, expand distribution and market presence, or fund growth. The programme focuses on nutraceutical products, industrial bio-products and new food technology.
• Clean Energy Fund (CEF) 2009-2014 (CAD 146 million) - Invests in small-scale demonstration projects of renewable and alternative energy technologies including bioenergy.
• EcoEnergy for Renewable Power 2007-2021 (CAD 1.48 billion) - Aims to increase Canada's supply of clean electricity from renewable sources including biomass by providing CAD 0.01/kWh for up to 10 years to eligible low-impact, renewable electricity projects. The programme will encourage the production of 14.3 terrawatt hours of new electricity from renewable energy sources, enough electricity to power about one million homes.
• Investments in Forest Industry Transformation (IFIT) 2013-2017 (CAD 100 million) – Provided to Canada's forest sector to precipitate increased market competitiveness and environmental sustainability through targeted investments in innovative technologies. Funding provided to projects (maximum 50% of total project costs) that implement new technologies leading to non-traditional high-value forest products and renewable energies.
Regulation
• Commitment to identify and evaluate regulatory barriers that inhibit sector development, improve regulatory timelines and enhance communication between government and industry to develop a clear and predictable regulatory framework.
• The Canadian Food Inspection Agency announced a pilot project for Plant Made Industrial Products (PMIPs) that will inform the possible development of a programme that will allow the emerging bioproducts industry to employ plants with novel traits to produce PMIPs on a commercial scale while protecting the security of Canada’s food and feed supply.

Table 7.A1.1. Federal initiatives to support bio-based products (*cont'd*)

Policy to encourage the development of the bio-based industry from production to utilisation
Producer level
• Ensure competitive, sustainable and efficient production informed by best management practices.
• The Canadian Biomass Network – The network brings together federal researchers, policy makers, industry, academia, non-governmental organisations and the international community to ensure the availability of knowledge, technology and enable policy required to support the development of a sustainable Canadian bioeconomy. A sub-committee focuses on developing and advancing next generation technologies for bioenergy, biofuels and industrial bioproducts and coordinates bioproduct research, development and demonstration across the Federal Government.
• Industrial Bioproducts Value Chain Committee – Industry-led forum designed to bring together key industry representatives with federal and provincial governments to discuss matters of common interest for Canada's various industrial bioproducts sectors. The committee aims to establish industry priorities, foster collaboration between industry and government, and enhance Canadian competitiveness and profitability within the industrial bioproducts sector.
• The Cellulosic Biofuel Network (CBioN) – A Canadian network of over 40 government and university scientists seeking to eliminate constraints for the Canadian bioethanol industry. The network's goal is to provide Canada with a low-cost economic and environmental plan for ethanol production based on food-crop residues, dedicated biomass crops and the use of marginal lands.
Research and Development
• Scientific Research and Experimental Development (SR&ED) Tax Incentive Program – A federal tax incentive programme that provides cash refunds or tax credits for research and development work conducted in Canada.
Commercialisation and Industry Support
• Foster an environment of shared risk to encourage investment without distorting market signals.
• Canadian Renewable Fuel Strategy (CRFS) – Announced in 2008, the initiative aims to combat climate change by stimulating demand for renewable fuel and ensuring adequate supply through investment. Regulations, programmes and policies are established to provide production incentives for renewable fuels, support farmer participation in the industry and encourage the next generation of bioproduct technology.
– Renewable Fuel Regulation - Mandates an annual average renewable content of 5% in gasoline and 2% cent in diesel.
– Eco-Energy for Biofuels Initiative 2008-2017 (CAD 1.5 billion) – Established to boost Canada's annual production of biofuels to 2.5 billion litres. The programme commits to increase the supply and availability of cleaner, renewable fuels such as ethanol and biodiesel by providing operating incentives to producers of renewable biofuels. Producers of renewable alternatives to gasoline receive $0.10/L, whereas producers of renewable alternatives to diesel receive $0.26/L for the first year. These incentives gradually decline in ensuing years to ensure industry self-sufficiency.
– Eco-Agriculture Biofuel s Capital Initiative 2008-2013 - The programme provided repayable contributions of up to $25 million per project for the construction or expansion of transportation biofuel (ethanol and biodiesel) production facilities in Canada which included new equity investment by farmers and used agricultural feedstock to produce the biofuels. The programme has been discontinued.
– NextGen Biofuels Fund (CAD 500 million) – Funded by Sustainable Development Technology Canada to bridge the funding gap in the innovation chain and derisk clean technology. The fund will help bring new technologies into the market and encourage the retention and growth of cellulosic ethanol and biodiesel production in Canada by providing firms the opportunity to rescale technology.
– Biomass Inventory Mapping Tool (BIMAT) – An interactive map that provides information about the types of bio-product in different areas, as well as the quantity and quality of the product. The tool is essential for planning and production purposes and facilitates informed decisions about bio-product supply.

Annex 7.A2

Evaluation procedures

At the national level, each federal government department is responsible for evaluation its own innovation programme. Within AAFC, there is an Office of Audit and Evaluation (OAE)[1] that is "in charge of evaluating staff, innovation programmes and system performance." It is required to conduct evaluations in a five year cycle to assess the value for money (i.e. relevance and performance) of federal government programmes.

AAFC and the OAE are guided by a federal evaluation policy framework. The Treasury Board Policy on Evaluation (2009) identifies core issues that evaluations need to address. Issues of relevance include: 1) Continued need for programme; 2) Alignment with Government priorities; and 3) Alignment with federal roles and responsibilities.

Issues of performance (effectiveness, efficiency and economy) include: 1) Achievement of expected outcomes; and 2) Demonstration of efficiency and economy. The policy requires that a neutral assessment of all direct programme spending will be evaluated within a five-year period.

