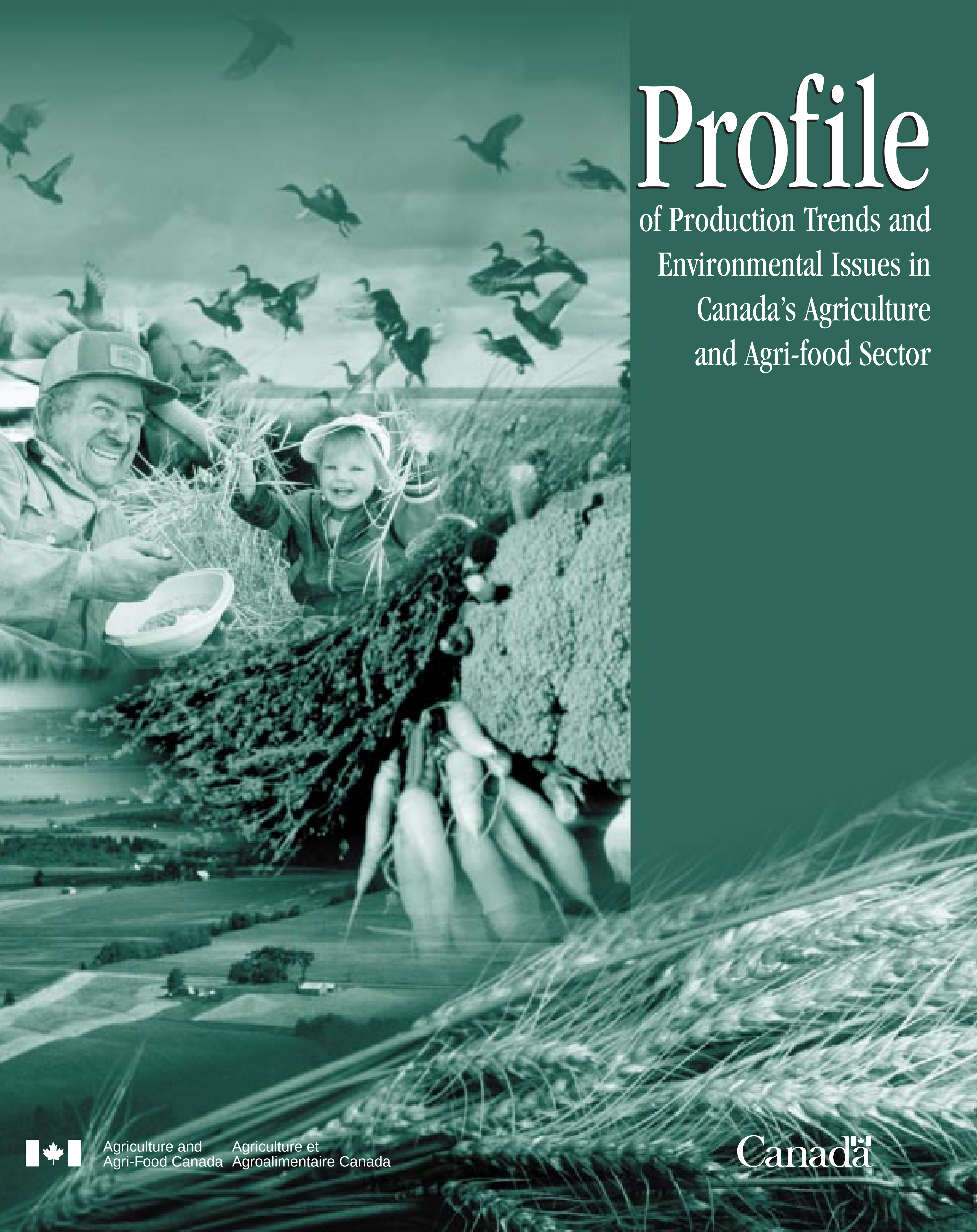

Profile

of Production Trends and Environmental Issues in Canada's Agriculture and Agri-food Sector

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A. Introduction

The federal government has presented a new environmental agenda, *A Guide to Green Government* (Government of Canada, 1995), that calls upon its departments to devise sustainable development strategies. These strategies will outline ways of bringing together Canada's economic, social, and environmental goals to ensure that development in this country proceeds *sustainably*. Agriculture and Agri-Food Canada's strategy will evolve over time but initially focuses on environmental sustainability with the goal of better integrating this concept into existing ways of doing business.

