Organisation for Economic Co-operation and Development
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ENVIRONMENTAL PERFORMANCE OF AGRICULTURE IN OECD COUNTRIES SINCE 1990:

Canada Country Section

This country section is an extract from chapter 3 of the OECD publication (2008) ***Environmental Performance of Agriculture in OECD countries since 1990***, which is available at the OECD website indicated below.

This text should be cited as follows: OECD (2008), *Environmental Performance of Agriculture in OECD countries since 1990*, Paris, France

A summary version of this report is published as ***Environmental Performance of Agriculture: At a Glance***, see the OECD website which also contains the agri-environmental indicator time series database at: http://www.oecd.org/tad/env/indicators

TABLE OF CONTENTS OF THE COMPLETE REPORT

BACKGROUND TO THE COUNTRY SECTIONS

Structure

This chapter provides an analysis of the trends of environmental conditions related to agriculture for each of the 30 OECD member countries since 1990, including an overview of the European Union, and the supporting agri-environmental database can be accessed at *www.oecd.org/tad/env/indicators*. Valuable input for each country section was provided by member countries, in addition to other sources noted below. The country sections are introduced by a figure showing the national agri-environmental and economic profile over the period 2002-04, followed by the text, structured as follows:

- ***Agricultural sector trends and policy context:*** The policy description in this section draws on various OECD policy databases, including the *Inventory of Policy Measures Addressing Environmental Issues in Agriculture* (*www.oecd.org/tad/env*) and the Producer and Consumer Support Estimates (*www.oecd.org/tad.support/pse*).
- ***Environmental performance of agriculture:*** The review of environmental performance draws on the country responses to the OECD agri-environmental questionnaires (unpublished) provided by countries and the OECD agri-environmental database supporting Chapter 1 (see website above).
- ***Overall agri-environmental performance:*** This section gives a summary overview and concluding comments.
- ***Bibliography:*** The OECD Secretariat, with the help of member countries, has made an extensive search of the literature for each country section. While this largely draws on literature available in English and French, in many cases member countries provided translation of relevant literature in other languages.

At the end of each country section a standardised page is provided consisting of three figures. The first figure, which is the same for every country, compares respective national performance against the OECD overall average for the period since 1990. The other two figures focus on specific agri-environmental themes important to each respective country.

Additional information is also provided for each country on the OECD agri-environmental indicator website (see address above) concerning:

- Details of national agri-environmental indicator programmes.
- National databases relevant to agri-environmental indicators.
- Websites relevant to the national agri-environmental indicators (*e.g.* Ministries of Agriculture)
- A translation of the country section into the respective national language, while all 30 countries are available in English and French.

Coverage, caveats and limitations

A number of issues concerning the coverage, caveats and limitations need to be borne in mind when reading the country sections, especially in relation to making comparisons with other countries:

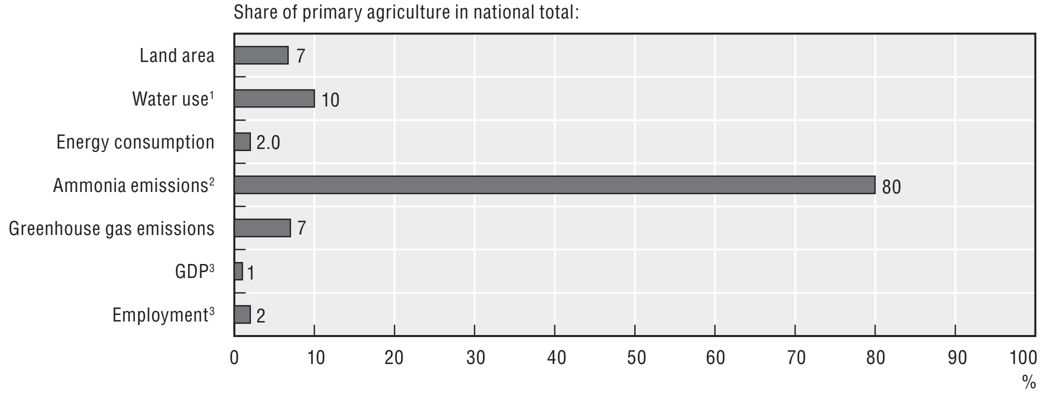
Coverage: The analysis is confined to examination of agri-environmental trends. The influence on these trends of policy and market developments, as well as structural changes in the industry, are outside the scope of these sections. Moreover, the country sections do not examine the impacts of changes in environmental conditions on agriculture (*e.g.* native and non-native wild species, droughts and floods, climate change); the impact of genetically modified organisms on the environment; or human health and welfare consequences of the interaction between agriculture and the environment.