AAFC aims to embed the discipline of evaluation into the life cycle management of policies, programmes and initiatives to:

- Develop results-based management and accountability frameworks for new or renewed policies, programmes and initiatives.
- Establish ongoing performance monitoring and performance measurement practices.
- Evaluate issues related to the early implementation and administration of the policy, programme or initiative, including those that are delivered through partnership arrangements (formative or mid-term evaluation).
- Evaluate issues related to relevance, results and cost-effectiveness.

Agricultural policy, like all policies in Canada, is evaluated against its expected strategic outcomes (Box 7.A2.1). One of the three strategic outcomes for agriculture, "an innovative agriculture, agri-food and agri-based products sector", includes programmes that support the "development and commercialisation of value-added agricultural based products, knowledge-based production systems, processes and technologies". Performance indicators for this outcome include total factor productivity and value added. The strategic outcome also includes programmes and activities that are designed to enable the sector to use sound business management skills and strategies in order to capture opportunities and manage change.

In 2010, AAFC completed a meta-evaluation of twelve of the Department's innovation programmes. Overall, the evaluation found that these programmes were aligned with federal and AAFC priorities and that government support was important in overcoming barriers to innovation in the agriculture sector. Recognising the significant time required in seeing results from innovation initiatives, the evaluation also found that the programmes were making progress towards the achievement of expected outcomes. However, the performance indicators likely reflect a broader range of policies than those considered in the assessment, and there is no specific evaluation of the impact of income support and supply-management measures on innovation outcomes. AAFC has recently been putting more emphasis on developing indicators to measure innovation performance.

Box 7.A2.1. Method to evaluate agricultural policy in Canada

In Canada, all programmes are evaluated in accordance to the Treasury Board Policy on Evaluation. According to this policy, all departmental direct programme spending must be evaluated every five years in order to evaluate the following core issues:

- Continued need for the programme.
- Alignment with government priorities.
- Alignment with federal roles and responsibilities.
- Achievement of expected outcomes.
- Demonstration of efficiency and economy.

At AAFC evaluations are undertaken by the Office of Audit and Evaluation (OAE), a group that is independent from programme operations. Evaluation methods employed include interviews, programme file and data review, literature review and case studies of projects.

AAFC performs an annual risk assessment exercise to determine its internal priorities and in doing so, considers the risks related to each programme delivered by the department. Because recommendations that are not addressed represent risks to the department, OAE monitors the implementation of action plans to address evaluation recommendations (along with internal audit and external audit requirements).

All transfer payments to departments have developed and implemented Performance Measurement Strategies that explain the logic of intervention of the programme and define the programme activities, outputs and expected outcomes. These strategies, developed in consultation with evaluators, ensure that credible and reliable programme performance data are collected to support evaluations. To support this strategy, performance indicators are identified for each recipient of programme funding. Recipients report periodically on those indicators and at the end of the project, report globally on innovation project findings.

With respect to agri-environmental programming, while the attribution of environmental effects to specific programme initiatives is difficult, all departments involved in Growing Forward 2 are jointly developing administrative and out-based performance measures for their environmental programmes. Administrative measures include tracking of training events, farm plans and Best Management Practices funded. Outcome based measures are more complex, given the multiple factors that can impact an environmental outcome, and biophysical uncertainties, bur are being examined by agricultural departments in Canada.

Note

1. For OAE evaluations, see http://www.agr.gc.ca/eng/about-us/offices-and-locations/office-of-audit-and-evaluation/audit-and-evaluation-reports/agriculture-and-agri-food-canada-evaluation-reports/?id=1231274036741.

Annex 7.A3

AAFC research centres

Pacific Agri-Food Research Centre: Agassiz and Summerland, British Columbia

The Pacific Agri-Food Research Centre in British Columbia consists of two research sites: Agassiz and a separate facility in Summerland. The mission of the Centre is to generate knowledge and technologies to promote sustainable and economically viable production of foods and novel bioproducts from high-value horticultural crops. Summerland is the home of the Canadian Plant Virus Collection which consists of freeze-dried and live viruses maintained in perennial plants.

Major research is conducted on understanding the linkages between food, nutrition and health, securing and protecting food production, and balancing the activities of agriculture with the goal of a sustainable environment. The focus is on horticultural crops such as grapes and tree fruits.

Lacombe Research Centre: Lacombe, Alberta

Activities at the Lacombe Research Centre focus on the study of food safety, red meat quality, carcass grading, cereal breeding and forage/beef production. The Centre also develops integrated, sustainable crop, animal and honey bee production systems, and crop varieties for short-season environments in this part of Canada.

Lethbridge Research Centre: Lethbridge, Alberta

The Lethbridge Research Centre is one of AAFC's largest research centres. Located in southern Alberta, the Centre conducts research in four main areas:

- Beef Cattle Science.
- Crop and Livestock Biotechnology Platforms.
- Sustainable Crop and Livestock Production Systems.
- Environmental Impact of Agriculture.

Saskatoon Research Centre: Saskatoon, Saskatchewan

The Saskatoon Research Centre conducts research on prairie crops to support the agri-food industry in western Canada. It is a major site for research and development in agricultural biotechnology, and is also home to the Plant Gene Resources of Canada and the Canadian Animal Genetic Resources Program, both of which have national mandates to protect and conserve Canada's national germplasm collections.

Leading research focuses on the following five initiatives with a supporting role in agronomy and northern agriculture:

- Integrated crop management for sustainable cropping systems on the Canadian Prairies.
- Sustainable management of clubroot on canola.
- Integrated strategies for genetic improvement of oilseed, legume, and forage crops.
- Genetic resource conservation, characterisation and utilisation.
- Bioproducts and bioresources.

Semiarid Prairie Agricultural Research Centre: Swift Current, Saskatchewan

Located at Swift Current, in the southwest corner of Saskatchewan, the Semiarid Prairie Agricultural Research Centre (SPARC) conducts major agricultural research on the dryland regions of Canada's prairies. The semi-arid prairie region, where SPARC – Swift Current is situated, encompasses 20% of the arable land in Canada (the Brown soil zone). In addition, SPARC's research extends across the Dark-Brown and Thin-Black soil zones via the associated research site at Indian Head.