Each department is required to include in its strategy an issue scan that involves a self-assessment of its policies, programs, and operations in terms of their impact on sustainable development. A brief scan of the environmental issues facing the agriculture and agri-food sector is given in *Strategy for Environmentally Sustainable Agriculture and Agri-food Development in Canada*. This document provides a more thorough assessment of the economics and production of the sector, examining the primary production of plant and animal commodities, the food- and beverage-processing industry, and changes in agricultural land use in Canada. It also gives a detailed profile of the environmental issues pertinent to the sector, examining issues such as the quality and use of water, agricultural inputs, and land. Examples of ways to address these issues are also identified.

Both this document and *Agriculture in Harmony with Nature — Strategy for Environmentally Sustainable Agriculture and Agri-food Development in Canada* have been developed in consultation with many sectoral and interest groups. Appendix 3 of the strategy lists individuals who received the documents and were invited to participate in the consultations.

Data and information presented in this document are drawn from various sources. The analysis focuses on the environmental impacts and risks resulting from agricultural and agri-food production. Although the sector has considerable potential to provide environmental benefits, such as adding to wildlife habitat and curbing the greenhouse effect, the nature and magnitude of such benefits are not presented in detail as they have not been thoroughly researched. The potential impacts of environmental change on agri-food production, such as damage to crops by ultraviolet radiation, are also not treated in detail.

Section B profiles the agri-food sector's contribution to the Canadian economy; the distribution of, and trends in, agri-food production in Canada; and agricultural land use changes. These factors strongly influence the nature of agriculture's relationship with the environment and serve as a backdrop to the analysis of biophysical issues facing agriculture and agri-food presented in sections C and D. Trends are typically analysed for the 1971–1991 period, with updates from 1991 (the most recent year for which census data are available) provided where possible. The document concludes with a qualitative environmental outlook for the sector in section E.

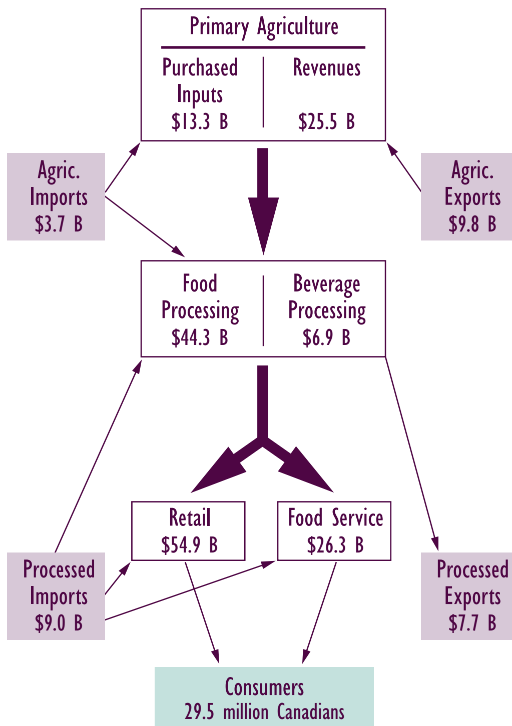
B. Nature and Distribution of Agri-food Production

1. Agriculture and Agri-food in the Canadian Economy

The total value of agri-food transactions in Canada for 1995 is illustrated in Figure 1.

Figure 1

Value of Agri-food Transactions in Canada, 1995



Source: Agriculture and Agri-Food Canada, 1996a.

The agri-food industry (primary agriculture; food and beverage processing; and retail, wholesale, and food services) contributed approximately 9% of Canada's Gross Domestic Product (GDP) in 1995, with retail and food service sales of more than $83.2 billion (in food goods and services).

Farm-level agricultural production accounted for about 2.1%, food and beverage processing for about 2.3%, and retail and food service transactions for about 4.3% of Canadian GDP (Agriculture and Agri-Food Canada, 1996b).

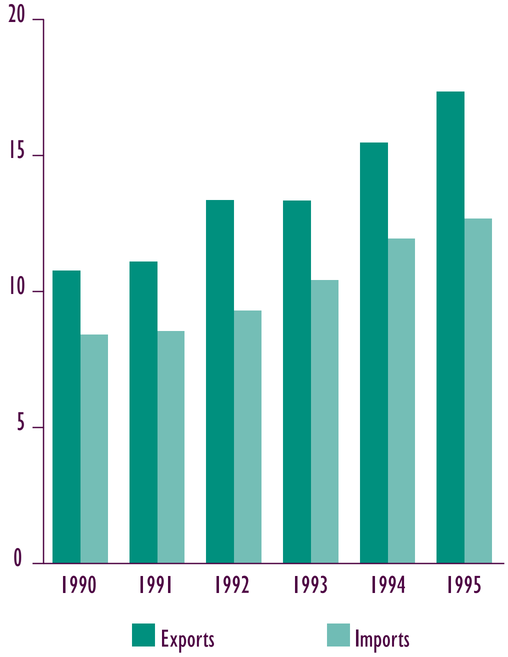
The importance of primary agriculture and food and beverage processing varies greatly across provinces and regions. For example, in 1994–1995 the agri-food sector accounted for 11.2% of Saskatchewan's GDP but only 4% of the GDP in Ontario and Quebec. However, at the GDP level Ontario and Quebec contribute 31% of Canada's primary agricultural production and about 72% of food and beverage processing.