Definitions and methodologies for calculating indicators are standardised in most cases but not all, in particular those for biodiversity and farm management. For some indicators, such as greenhouse gas emissions (GHGs), the OECD and the UNFCCC are working toward further improvement, such as by incorporating agricultural carbon sequestration into a net GHG balance.

- ***Data availability, quality and comparability*** are as far as possible complete, consistent and harmonised across the various indicators and countries. But deficiencies remain such as the absence of data series (*e.g.* biodiversity), variability in coverage (*e.g.* pesticide use), and differences related to data collection methods (*e.g.* the use of surveys, census and models).
- ***Spatial aggregation*** of indicators is given at the national level, but for some indicators (*e.g.* water quality) this can mask significant variations at the regional level, although where available the text provides information on regionally disaggregated data.
- ***Trends and ranges in indicators***, rather than absolute levels, enable comparisons to be made across countries in many cases, especially as local site specific conditions can vary considerably. But absolute levels are of significance where: limits are defined by governments (*e.g.* nitrates in water); targets agreed under national and international agreements (*e.g.* ammonia emissions); or where the contribution to global pollution is important (*e.g.* greenhouse gases).
- ***Agriculture's contribution to specific environmental impacts*** is sometimes difficult to isolate, especially for areas such as soil and water quality, where the impact of other economic activities is important (*e.g.* forestry) or the "natural" state of the environment itself contributes to pollutant loadings (*e.g.* water may contain high levels of naturally occurring salts), or invasive species that may have upset the "natural" state of biodiversity.
- ***Environmental improvement or deterioration*** is in most individual indicator cases clearly revealed by the direction of change in the indicators but is more difficult when considering a set of indicators. For example, the greater uptake of conservation tillage can lower soil erosion rates and energy consumption (from less ploughing), but at the same time may result in an increase in the use of herbicides to combat weeds.
- ***Baselines, threshold levels or targets for indicators*** are generally not appropriate to assess indicator trends as these may vary between countries and regions due to difference in environmental and climatic conditions, as well as national regulations. But for some indicators threshold levels are used to assess indicator change (*e.g.* drinking water standards) or internationally agreed targets compared against indicators trends (*e.g.* ammonia emissions and methyl bromide use).

3.4. CANADA

Figure 3.4.1. **National agri-environmental and economic profile, 2002-04: Canada**



StatLink http://dx.doi.org/10.1787/288861614413

1. Data refer to the year 1996.
2. Data refer to the year 1995.
3. Data refer to the year 2004.

Source: OECD Secretariat. For full details of these indicators, see Chapter 1 of the *Main Report*.

3.4.1. Agricultural sector trends and policy context

Growth in agricultural production was more than double the OECD average between 1990-92 and 2002-04, owing in part to recent strong growth in production and sales in the pig and horticultural sectors (Figure 3.4.2). Farming's contribution to the economy accounts for around 2% of employment and 1% of GDP, while the whole agriculture and agri-food system accounts for approximately 13% of employment and 8% of GDP [1] (Figure 3.4.1). Canada is a major world exporter of cereals, oilseeds, animals and red meats (around 3% of world farm export value), with nearly 25% of production exported in 2004 [1, 2].

Agricultural production is intensifying and concentrated in fewer farms [1, 3]. Farm size and intensity varies across Canada depending on commodity specialisation, geography and land availability. The range of climates, soil types, resource availability, population distribution and competing land uses across the country allows some regions to implement more intensive management practices than others, including higher uses of inputs such as fertiliser, pesticides, energy and water (Figure 3.4.2), and higher densities of livestock. The result has been a greater rise in annual multifactor productivity growth for the agriculture sector (3%) than for industrial sectors (1.5%) over the period 1997 to 2003 [1]. The increase in intensity began in the 1940s, in part, due to economies of scale associated with a change to more capital-intensive technologies, with both farm and herd size increasing ever since [1]. This is reflected in that only one-third of farms report sales over CAD 100 000 (USD 76 000) but account for nearly 90% of farm production [1].

Agricultural support has declined. Support to farmers (as measured by the OECD Producer Support Estimate – PSE) fell from 36% to 22% of farm receipts between 1986-88 and 2002-04, compared to the performance of the OECD area where the average decreased from 37% to 30%. The share of output and input linked support also fell from 82% in 1986-88 to 57% of the PSE in 2002-04 [4]. The 2003-08 *Agricultural Policy Framework* (APF) provides Federal, Provincial and Territorial support to the farm sector through various programmes that fall under the headings of: business risk management; food safety and quality; environment; science and innovation; and renewal. Total agricultural expenditure was CAD 10 (USD 7) billion annually over 2002-04, or just under 1% of GDP [4].