Today, SPARC wheat varieties are grown on about 50% of the wheat acreage in Canada. Durum wheat varieties at SPARC account for well over 90% of the Canadian acreage. In addition to a strong effort in wheat research, scientists at SPARC are conducting research to further understanding of integrated cropping systems, especially for pulse and forages, and developing best practices to enhance environmental performance and sustainability.

Brandon Research Centre: Brandon, Manitoba

Research and development activities conducted at the centre and satellite locations use expertise in agronomy, soil, water, organic and inorganic nutrients, invasive species, rangeland management, agroforestry, landscape based resource management and cereal breeding to develop and evaluate crop production systems, addressing the risk and opportunity in this sector.

The Brandon Research Centre has a large collection of growth chambers and research greenhouses with a significant capacity to conduct field and laboratory research and develop best management practices (BMP's) to ensure environmental sustainability. It also operates a cereal quality lab, providing end-use quality testing for cereal breeders and research centres in western Canada.

Cereal Research Centre: Morden, Manitoba

The Cereal Research Centre is dedicated to the development of superior varieties of high quality and disease resistant cereals, oilseeds and pulse crops that minimise producer risks and enhance opportunities in sustainable crop systems.

The centre leads research in six areas:

- Cereal diseases.
- Cereal germplasm and genomics.
- Flax and Eastern Prairie Pulse crop germplasm.
- Human nutrition, food health attributes, and functional foods.
- Bioprospecting from bioresources: cereals, pulses, and oilseeds.
- Grain and grain products storage research.

Southern Crop Protection and Food Research Centre: London, Ontario

The Southern Crop Protection and Food Research Centre conducts research in the areas of genomics, biotechnology and integrated pest management (insects and plant diseases). Scientists develop alternative and environmentally acceptable technologies to improve crop value and crop performance to biotic (plant pathogens and insect pests) and abiotic stress and determine the impacts of agricultural practices on soil and water quality. A satellite research site is located at Vineland, in the Niagara Peninsula region of Ontario. The Vineland site supports the centre's mission to develop alternative and environmentally acceptable technologies to protect crops. It is also the main site of tree fruit research.

Eastern Cereal and Oilseed Research Centre: Ottawa, Ontario

The Eastern Cereal and Oilseed Research Centre (ECORC) is located on the historic Central Experimental Farm, and is involved with a wide range of research activities. The Centre leads Eastern

Canada in crop development, targeting corn, soy, spring wheat, winter wheat, oats and barley. ECORC also has a national mandate for assessing and utilising biodiversity and environmental resources for Canadian agriculture.

The Centre has been at the forefront of pioneering gene isolation, gene transfer, and studying gene expression in crop plants for the last 25 years. It has a mandate to lead biosystematics research of vascular plants (botany), fungi, bacteria, and invertebrates (insects, arachnids and nematodes), relevant to agriculture. It also supports research conducted at other Research Centres in the areas of food safety, mycotoxins, and biocontrol.

Four biological collections of national importance are located at ECORC: the Vascular Plant Collection, the National Mycology Herbarium, the Canadian National Collection of Insects, Arachnids and Nematodes, and the Canadian Collection of Fungal Cultures.

Guelph Food Research Centre: Guelph, Ontario

The Guelph Food Research Centre specialises in food safety, quality and nutrition. Research covers all aspects of food production from the field to the fork. In addition to its focus on food quality and safety, much of the Centre's work explores the potential for conventional foods to offer nutritional and other therapeutic benefits. Scientists are also developing innovative methods to reduce food-borne biological and chemical hazards that may be present in farm commodities, fresh market and processed foods.

The Guelph Food Research Centre is a partner in many collaborative projects with industry, farm groups and University of Guelph[1] in the areas of product development, packaging, shelf life, food safety and the improvement of food quality and productivity.

Greenhouse and Processing Crops Research Centre: Harrow, Ontario

The Greenhouse and Processing Crops Research Centre operates one of the largest greenhouse research facilities in North America. The centre's mission is to develop and transfer new technologies for the production and protection of greenhouse vegetables and ornamentals, and field crops, including soybeans, edible beans, corn, winter wheat and tomatoes.

Research on the quality and sustainable use of Ontario soils, reductions in greenhouse gas emissions and nutrient losses from agricultural soils are also significant activities at the centre. The centre has expertise in plant breeding, crop physiology and management, entomology, plant pathology, weed science, and soil science.

Dairy and Swine Research and Development Centre: Sherbrooke (Lennoxville Sector), Quebec

The centre is the only AAFC research centre specialised in research primarily for the Canadian dairy and swine industries. The centre leads research in three key areas:

- Environmental sustainability.
- Dairy and swine production systems.
- Dairy and swine health and welfare.

Food Research and Development Centre: Saint-Hyacinthe, Quebec

The Food Research and Development Centre focuses on developing methods to preserve food and maintain its quality and to process food safely and efficiently. Research is also conducted on food ingredients having health and other benefits beyond basic nutritional values.

Food safety is also a major area of research, and the Centre collaborates with the University of Montreal's Faculty of Veterinary Medicine and the Canadian Food Inspection Agency.

Through the Centre's Industrial Program, pilot plants are leased to agri-food companies in support of their small-scale food processing and testing needs. The Centre also provides extensive information retrieval and analysis services to the sector.

Soils and Crops Research and Development Centre: Quebec, Quebec

The Soils and Crops Research and Development Centre conducts research in perennial crop production systems, bioproducts, and the environmental performance of perennial and short-season crops and cropping systems in Eastern Canada. Research conducted is designed to make crop systems more sustainable in cold, wet climates by developing crop rotations that promote the use of forage species.

Researchers work in close co-operation with other government colleagues and university scientists, as well as industry and producer associations. The centre has a satellite location, the Normandin Research Farm, which supports research into northern agriculture.

