

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

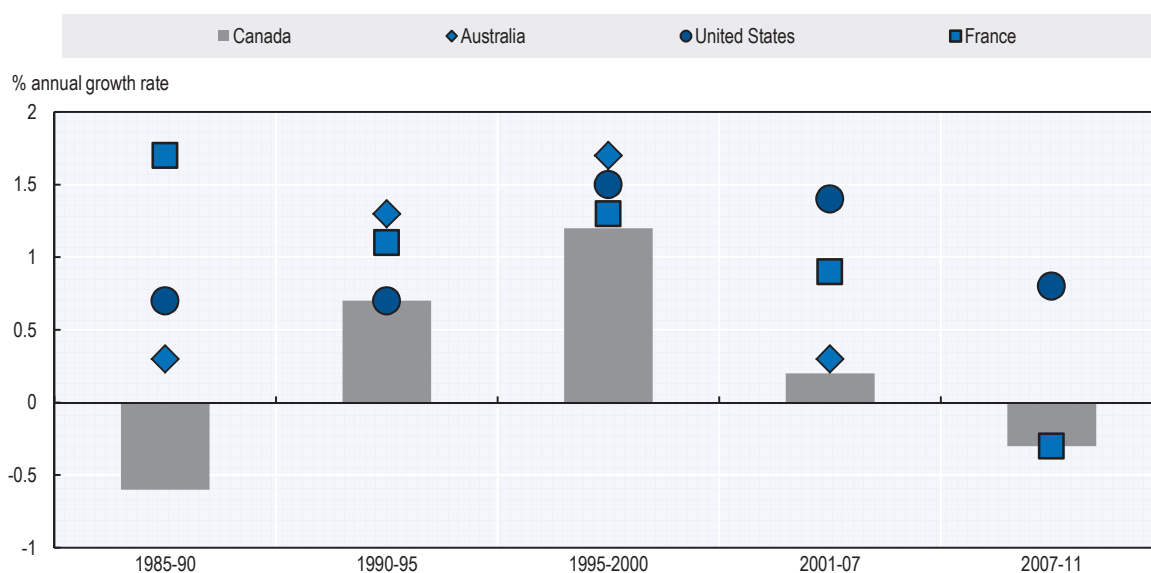
Trade (average of exports and imports) as a percentage of GDP



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

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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.

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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

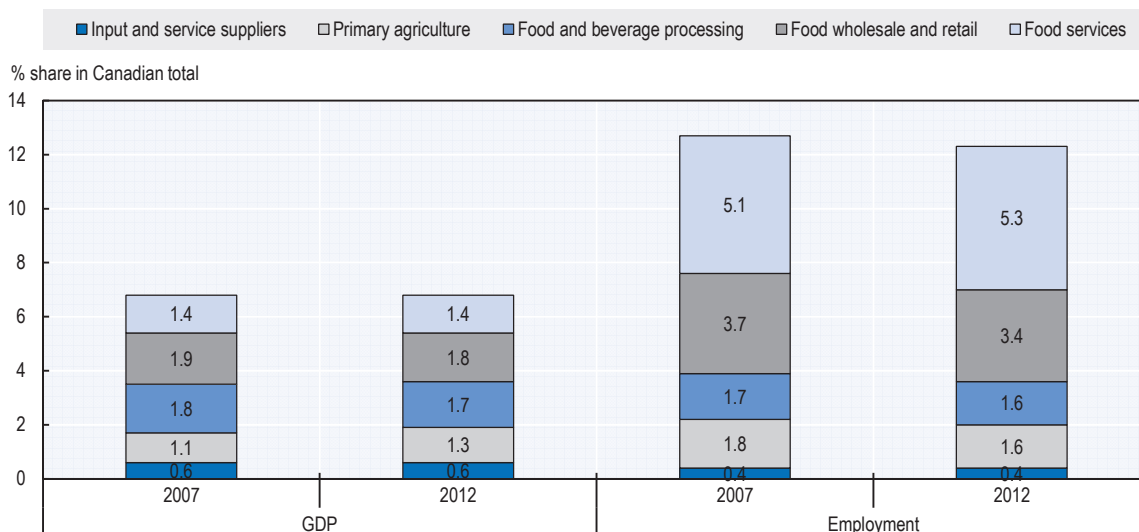
The Canadian food and agriculture system, from farm input and service suppliers and primary agriculture to food and beverage processors and retailers, plays a significant role in the Canadian economy. It accounted for 6.7% of total GDP in 2012 and is the seventh-largest contributor to national GDP after 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