There is growing emphasis on the environment in agricultural policy. Over the 1990s much of the focus of agricultural policy was on economic and production objectives, but environmental considerations became a key part of the APF [5]. Agriculture and environment are shared responsibilities between Federal, Provincial and Territorial governments. Most APF agri-environmental programmes are cost-shared between the Federal, Provincial and Territorial Governments, with CAD 700 (USD 490) million of funding over 5 years (2004-08) provided by the Federal Government [4, 6]. Programmes under the environment chapter of the APF provide producers with assistance to improve their environmental management of soil, water, land and biodiversity by cost-sharing activities such as technical assistance, extension, research and demonstration activities, although there are some exceptions [7, 8].

Several national environmental and taxation policies impact agriculture. The *Canadian Environmental Protection Act* addresses air pollution and toxic substances and involves the agriculture sector when developing risk management plans for listed substances. The Pest Management Regulatory Authority monitors and regulates pesticide products and their use under the *Pest Control Products Act*. Farmers are supported with an on-farm fuel tax exemption, equal to CAD 285 (USD 200) million annually during 2002-04 [9]. Some farm inputs (*e.g.* fertilisers, pesticides) are exempt from the Federal Goods and Service Tax [9]. Irrigation water charges have risen from CAD 11 to 31 (USD 7 to 22) per m^3 between the 1980s and 2000 [3]. *Integrated Water Resources Management* is being used to bring together Federal, Provincial and Municipal authorities in the planning and management of water policies [3, 10]. Biofuels are exempt from the Federal excise taxes on transport fuels [4].

Producers are also affected by commitments under several international environmental agreements. Under the *North America Free Trade Agreement* Canada, together with Mexico and the United States, is seeking greater harmonisation of pesticide regulations [2]. In eastern Canada producers are impacted by commitments made under the *Great Lakes Water Quality Agreement* with the US, co-ordinated through the International Joint Commission, which addresses concerns related to agricultural water pollution and water withdrawals for irrigation and other uses [3, 11]. A plan was initiated in 1997 to improve biodiversity conservation in agriculture as part of Canada's commitments under the *Convention on Biological Diversity*. [3]. Canada is a signatory to the *Kyoto Protocol* to address greenhouse gas emissions, the *Gothenburg Protocol* to reduce ammonia emissions (although emission targets have not yet been determined), and the *Montreal Protocol* to phase out ozone depleting substances, including methyl bromide.

3.4.2. The environmental performance of agriculture

The key environmental challenges concerning agriculture include soil, water and air quality. The growing agricultural demand for water and the impact of farming on biodiversity are also important issues. There are a number of environmental concerns between farming and urban communities [12, 13], notably odours from livestock operations, and the conversion of farmland to urban use [14]. Canada is the second largest country by area in the world, but climate, topography and the range of soil types limit the land suitable for agriculture to approximately 7% (2002-04) of the total land area [15]. Between 1990-92 and 2002-04 the total area of farmland decreased by over 2%, largely because the land suitable for agriculture is already being used for that purpose (Figure 3.4.2). Approximately 60% of farmland is cultivated, 30% pasture and 10% used for other purposes (*e.g.* woodlots). The increase in cropped land is primarily due to the reduction in the use of summerfallow in rotations. Summerfallow area decreased by more than half between 1981 and 2001. The more intensive use of cropland is a result of the adoption of management practices that allow for continuous cropping or extended crop rotations [2].

Overall soil quality – erosion, soil organic carbon, salinity – has improved, during the period 1991 to 2001. Improvements include: an increase in the share of cropland under vegetative cover for more than 300 days annually; a higher share of cropland in low erosion (water, wind and tillage soil erosion) and salinisation risk classes; and a net accumulation of soil organic carbon in cropland since 1996 (Figure 3.4.2) [2, 16, 17, 18]. These developments are a result of: increased adoption of reduced tillage or no-till practices, rising from around 30% in 1991 to 60% of cropland in 2001; reduced use of summerfallow; and expansion in the area of perennial vegetation which primarily involves the conversion of marginal cropland to forage production. There is still room for improvement, however. Approximately 4% of cropland considered to be at high risk for soil degradation (erosion and salinity) was still under cultivation in 2001. In 2006 about 28% of agricultural land in Canada remains under conventional tillage practices, with a higher share in the Atlantic Provinces and Québec, largely due to crop type and climate, and 30% of cropland is still considered to be in the low soil cover class (especially in Ontario and Saskatchewan) [2].