Horticulture Research and Development Centre: Saint-Jean-sur-Richelieu, Quebec

The Horticulture Research and Development Centre (HRDC) specialises in field vegetable crops and conducts research into the production, protection and conservation of horticultural commodities.

The centre promotes the use of low inputs, which minimises the environmental impact and aims to increase crop quality at pre- and post-harvest stages. The centre also has staff specialised in pest and crop bioclimatic modelling.

Potato Research Centre: Fredericton, New Brunswick

The Potato Research Centre develops new varieties, new knowledge, and new technologies to support the implementation of economically and environmentally sustainable potato production systems. It is also the custodian of the Canadian Potato Genetic Resources.

The main focus of research conducted at the centre is in three areas:

- Potato germplasm enhancement.
- Crop protection.
- Enhancing the environmental performance of potato production systems.

Atlantic Food and Horticulture Research Centre: Kentville, Nova Scotia

The Atlantic Food and Horticulture Research Centre conducts research related to the horticultural and food system, with a focus on the regional needs of Atlantic Canada.

Research at the centre is focused on horticulture, functional foods, and post-harvest processing of horticultural products. The centre also supports research in agri-environmental science and the identification of beneficial management practices in intensively farmed land. Research on beef systems and nutrition programs for the Atlantic region is conducted at the nearby Nappan Research Farm.

Crops and Livestock Research Centre: Charlottetown, Prince Edward Island

The Crops and Livestock Research Centre conducts research in integrated crop production systems, agricultural diversification, development of bio-based products and processes from bioresources, existing or emerging crops, as well as management strategies and practices to improve the environmental performance of production systems in the region.

Its mission is to undertake research to enhance environmental sustainability of crop production systems in the heavily leached soils and sensitive watersheds of the Atlantic Region, diversification through bioprospection from bioresources both regionally and nationally, and innovation in primary

production agriculture. The centre also supports national research in integrated crop protection and several national crop breeding programs.

The centre is associated with two satellite locations: Harrington Research Farm and the Institute of Nutrisciences and Health (INH) located on the University of Prince Edward Island campus. These locations support research in human health and wellness and the protection of the food supply.

Atlantic Cool Climate Crop Research Centre: St. John's, Newfoundland and Labrador

The Centre lies within, and has a research focus on, crops and cropping systems that are applicable to the boreal ecosystem (sometimes referred to as the Boreal Shield). Agricultural practices in this unique zone differ from those in the conventional agricultural areas of Canada because of the cool summer temperatures (an average of only 13°C). The boreal zone includes a range of other agro-climatic zones, from the Maritime climate of Newfoundland and Labrador to the humid regions of the southern Prairies. However the high latitude, stony soils and cool summers of Newfoundland and Labrador place the Centre in a unique position to lead research with a northern, boreal focus.

The centre undertakes research in primary production agriculture, with a focus on berries suitable for production in the boreal ecosystem, and on forage and cereal crops that support the regional dairy value chain. Research is also conducted on environmental stewardship, through the improved performance of the agricultural production systems in the fragile boreal environment.

Note

1. www.uoguelph.ca/.

Annex 7.A4

List of provincial and territorial programmes promoting improved business and management skills in farming

This list includes cost-shared programmes under growing forward policy framework.

British Columbia

- ***SmartFarm BC website***: Helps farmers learn and implement best practices for agricultural business growth. The website includes resources for new entrants and transitioning farmers.

Manitoba

- ***Bridging Generations Initiative***: Provides young farmers with financial incentives, valuable training opportunities, and customised terms and payment options.
- ***Resources for Succession Planning***: The Manitoba Agriculture and Rural Initiatives' website provides a number of resources related to succession planning.

Ontario

- ***Capacity Building Funding Assistance for Producers***: Provides funding assistance to support producers to increase their knowledge and skills so that they can effectively manage their operations. Producers can take part in education and training opportunities to better understand the best management practices and tools that can help manage their operations.
- ***Resources related to farm succession and starting a farm***: The Ontario Ministry of Agriculture, Food and Rural Affairs website provides resources related to succession planning.

Quebec

- ***Appui au développement des entreprises agricoles***: Aimed at helping agriculture producers pursue integrated business management practices and helping to ensure the sustainability and competitiveness of agriculture. The programme consists of four components: 1) Intake and Referral; 2) Advisory Services for farm businesses; 3) On-farm Management Best Practices; and 4) Development of Knowledge and Expertise.
- ***Resources related to farm succession and starting a farm***: The Ministère de l'Agriculture, des Pêcheries et de l'Alimentation website, provides resources related to succession planning.

New Brunswick

- ***Agriculture by Choice***: Promotes the agriculture sector and its connection to healthy lifestyles both to the general public and to potential beginning farmers. It will also be used to support youth training initiatives and recent entrants to agriculture in the crucial early establishment period.
- ***Developing Management Skills Program***: Enhances the capacity of eligible applicants to better understand and manage their business both financially and technically. The programme has several elements including:

- ***Business Management Self-Assessment and Action Plan***: Encourages farmers to assess their current business management practices and skills, determine their priorities and goals, and to develop and implement farm action plans.
- ***Planning***: Provides assistance to help applicants undertake, develop, and implement formal plans for their operations, which may include business, marketing, human resource management, diversification, value added or succession plans.
- ***Individual Training***: Provides assistance for strategic agriculture related training, technical skills development, marketing, human resource management and business development initiatives.
- ***Benchmarking***: Support for the development of cost of production analysis and benchmarking activities.
- ***Group planning and training***: Provides assistance to groups of agriculture producers and agricultural producer associations to assist them with the development of strategic directions for their organisation and to acquire the skills and training needed to operate a successful organisation.