The 1991 Census of Agriculture recorded 280,043 farms, down significantly from a high of 733,000 farms in 1941. Total farm area has remained relatively constant, but between 1971 and 1991 the average size of farms increased from 96 hectares (ha) to 242 ha. The trend toward fewer but larger farms is expected to continue. The food- and beverage-processing industry is very diverse and includes both large and small enterprises.

The agri-food sector also makes an important contribution to Canada's international trade. In 1995, Canada exported about $17.5 billion of agri-food products (Fig. 2), representing about 6.9% of all Canadian exports. The net agri-food trade surplus in 1995 amounted to $4.8 billion, or 17% of Canada's overall trade surplus. The principal agricultural commodities exported by Canada are grains and grain products (32.3% of total agri-food exports); red meats, including live animals and excluding poultry (18%); and oilseeds and oilseed products (16%) (Agriculture and Agri-Food Canada, 1996c).

Figure 2

Agri-food Trade in Canada, 1990–1995



Source: Agriculture Canada and Agri-Food Canada, 1996a.

2. Agriculture and Agri-food Production

The value of the principal agricultural commodities grown in Canada is shown in Figure 3. The two largest generators of farm cash receipts in Canadian agriculture in 1995 were grains and oilseeds (34% of the total) and red meats (27%). Other major sectors of primary agricultural production include dairy, horticulture, and poultry and eggs.

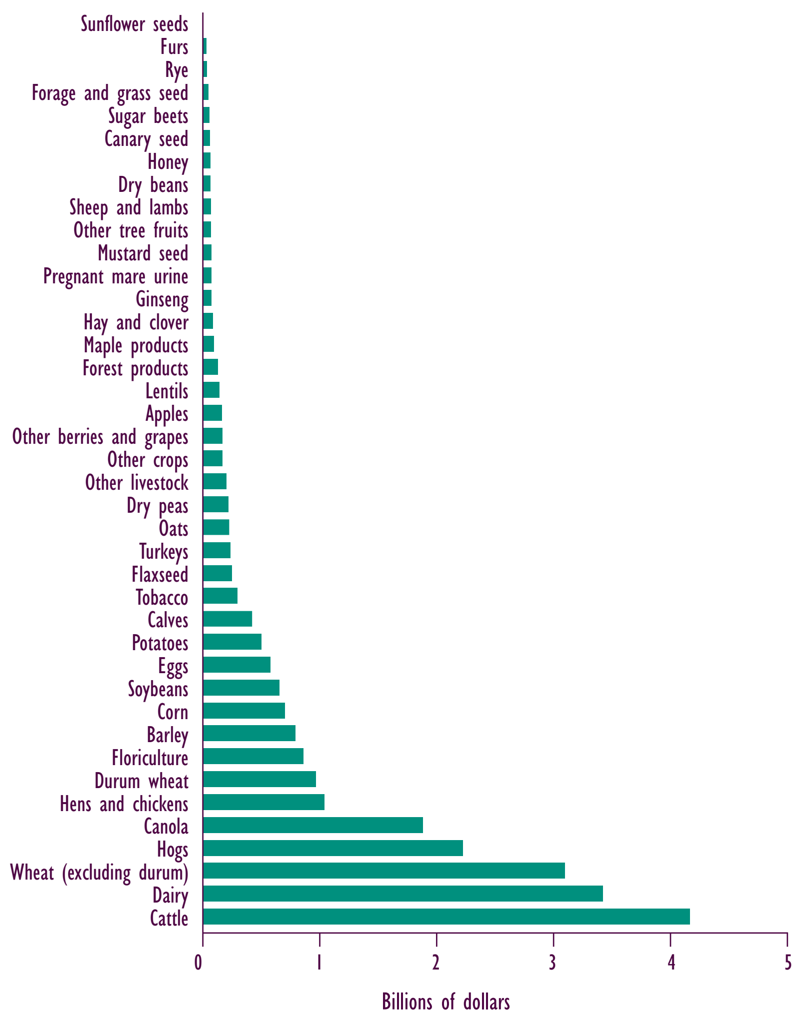
a. Grains and Oilseeds

The principal grain crops grown in Canada are wheat, oats, barley, and corn. The principal oilseeds are flaxseed, canola, soybeans, and sunflower seeds. Other grain and oilseed specialty crops include lentils, peas, canary seed, and mustard seed.