Water contamination from agricultural sources is a concern and risk of water contamination from agriculture has increased since 1981 [3, 19, 20, 21, 22, 23, 24, 25]. Agriculture is a key source of nitrogen and phosphorus in the environment, although risk of contamination tends to be localised [26]. The increase in nutrient surpluses is reflected in the rising trend in the Indicator of Risk of Water Contamination by Nitrogen (IROWC-N) [2]. For instance, the share of farmland in the high to very high risk category for IROWC-N rose from 11% in 1991 to 16% by 2001, and was about 50% in certain regions [2]. Some regions in Canada are at higher risk of poor water quality than others, owing to: surrounding land uses; population density; increased use of inputs, such as fertilisers; and climatic conditions of heavy annual or seasonal precipitation. Overall water quality in Canada is high but it is difficult to provide a national overview as there is no comprehensive water quality monitoring system [3, 21, 27]. About 10% of the total population draws water from private rural household wells, which routinely do not meet drinking water quality standards for bacteria and nitrates. In some Provinces environmental water standards are exceeded for pesticides and phosphorus [3, 21, 28, 29, 30] which also impacts livestock water supplies [28]. About 15% of rural wells exceed guidelines for nitrates in drinking water (45 mg/litre) [3]. Depending on the region, 20-40% of surveyed rural wells have occurrences of *coliform* bacteria in excess of drinking water guidelines [3, 28, 30].

The Great Lakes ecosystem is stressed by farm nutrients, pathogens, pesticides and soil sediments, both from Canadian and US sources. These pollutants threaten recreational opportunities and raises costs of treating drinking water and dredging harbours [31, 32]. There has been some improvement in certain areas of the Great Lakes, such as the attainment of guideline levels of phosphorus for all lakes (except Lake Erie), due to a reduction of P inputs from agricultural, municipal and industrial sources. There is evidence that Canadian agricultural nutrient inputs (especially phosphate) to the Great Lakes could be declining as a result of improved farm management practices [33, 34]. Nutrient surpluses are an issue in some key watersheds, such as Lake Winnipeg which is showing signs of eutrophication [41], although farming is not the only source of nutrient pollution [35].

Agricultural nutrient surpluses per hectare are among the lowest in the OECD, however, they show the highest per cent increase across the OECD (Figure 3.4.2). In absolute values, the N surplus was 35 kg N/ha, about half the OECD average of 74 kg N/ha (2002-04). Both nitrogen (N) and phosphorus (P) surpluses grew respectively by 85% and 123% between 1990-92 and 2002-04. Nutrient surpluses (in tonnes) have grown in response to: greater inorganic fertiliser use – N fertiliser use rose by 35% between 1990-92 and 2002-04 and P use rose by 11% over the same period; the rise in pulse crop area (*i.e.* greater biological nitrogen fixation) without a concurrent reduction in fertiliser use; and higher livestock numbers generating growing quantities of manure [2]. In 1990-92, an estimated 40% of farmland suffered from a nitrogen deficit, however, this problem was addressed and by 2001 no land showed a nitrogen deficit. There are large regional variations in nutrient balances, owing to differing climates and types of soil, farming types and crops types, and also varying topography across the agricultural regions of Canada [2, 37].

Nutrient efficiency has declined, but the ratio is close to the OECD average for nitrogen and above it for phosphorus (nutrient efficiency is defined as the ratio of nutrient inputs and outputs). While the share of farms with formal nutrient management plans is low at 15% in 2001, several management practices are being adopted to protect water quality such as: establishing riparian areas adjacent to surface water on 75% of farms; conducting regular (1-5 years) soil nutrient tests on approximately two-thirds of farms; avoiding livestock feeding less than 100m from surface water during winter (on over 90% of farms); and preventing direct access of grazing livestock to surface water (nearly 60% of farms). Manure storage and application are key elements of most nutrient management plans, but between 1995 and 2001 manure application methods changed little, manure storage capacity was relatively low compared to manure production and timing of applications was not always optimal [2]. Between 1995 and 2001, 15% of producers adopted the optimal beneficial management practices for application of manure, representing 18% of total manure produced [2]. In 2001 10-11% of pig, poultry and dairy farms and 6% of beef farms, reported making environmental investments to reduce the risk of contamination to the environment from their operations [37].

Pesticide sales in Canada doubled between 1990 and 2003 [1, 2]. The risks associated with higher pesticide use, however, may to some extent be offset by: the use of new lower dose products that allow for targeted application; the expansion of genetically modified crops that are more pest-resistant; and the growth in organic farming, which accounted for under 1% of farmland and farms by 2003 and 1-2% of food sales despite its rapid growth in the past decade [1, 38, 39]. The growth in pesticide use is linked to the expansion in crop production, reduction in the use of summerfallow and greater intensity of farming [1]. Pesticides are used on over 80% of cropland [2, 40]. Over 60% of farmers are certified as

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pesticide applicators, however, more efforts are required to encourage the uptake of beneficial management practices, such as recalibrating the sprayer before changing products, and spraying products at optimal times [1].