Prince Edward Island

- ***Business Development Programming***: Provides farmers skills training, business practices assessment and business planning assistance. The initiatives are designed to enhance the ability of farmers to respond to change and to facilitate the development of sound business practices. Subprograms include:

  - Planning: Designed to enhance farmers' ability to manage transition, respond to change, and adopt innovation. Participants receive assistance towards consulting services to help in the development of action plan projections, business plans, strategic plans, succession plans and feasibility studies.
  - Self-assessment: helps farmers assess their current farm management practices and skills; to build on the strengths they have identified; then to develop and implement sound business management practices and Action Plans.
  - Agriskills: Provides farmers and spouses with access to skills training which has the potential to increase farm profitability, and to enable farm families to pro-actively manage business risks, and be better positioned to adopt new technologies for the farm.
  - Training: Encourages farmers to investigate, understand and utilise improved business practices in their decision-making. Agriculture industry organisations and groups of agricultural producers are eligible to receive 90% of eligible expenses, to a maximum of CAD 30 000 per project.
  - Benchmarking and Risk Management: Helps farmers better understand their financial situation, know their costs of production, and benchmark their farm performance. In addition, the programme enhances the ability of farmers to respond to change and to assume responsibility for comprehensive risk management in their agricultural operations.

Saskatchewan

- ***Agriculture Awareness Initiative:*** The purpose of the Agriculture Awareness Initiative is to provide funding to promote the benefits of a career in agriculture and to enhance the public's perception of agriculture and its role in the economy.

- ***Agriculture Demonstration of Practices and Technologies (ADOPT):*** The ADOPT programme accelerates the transfer of knowledge to Saskatchewan farmers and ranchers. Funding is provided to help producer groups evaluate and demonstrate new agricultural practices and technologies at the local level.

- ***Agri-ARM:*** Agri-ARM connects eight regional applied research and demonstration sites into a province-wide network. Each location has an affiliated producer group that sets the research priorities for that site.

- ***Agriculture Knowledge Centre:*** The Agriculture Knowledge Centre provides the latest answers on topics ranging from crops and livestock to nutrient management and the economic implications of management decisions.

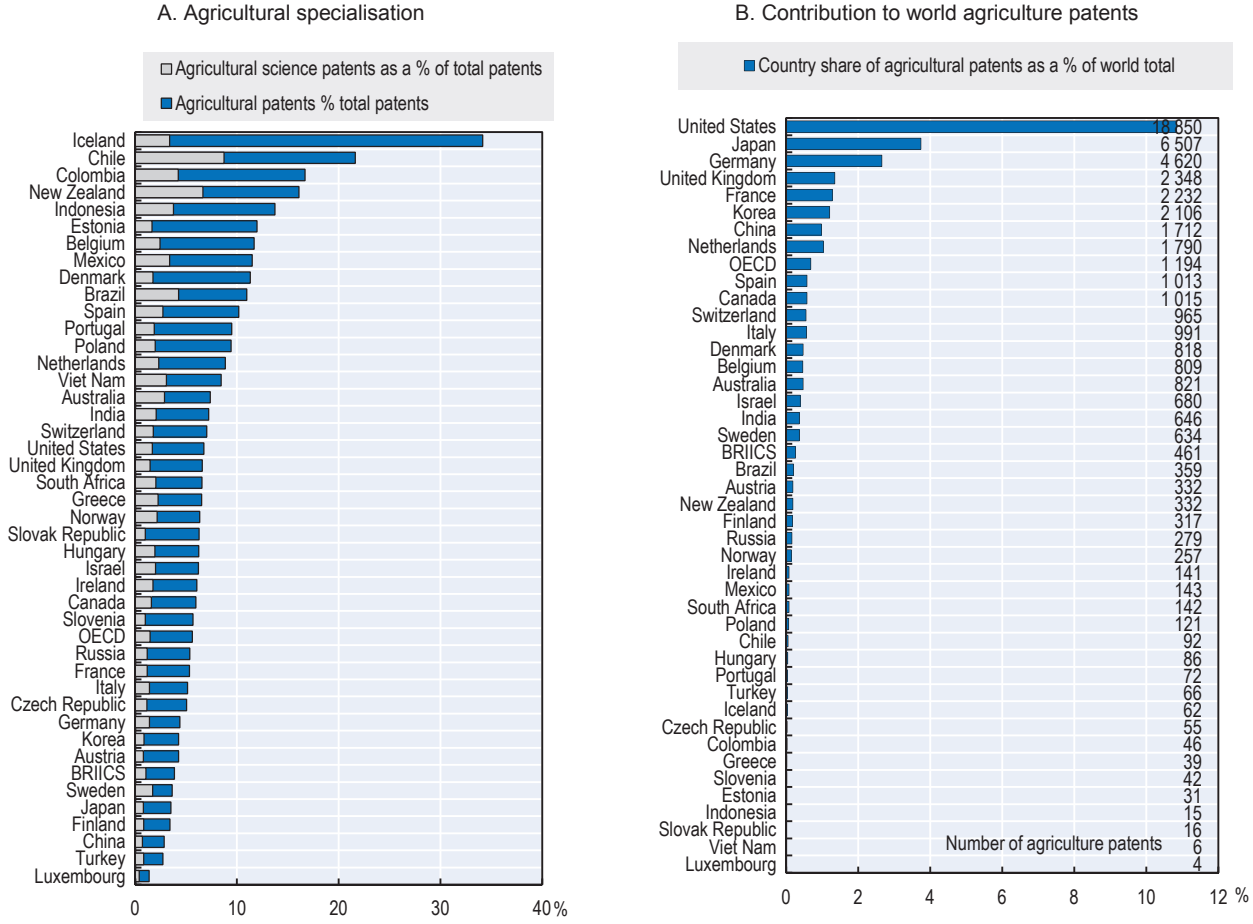
- ***Farm Business Development Initiative:*** The Farm Business Development Initiative helps farmers to develop business plans and enhance business skills in nine business practice areas: business strategy, marketing, production economics, human resources, finance, environment, succession planning, and business structure and risk management.