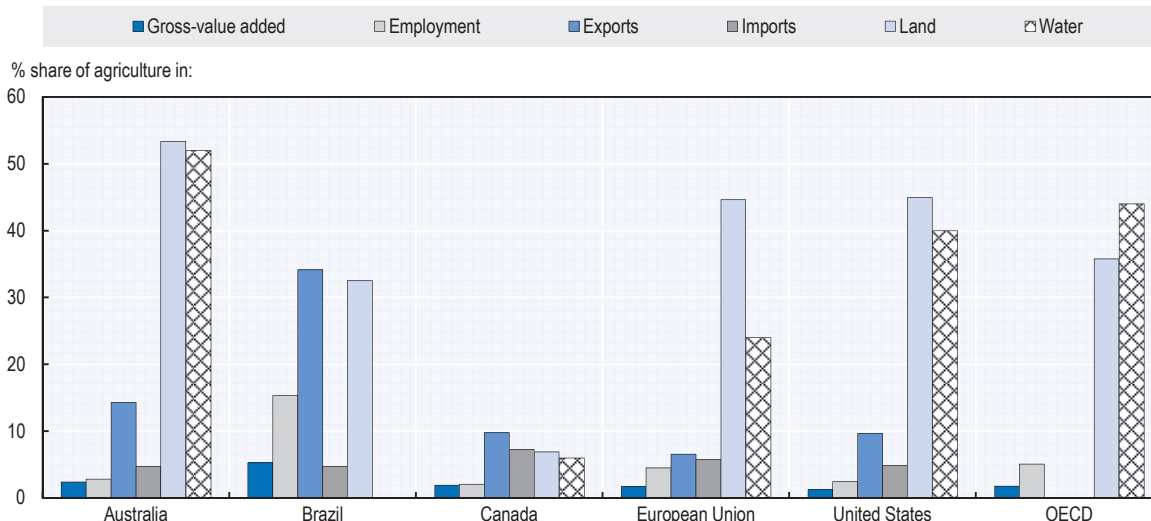


GDP shares are based on constant 2007 CAD.

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 B.1.1 and B.1.3, available at: http://ageconsearch.umn.edu/bitstream/59885/2/overview_2009_e.pdf

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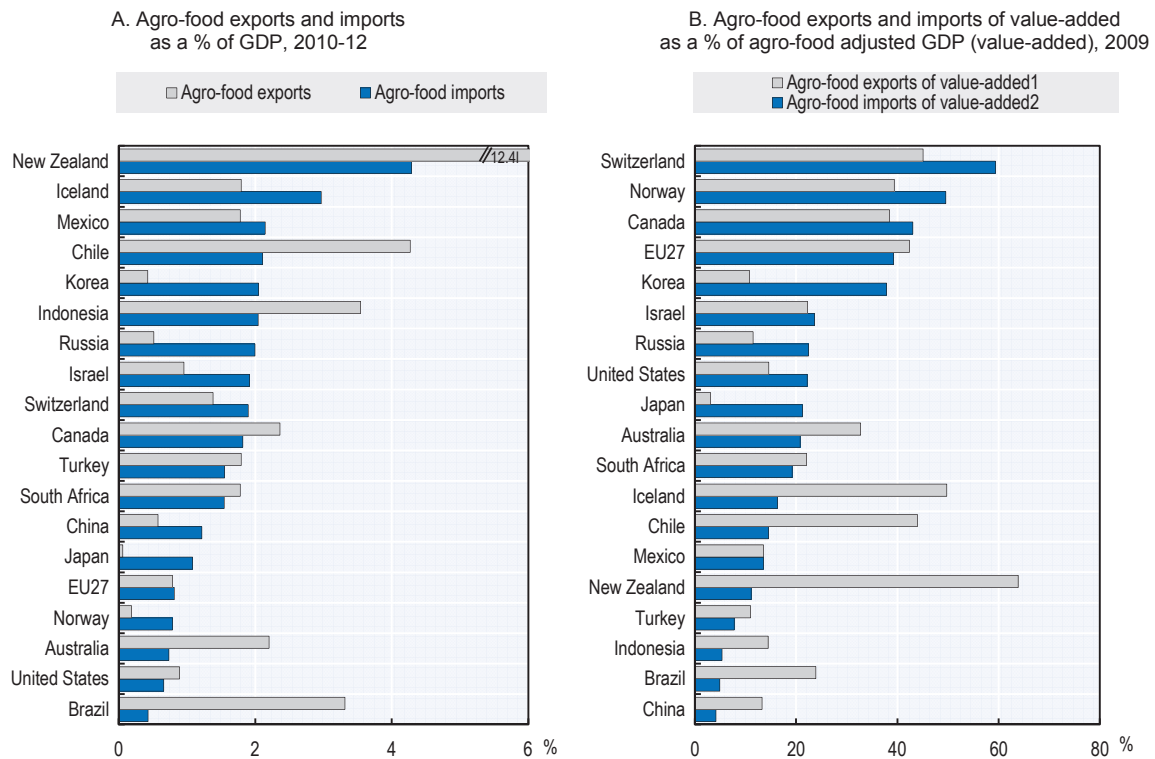
Figure 2.4. Share of primary agriculture in the economy and in resource use, selected economies, 2012



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.