Under 10% of arable and horticultural farms in 2001 reported making environmental investments for pesticide storage and to combat water pollution from pesticides [37]. Pesticide residues have been detected in water bodies, but there is no systematic monitoring of pesticides in the environment [2, 19, 30]. Only 0.1% of rural wells were found to exceed drinking water standards for pesticides, which suggests management practices are helping to reduce risks [3]. The share of fresh fruit and vegetables with detectable pesticide residues decreased over the period 1995 to 2002 [30]. Since 1994 more than 20 instances of fish kills (with up to 35 000 dead fish collected in each incident) were attributed to pesticides in Prince Edward Island, and in British Columbia birds of prey were lost following the use of granular pesticides [40].

Agricultural water use is increasing. Water resources are abundant nationally; however, water availability varies across different regions of the country [2, 3]. In 1996 agriculture's share of total water use was over 10%, having increased by 3% from 1991 (Figure 3.4.2). Most of the growth in water use is being driven by the expansion in the area irrigated, which rose by 20% from 1990-92 to 2001-03, with most irrigation occurring in Alberta (55%) and British Columbia (21%) [19]. About 30% of irrigators in 2001 were fully or partially using best management practices. Water for irrigation is largely drawn from surface water [41, 42]. A study of Alberta shows improvements in irrigation efficiency over the past 30 years, but there is room for further progress with over 20% of the irrigated area using the less efficient gravity irrigation practices [43]. Increased risk of drought is a growing problem for farming in some regions, and one of Canada's most costly types of natural disaster [10], even in some of the usually more humid areas, such as the Atlantic Provinces [3].

Trends in harmful air emissions from agriculture have shown mixed results. The 3% growth in ***ammonia emissions*** between 1990 and 1995 was largely due to an intensification of livestock operations (Figure 3.4.2). Farming accounted for 80% of anthropogenic ammonia emissions, of which over 80% were from livestock. As industrial sources of acidifying substances (*e.g.* sulphur dioxide) have declined, the rise in agricultural ammonia emissions has eroded the benefits from this reduction [26]. In 2003 gaseous ammonia was listed on Schedule 1 of the *Canadian Environmental Protection Act* for its potential risk to human health as a precursor to fine particulate matter. Research is ongoing to learn more about ammonia emissions levels, transport, deposition and interaction with other substances in the air, and the contribution of the agriculture sector to the emissions. Over 45% of the total land area is highly sensitive to acid rain, with ammonia emissions contributing to the acidification of terrestrial and aquatic ecosystems [27, 44].

***Canada has agreed to phase out its use of methyl bromide by 2005 under the* Montreal Protocol.** By 2004 use was reduced by over 70% from 1991 levels. In 2005 a *Critical Use Exemption* (CUE) was agreed, that allows methyl bromide use of up to 37 tonnes ozone depleting potential, which under the terms of the *Protocol* allows farmers more time to find substitutes for this pesticide.

Net greenhouse gas (GHGs) emissions from agriculture increased by around 1% between 1991 and 2001. This reflects an increase in both nitrous oxide, due to increased crop production and fertiliser use, and methane emissions, from the higher intensity in livestock operations, offset by a large net increase in carbon sequestration by soils as a result of land use changes and improved management practices (Figure 3.4.3) [2, 45, 46]. Changes in agricultural management practices which are being implemented across Canada to reduce emissions, are largely market driven through innovations in equipment, as well as changes in relative prices of crops and inputs [47]. The increase of gross agricultural GHG emissions over the period 1990-92 to 2002-04 (18%) was substantially above the OECD average (–3%) but lower than the rise of 23% for total Canadian GHG emissions (Figure 3.4.2). Agriculture's share in total GHGs was 7% in 2002-04. Canada's commitment under the *Kyoto Protocol* is to reduce total GHG emissions by 6% by 2008-12, but recent announcements by the Government of Canada indicate that it may not be possible to meet this target.

Direct on-farm energy consumption rose by 5% between 1990-92 and 2002-04, which contributed to GHG emissions (Figure 3.4.2). Farm energy efficiency (the ratio of energy inputs to outputs) declined by 3% over the period 1989-93 to 1997-01, mainly due to the rise in diesel fuel and fertiliser use, the largest input components [2]. The production and consumption of ***renewable energy*** from agricultural biomass is minor compared to national total energy consumption, although under the new federal policy on biofuels the target is to achieve a 5% average renewable fuel content in transport fuel by 2010. This should create opportunities for biofuel producers to increase their renewable energy capacity [48, 49, 50].

Overall pressure on agricultural biodiversity continues. For ***agricultural genetic resources***, Canada has *in situ* programmes and extensive *ex situ* collections of plant and animal genetic material, and efforts are underway to further expand this capacity [41, 51]. The number of major crop varieties and livestock breeds used in production has increased in diversity over the period 1990 to 2002. During this period the number of endangered livestock breeds rose from 47 to 51 (mainly cattle and sheep breeds), with only one breed under a conservation programme. This is in contrast to most other OECD countries where numbers of endangered breeds have declined as more livestock have come under conservation programmes, although two Canadian non-governmental organisations are involved in conserving rare livestock breeds [41].