- ***Green Certificate Farm Training Program:*** In co-operation with industry, Saskatchewan Agriculture's Regional Services Branch administers an apprenticeship style, on-farm, skill-training programme. Trainees can acquire skills in one of several agricultural sectors, including feedlot, cow/calf, dairy, sheep, crop and irrigated crop production. Two levels of training are available in each area covering skills for production technicians and production supervisors.

Annex 7.A5

Background indicators of R&D outcomes

Figure 7.A5.1. Agriculture patents applications filed under the Patent Co-operation Treaty (PCT), 2006-11



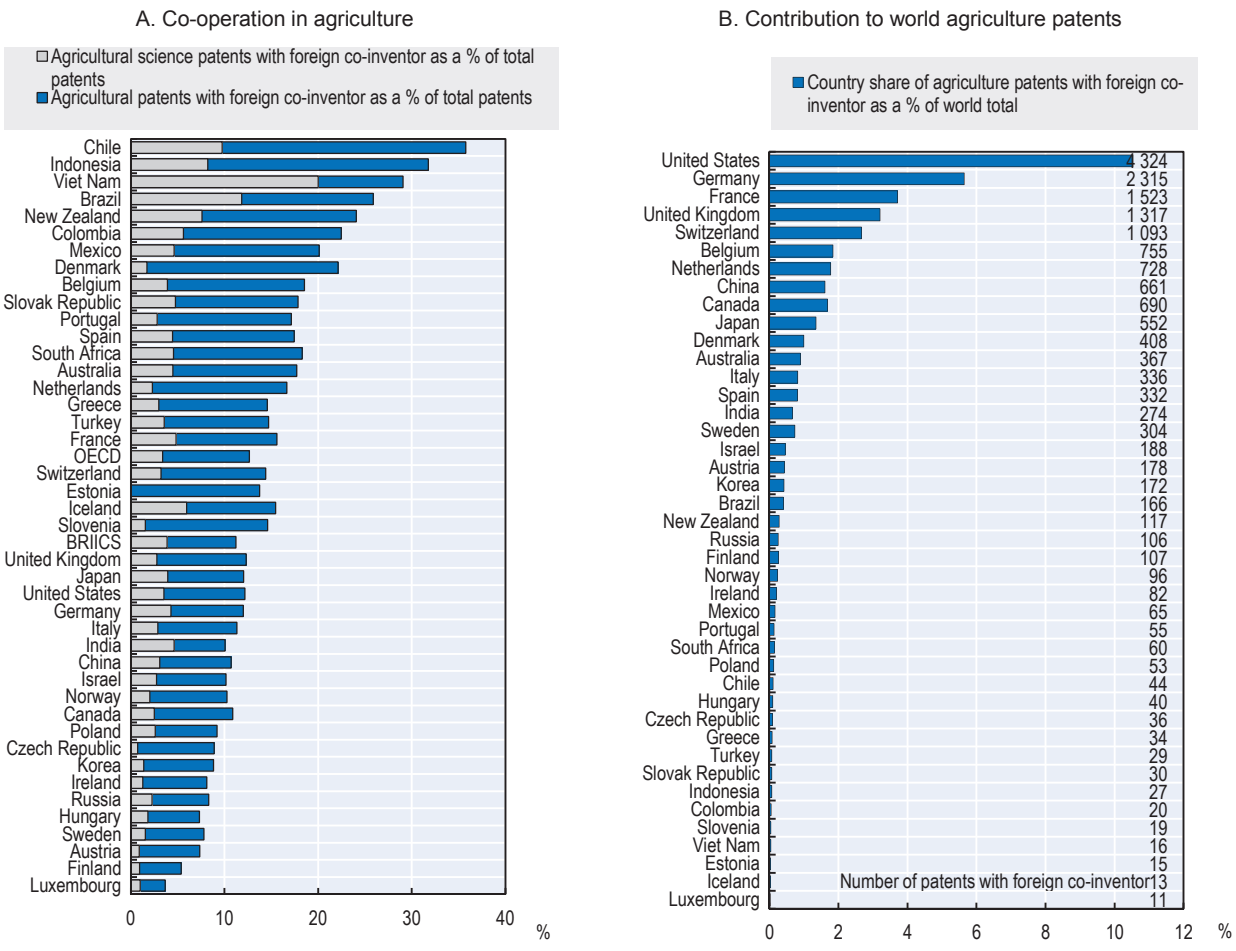
Agriculture includes patents from IPC classes A01, A21, A22, A23, A24, B21H 7/00, B21K 19/00, B62C, B65B 25/02, B66C 23/44, C08b, C11, C12, C13, C09K 101/00, E02B 11/00, E04H 5/08, E04H 7/22, G06Q 50/02.

Patent counts are based on the priority date (first filing of the patent worldwide), the inventors country of residence, using fractional counts.

Source: OECD Patent Database, January 2014.

StatLink http://dx.doi.org/10.1787/888933250641

Figure 7.A5.2. Agriculture patents with a foreign co-inventor filed under the Patent Co-operation Treaty (PCT), 2006-11



Agriculture includes patents from IPC classes A01, A21, A22, A23, A24, B21H 7/00, B21K 19/00, B62C, B65B 25/02, B66C 23/44, C08b, C11, C12, C13, C09K 101/00, E02B 11/00, E04H 5/08, E04H 7/22, G06Q 50/02.