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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>.

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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

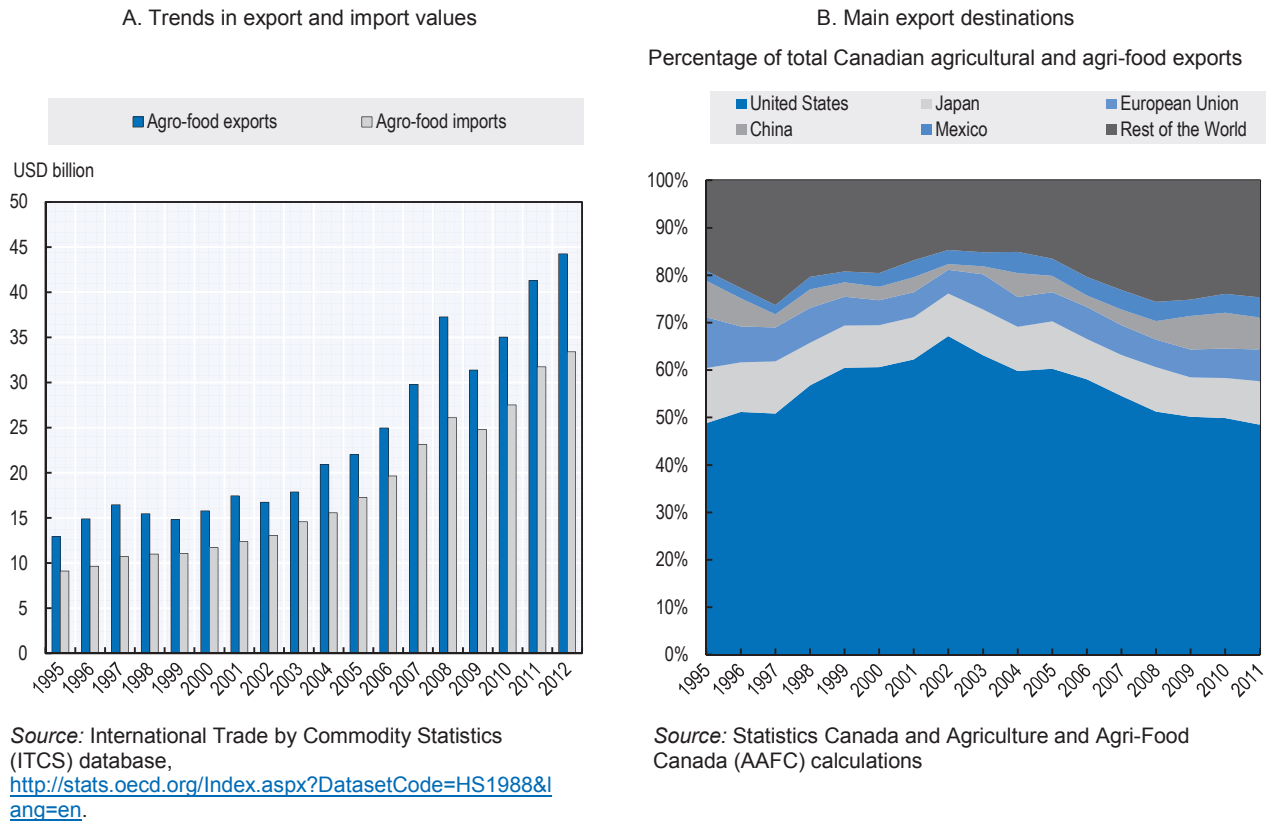
(Figure 2.6). This represented 3.3% of the total value of world food and agriculture exports (AAFC, 2014).