There has been a substantial increase in the area under transgenic crops since the mid-1990s, accounting for 9% of the total agricultural land area in 2005, mainly canola with 70% of the sown crop genetically modified (GM) [35]. Canada is now the second major OECD producer, in terms of area, of transgenic crops after the United States.

The capacity of farmland to support wildlife showed a decline over the period 1991 to 2001. Over this 10 year period, 87% of Canada's farmland showed moderate to large decreases in habitat capacity compared to the 1981-2001, period when 30% of Canada's farmland showed a moderate to large decrease in habitat capacity (Figure 3.4.4). The agricultural intensification that has occurred in some areas of the country since 1981 is considered one of the drivers of the decrease in habitat capacity, such as the increase in cropland that occurred at the expense of more valuable habitats, for example wetlands, woodlots and natural pasture in Eastern Canada. Agricultural habitats, however, make a significant contribution to supporting many wild species by providing the necessary resources for breeding, feeding and cover [2].

Overall 24% of farms in 2001 were fully or partially using best management practices for wildlife conservation [41]. A number of regional studies suggest that the changing structure and fragmentation of agricultural habitats, and some farming practices, have raised concerns for the conservation of terrestrial and aquatic ecosystems, for example: the reduction in size and loss of forest patches on farmland [52]; the fragmentation of native ecosystems [53, 54, 55]; the drainage of agricultural land and straightening of watercourses [55, 56, 57]; and run-off of excess nutrients and pesticides into surface water bodies.

The conversion of native ecosystems to farmland is considered to have been the main cause for the decline of most wild species, including threatened species [58]. The Canadian Wildlife Service grassland species breeding bird population index, decreased by almost 30% between 1990-92 to 2002-04, part of a longer term downward trend since the late 1960s, although from 2001 to 2004 there has been a small upward trend in the index of almost 10% [59]. Possible causes of the decline in grassland bird species include agricultural activities, urban growth into rural areas, and a decline in quality of wintering sites, among others. There is also evidence of recent increases in the Prairies breeding duck populations, although the longer term trend has been variable, for example declining in Southern Alberta, but expanding in Southern Saskatchewan [60].

3.4.3. Overall agri-environmental performance

Changes in farming practices and land use over the past decade have been successful in addressing environmental issues in some areas, but still need improvement in others. The adoption of soil management practices have resulted in improved soil quality, however the expansion and intensification of production over the past decade has increased environmental pressures in other areas [2, 61]. These include mainly water quality, especially in relation to manure management; growing competition for water resources; increase in ammonia and greenhouse gas emissions; and pressure on biodiversity. Given the size of Canada and its diversity of climate and soil types, there are wide regional differences in the environmental impacts of agriculture.

A comprehensive set of indicators to monitor the environmental performance of agriculture has been developed, within the context of *Canada's Agricultural Policy Framework* (APF) [2, 61]. Two agri-environmental indicator reports have been published to date (2000 and 2005), and a third is planned for 2008/09. Further development work is underway to strengthen the agri-environmental indicators in a number of areas, for example, soil biodiversity, particulate matter, and integrated pest management [2, 5]. A crucial challenge for indicator development and policy integration capacity are data limitations in key areas, such as pesticide use, agricultural water use, and a national monitoring network on water quality.

Canada is one of only a few OECD countries that does not regularly report the annual volume of pesticide use, although the Federal government stated in 1994 that it would establish a pesticide use database [40]. The lack of a national monitoring network on the quality of water (surface and groundwater) in rural areas has also been recognised as an impediment to effective policy analysis [33], while data related to agricultural water use are poor [42]. Efforts are being made, however, by the Federal government to collaborate with Provincial governments to fill these gaps, by conducting national surveys and establishing collaborative relationships with industry and academia. Agriculture and Agri-Food Canada is investigating the relationship between trends in critical habitat for wild species at risk and trends in agricultural land use.

Growing efforts by Federal and Provincial governments are tackling agri-environmental concerns. Under the environment pillar of the APF several programmes have been launched with the goal of reducing the sector's risk to the environment while remaining economically competitive. Programmes such as the *National Farm Stewardship Program* provide technical support for producers to conduct environmental scans of their operations and develop *Environmental Farm Plans*. The Plans that identify actions to improve on-farm environmental performance, as well as providing cost-share support to implement these actions (*i.e.* fencing livestock out of water). There is still room for improvement to limit the impact of pesticides in the environment, however, work is ongoing to encourage producers to develop and adopt integrated pest management (IPM) systems which allow for continuous monitoring, adoption of alternative strategies for controlling pests, and targeted and efficient use of pesticides when required. The uptake of IPM practices is beginning to increase.