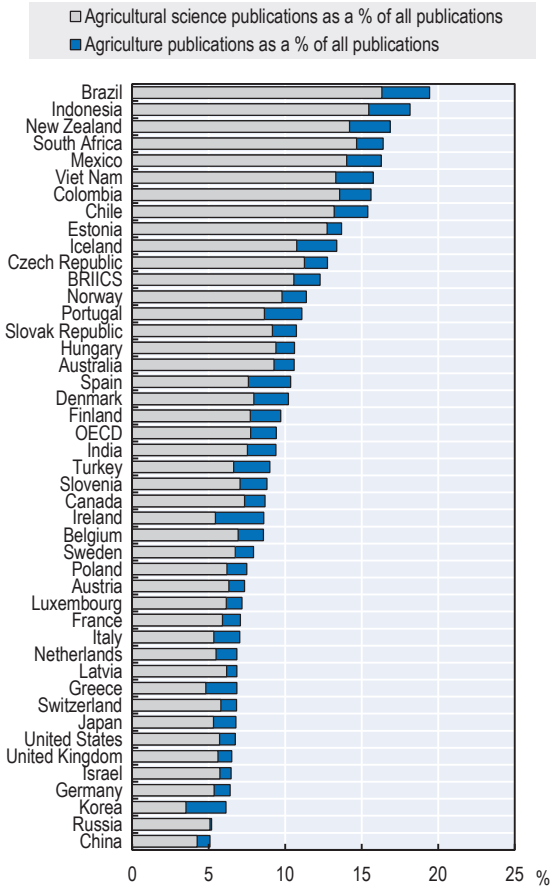
Patent counts are based on the priority date (first filing of the patent worldwide), the inventors country of residence, using fractional counts. EU28 and BRIICS totals exclude intra-zone co-operations.

Source: OECD Patent Database, January 2014.

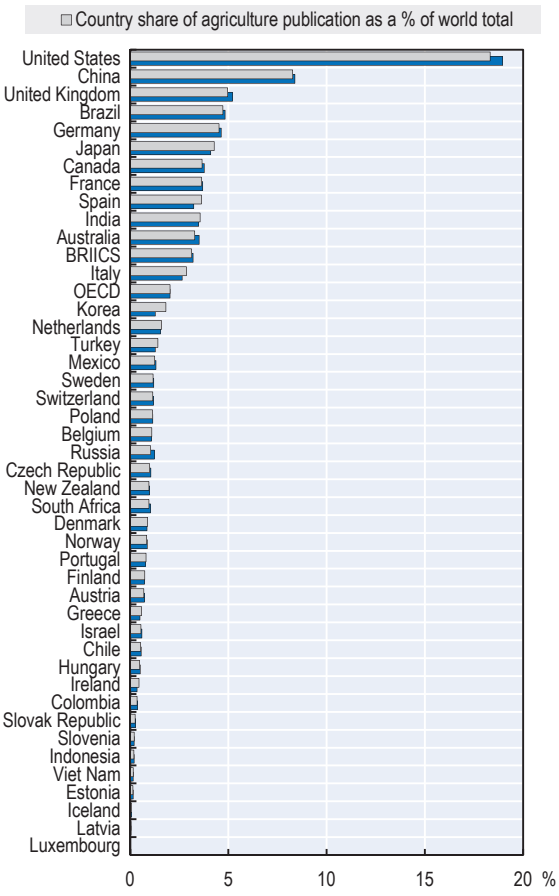
StatLink http://dx.doi.org/10.1787/888933250659

Figure 7.A5.3. Agriculture publications, 2007-12

A. Agricultural specialisation



B. Contribution to world agricultural publications



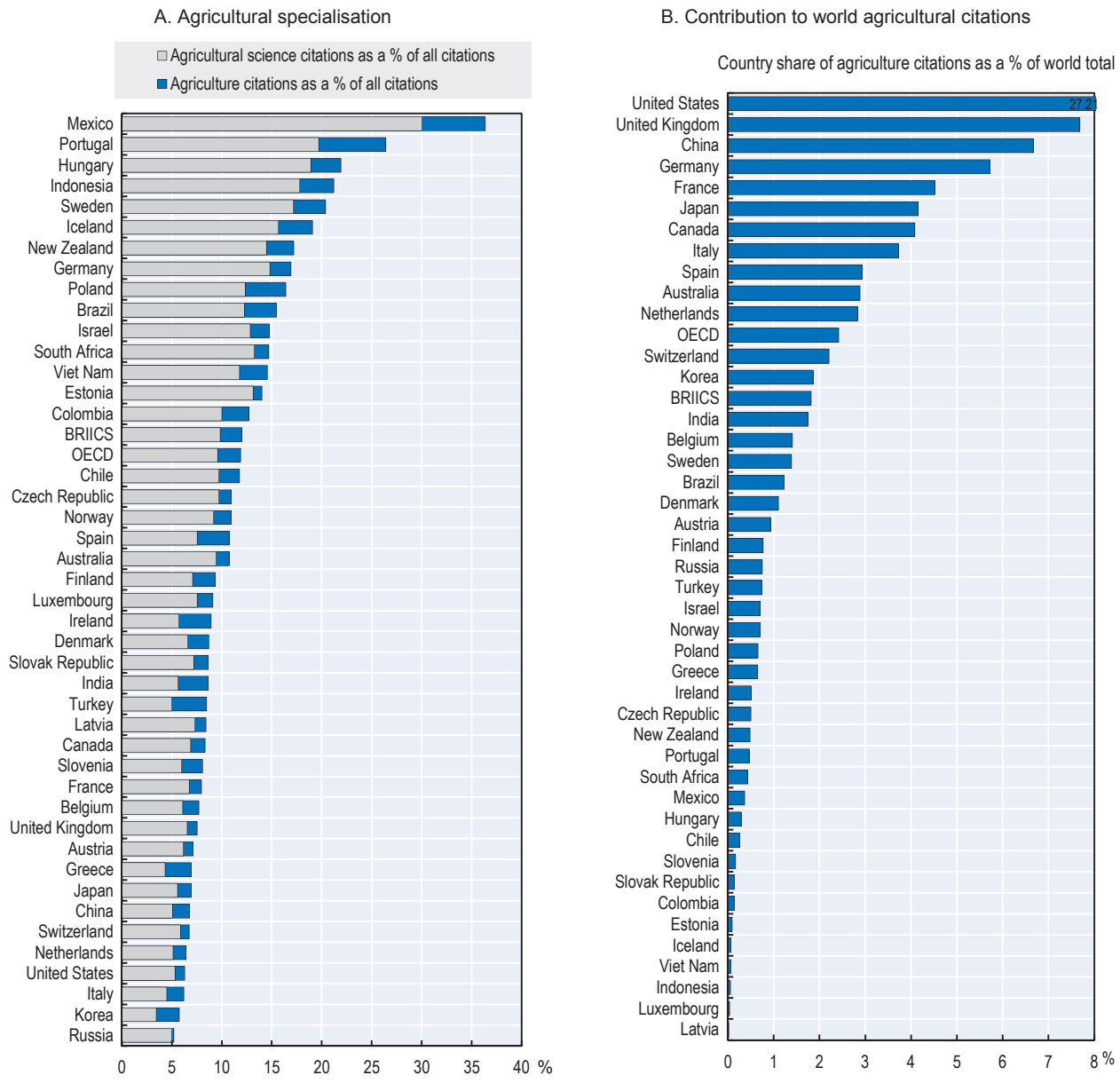
Agricultural sciences include Scopus journal classifications: agronomy and crop science, animal science and zoology, aquatic science, ecology/evolution/behaviour systematics, forestry, horticulture, insect science, plant science and soil science, and miscellaneous agriculture/biological sciences.