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



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

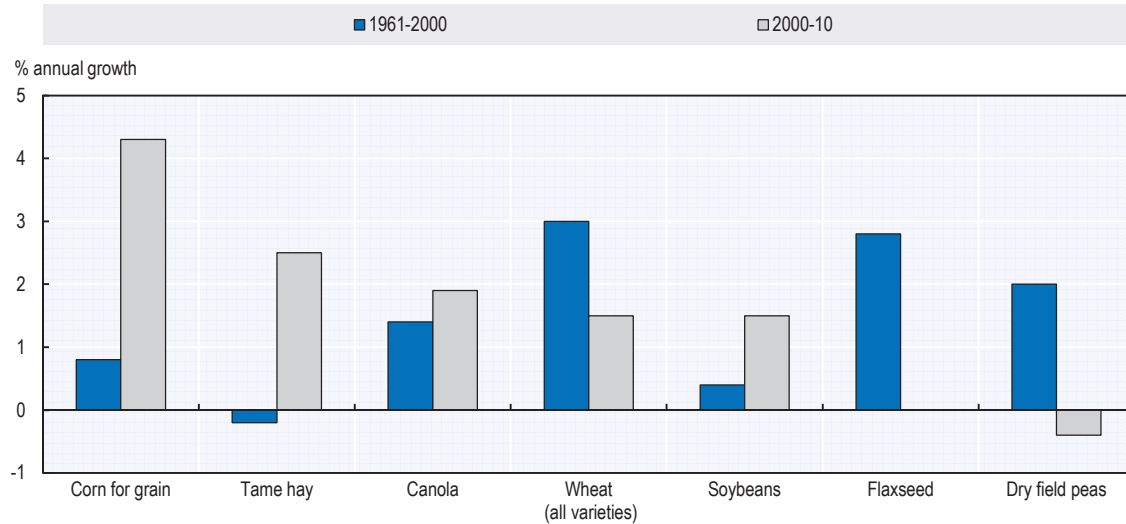
Principal crops grown in Canada including wheat, corn for grain, canola, soybeans, flax and dry field peas, have experienced various degrees of **yield growth**. Compared to the period 1961 to 2000, corn, canola, and soybean yields grew more over the period 2000 to 2010 (Figure 2.7). For example, corn 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

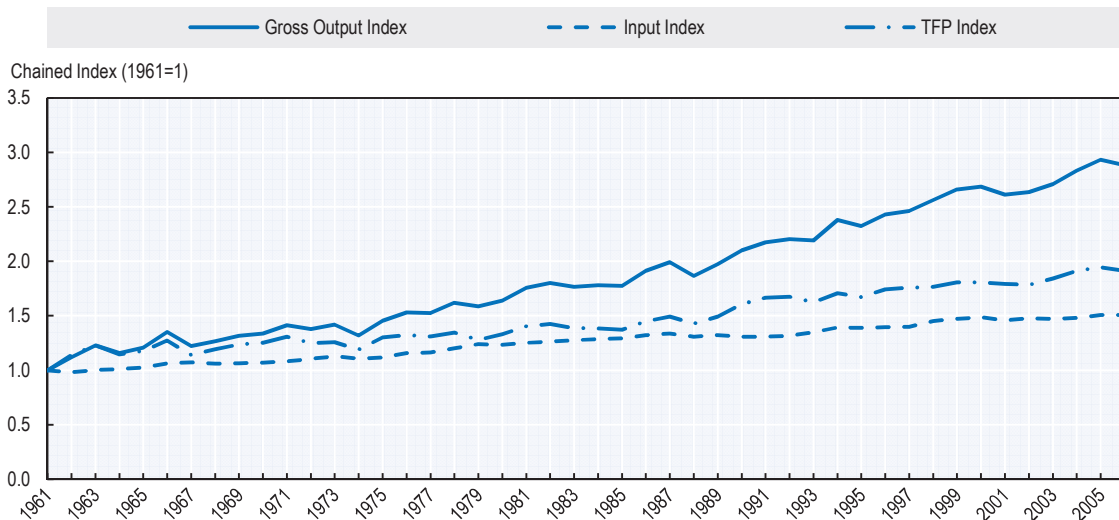
Figure 2.7. Average yield growth for principal field crops in Canada, 1961-2000 and 2000-10



Source: Statistics Canada.