Within the APF the four-year CAD 60 (USD 45) million National Water Supply Expansion Program (2005) will address the growing risks of water shortages. The Program is making support available for on-farm water infrastructure, among other measures, and by providing a third of project costs [4]. The *Environmental Technology Assistance for Agriculture* programme evaluates innovative new technologies and production systems that are expected to contribute to improved on-farm economics and environmental performance, through nutrient management and the production of biofuels and renewable energy. Some of the key Provincial Government agri-environmental initiatives include: the implementation of a tax of CAD 1.2 (USD 0.8) per litre of pesticides in British Columbia; and Quebec's CAD 28 (USD 20) million *Prime-Vert Program* to control manure related pollution including a subsidy of 70-90% for the construction of manure storage facilities and restraints on manure spreading over winter [3, 5, 62].

The greenhouse Gas (GHG) Mitigation Program is an information and awareness programme, that encourages voluntary adoption of farm practices to reduce GHG emissions and increase carbon sinks. A comprehensive strategy to implement a 5% renewable fuels mandate for transport by 2010 is being established. The strategy plans to provide significant government incentives to support the expansion of the ethanol and biodiesel industry, and investment in research and development to encourage the growth of second generation biofuels, such as cellulosic ethanol.

A number of Provincial governments have in recent years introduced a range of measures to control water pollution from intensive livestock operations. These include, for example, the *Nutrient Management Act* in Ontario and the *Water Protection Plan* in Manitoba, which set targets for N and P levels in water bodies, and regulate some activities such as the timing of manure spreading to reduce risk of water contamination by agricultural sources [3, 19, 63]. Continued promotion of management practices that help reduce run-off of fertilisers and pesticides into the Great Lakes are planned as there are still improvements to be made [11]. Canada and the United States have also been working closely to develop an action plan to mitigate agricultural and industrial risks to the Great Lakes Basin under the *Great Lakes Regional Collaboration*, which aims to set goals to 2010 and 2015 to reduce agricultural pollutants into the Great Lakes, such as reducing livestock non-point source loading [31].

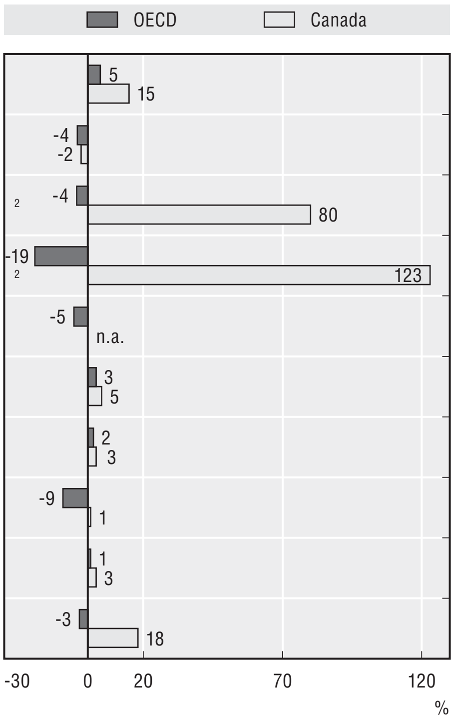
The agriculture sector is continuing efforts to reduce emissions of ammonia through the development and implementation of beneficial management practices that address manure management, storage and spreading and fertiliser application and storage. Research is ongoing to learn more about ammonia emission levels, transport, deposition and interaction with other substances in the air, as well as develop new beneficial management practices to reduce risk.

The projected expansion of agriculture to 2015 presents a considerable challenge to avoid an increase in environmental pressure [2, 64]. Changes in farming practices, especially the shift to reduced or no tillage, and land use changes, notably the reduction in summer fallow have yielded considerable environmental benefits, including: improved soil and water quality; lower energy use; reduced greenhouse gas emissions; and improvements for biodiversity. But these gains have partly been offset by the decreasing efficiency of nutrient and energy use. Rapidly growing nutrient surpluses could be offset with improvements to increase the uptake of best managements practices (BMPs), as only 15% of farms use BMPs to apply manure. Raising the efficiency of nutrient use would bring economic and environmental benefits. Subsidising on-farm fuel costs is a disincentive to improving energy use efficiency, reducing GHGs, and adopting conservation tillage (which requires less energy than conventional tillage) [65]. Only 6% of farms reported investment in environmental protection (*i.e.* manure storage, pesticide and fuel storage and waterway protection), averaging over CAD 19 200 (USD 12 400) or almost 4% of total farm investment in 2001 [37, 66].