Agriculture publications include food sciences.

Source: SCImago (2007), *SJR — SCImago Journal & Country Rank*, Retrieved March 2014, from http://www.scimagojr.com.

StatLink http://dx.doi.org/10.1787/888933250659

Figure 7.A5.4. Agriculture citations, 2007-12



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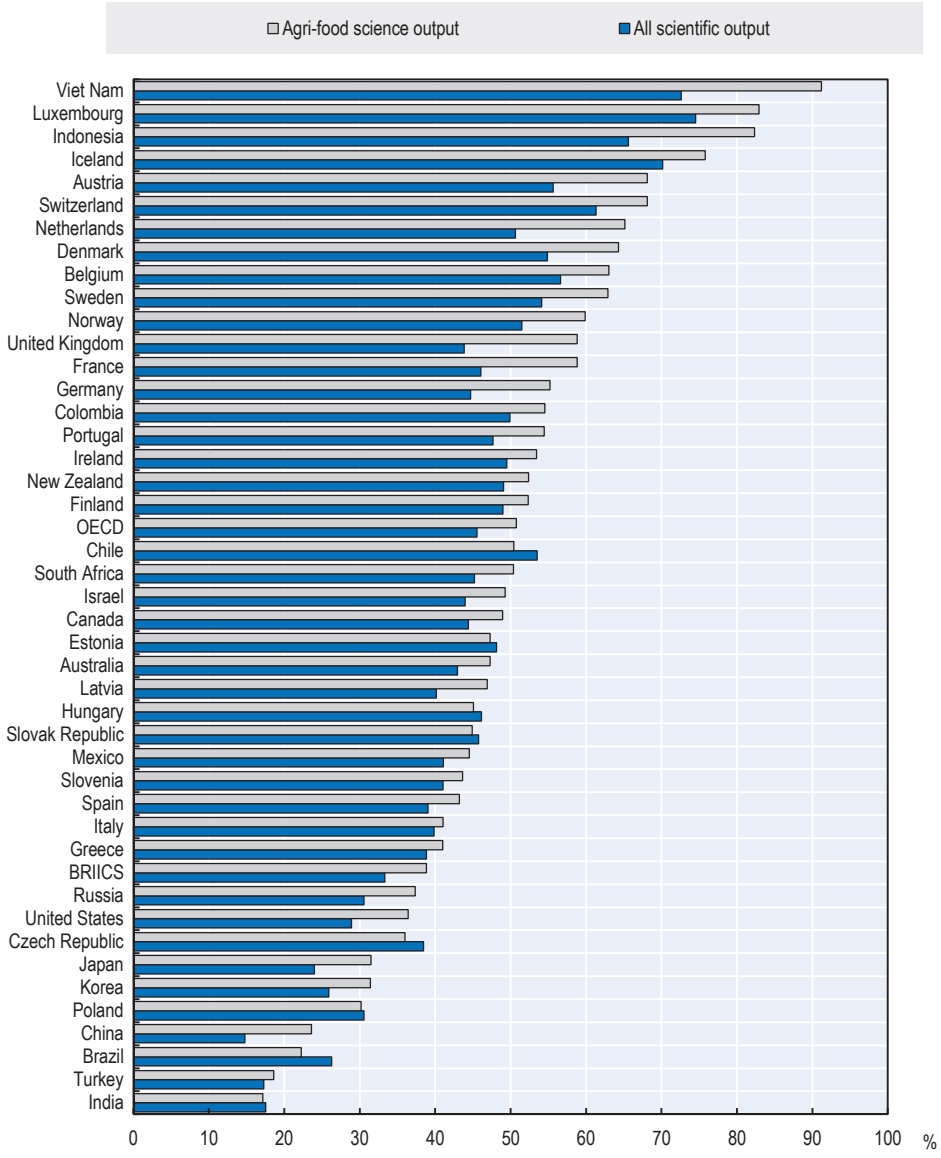
Agriculture citations include food sciences.

Source: SCImago. (2007), *SJR — SCImago Journal & Country Rank*, Retrieved March 2014, from http://www.scimagojr.com.

StatLink http://dx.doi.org/10.1787/888933250667

Figure 7.A5.5. International collaboration, 2007-12

Percentage of documents with collaborating authors in foreign country



Agricultural sciences include Scopus journal classifications: agronomy and crop science, animal science and zoology, aquatic science, ecology/evolution/behaviour systematics, forestry, horticulture, insect science, plant science and soil science, and miscellaneous agriculture/biological sciences.

Source: SCImago. (2007), *SJR — SCImago Journal & Country Rank*, Retrieved March 2014, from http://www.scimagojr.com.

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