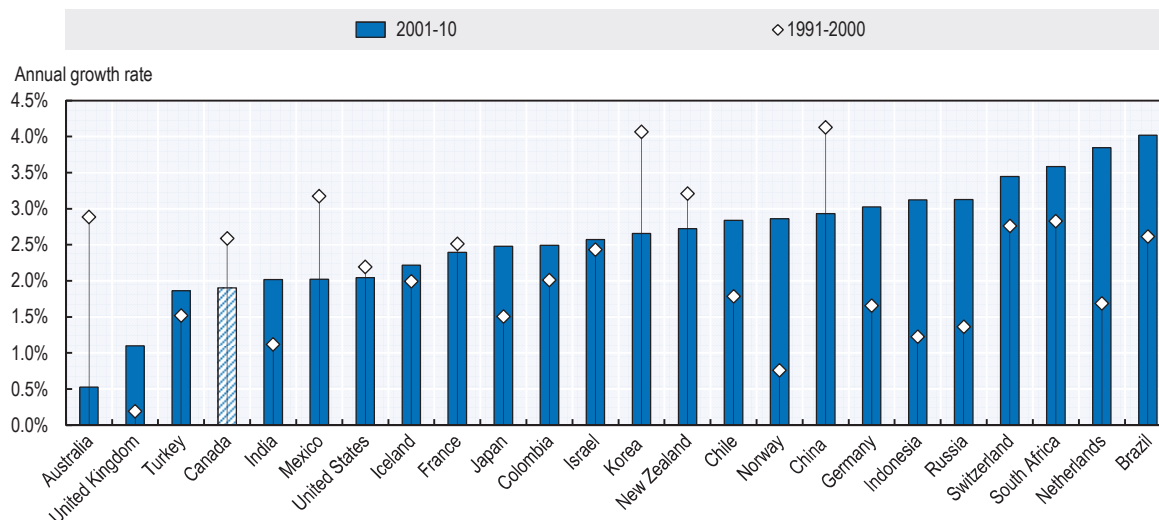
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Figure 2.8. Gross output, input and total factor productivity (TFP) growth in Canadian primary agriculture, 1961-2006



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

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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.

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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.

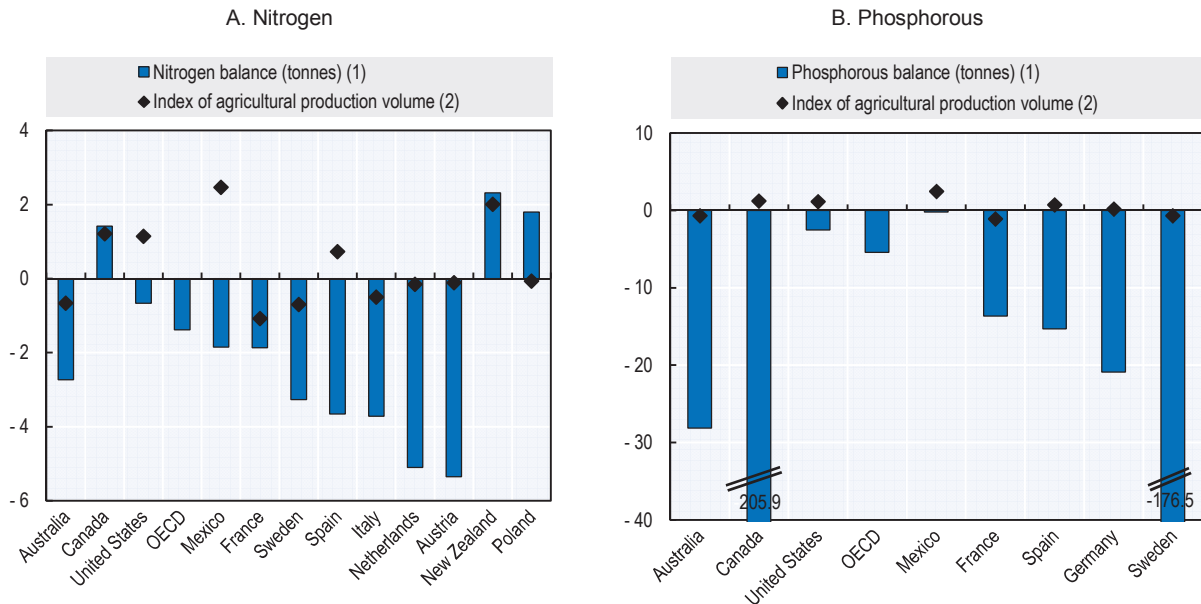
A very small proportion of agricultural land area is classified as having moderate to severe water erosion risk (2%) or as having moderate to severe wind erosion risk (1.7%). Past soil erosion problems

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).

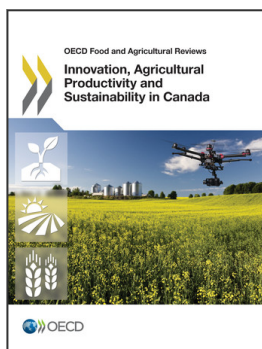
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Notes

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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