A further challenge will be meeting Canada's international environmental commitments related to agriculture. The *International Joint Commission* has been requested to examine water diversions and removals from the Great Lakes, including for irrigation purposes, especially as water use conflicts and litigation have increased rapidly over the past decade [3]. Subsidised irrigation water and infrastructure do not facilitate the conservation of water resources and promotion of the efficient allocation of water between farming and other uses [3, 19]. While there has been success in lowering the use of *methyl bromide* since 1990, a further reduction will be required if Canada is to phase out its use as agreed under the *Montreal Protocol*. Given the increase in agricultural *ammonia* and gross *GHG emissions* it will also be a major challenge for Canada to meet its commitments to reduce emissions under the respective *Gothenburg* and *Kyoto Protocols*, although success has been achieved in increasing carbon sequestration in agricultural soils, helping to reduce net GHG emissions.

Figure 3.4.2. **National agri-environmental performance compared to the OECD average**

Percentage change 1990-92 to 2002-04[1]



Absolute and economy-wide change/level

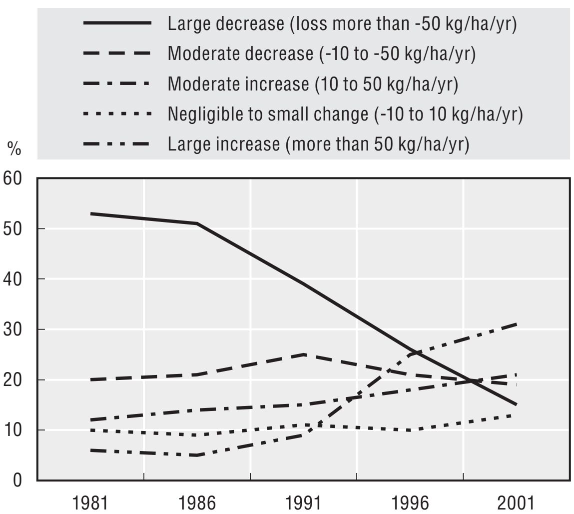
Variable	Unit		Canada	**OECD**
Agricultural production volume	Index (1999-01 = 100)	1990-92 to 2002-04	115	105
Agricultural land area	000 hectares	1990-92 to 2002-04	–1 521	–48 901
Agricultural nitrogen (N) balance	Kg N/hectare	2002-04	35	74
Agricultural phosphorus (P) balance	Kg P/hectare	2002-04	1	10
Agricultural pesticide use	Tonnes	1990-92 to 2001-03	n.a.	–46 762
Direct on-farm energy consumption	000 tonnes of oil equivalent	1990-92 to 2002-04	+184	+1 997
Agricultural water use	Million m^3	1990-92 to 2001-03	+113	+8 102
Irrigation water application rates	Megalitres/ha of irrigated land	2001-03	3.6	8.4
Agricultural ammonia emissions	000 tonnes	1990-92 to 2001-03	+14	+115
Agricultural greenhouse gas emissions	000 tonnes CO_2 equivalent	1990-92 to 2002-04	+8 043	–30 462

n.a.: Data not available. Zero equals value between –0.5% to < +0.5%.

1. For agricultural water use, pesticide use, irrigation water application rates, and agricultural ammonia emissions the % change is over the period 1990-92 to 2001-03.
2. Percentage change in nitrogen and phosphorus balances in tonnes.

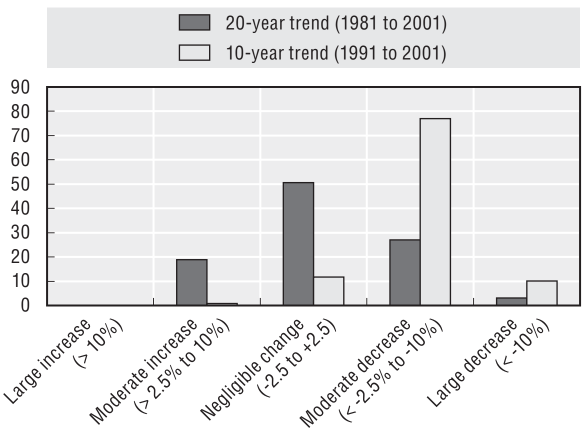
Source: OECD Secretariat. For full details of these indicators, see Chapter 1 of the *Main Report*.

Figure 3.4.3. **Share of cropland in different soil organic carbon change classes**



Source: Lefebvre, A., W. Eilers and B. Chunn (eds.) (2005), *Environmental Sustainability of Canadian Agriculture*, AEI. Report Series, Report 2, Agriculture and Agri-Food Canada, Ottawa.

Figure 3.4.4. **Share of farmland in different wildlife habitat capacity[1] change classes**



1. "Habitat capacity" is the capacity of agricultural land to sustain populations of wild terrestrial vertebrates, *i.e.* birds, mammals, reptiles and amphibians.

Source: Lefebvre, A., W. Eilers and B. Chunn (eds.) (2005), *Environmental Sustainability of Canadian Agriculture*, AEI Report Series, Report 2, Agriculture and Agri-Food Canada, Ottawa.

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