The environmental risks associated with grain and oilseed crops vary widely by crop. Small grain crops, such as wheat, barley, oats, and rye, generally pose relatively lower risks, because they require only moderate fertilization and provide a fairly good vegetative cover over the soil during and after the growing season. Other field crops may pose higher environmental risks, because they have higher fertilization requirements and/or provide less vegetative cover over soil. Corn and canola, for example, generally have higher requirements

Figure 3

Commodities Grown in Canada, Value of Farm-level Sales, 1995



Source: Statistics Canada, 1996a.

for nitrogen fertilization than small grains but provide comparable levels of soil cover when grown under reduced tillage systems. Soybeans provide less soil cover than small grains but require no inputs of nitrogen. The environmental risks associated with grain and oilseed production can be reduced through the use of sound management practices, such as reduced tillage and crop rotations.

Between 1951 and 1996, aggregate production of grain and oilseed crops more than doubled, but there are important differences between crops and regions.

Recent domestic and international policy developments will influence cropping decisions in the grains and oilseeds sector. These include elimination of the *Western Grain Transportation Act* (WGTA) subsidy, changes in the grain-pooling system, and the conclusion in 1994 of the World Trade Organization (WTO) Agreement. The distribution of grain and oilseed production, and historical and projected production trends, are as follows (these numbers are taken from Agriculture and Agri-Food Canada, 1996d and Statistics Canada, 1996b, 1992c, 1992d):

- About 97% of Canada's area in wheat is in the Prairie provinces. In the late 1960s, Prairie wheat area averaged about 11.7 million hectares (Mha) and then dropped to about 4.8 Mha in 1970 due to depressed prices and government programs designed to reduce wheat production. Area remained below 10 Mha until 1976 and then gradually increased to a high of 13.9 Mha in 1992. Harvested area in 1996 was about 12.65 Mha. Elimination of the WGTA subsidy, combined with a desire by producers to diversify beyond wheat, is expected to keep production from returning to the peak levels of the early 1990s. By 2000, Canada's area in wheat is expected to range somewhere around 13 Mha, depending on the strength of wheat prices.
- About 94% of Canada's area in barley is in the Prairie provinces. Between 1971 and 1996, barley area in the Prairies decreased by 9%, from about 5.4 Mha to about 4.9 Mha. Canada's area in barley is expected to be about 4.9 Mha by 2000. Factors affecting barley area include higher wheat and oilseed prices and elimination of the WGTA, which favours higher-valued crops for export. Decreases could be moderated by potentially increased demand for barley from an expanding livestock sector.
- About 95% of Canada's area in grain corn and silage corn is in Ontario and Quebec. Between 1971 and 1996, area in corn for grain and silage increased by about 35%, from 891,000 ha to about 1.2 Mha (of which 84% was grain corn, 16% silage corn). Since 1991, area in corn in eastern and central Canada declined by about 5% as strong soybean prices and new, hardier soybean varieties have promoted soybeans over corn in production decisions. Area in grain corn is expected to be at around 1.16 Mha by 2000.
- About 99% of Canada's area in canola is in the Prairie provinces. Between 1971 and 1996, area in canola increased by almost 64%, going from about 2.2 Mha to about 3.6 Mha and peaking in 1994 at about 5.8 Mha. The production forecast for the year 2000 is about 5.3 Mha, depending on the direction of canola prices as well as prices for grains such as wheat.
- Ontario accounts for about 89% of Canada's area in soybeans. Between 1971 and 1996, area in soybeans increased by about 481%, from 148,635 ha to 863,200 ha. Canada's area in soybeans is projected to be at around 910,000 ha by 2000.
- Virtually all of Canada's area in flaxseed is in the Prairie provinces. Flax production declined by 30%, from about 710,000 ha

in 1971 to 500,000 ha in 1991. In 1996, area in flaxseed had increased to about 575,000 ha and is expected to be at around 670,000 ha in 2000.

- Western Canada accounted for more than 80% of the area in specialty crops in 1991. The area planted to specialty crops (peas, sunflower seed, mustard seed, lentils, and canary seed) increased from about 150,000 ha in 1961 to more than 900,000 ha in 1991. Since 1991, the area in specialty crops has grown even more rapidly and was 1.41 Mha in 1996. This growth indicates that producers have diversified their crop mix beyond the more traditional crops (e.g., wheat). However, continued diversification into specialty crops over the medium term is not expected to any great extent; area in specialty crops will reach about 1.8 Mha in 1997 and then stabilize through to 2000.

b. Red Meats

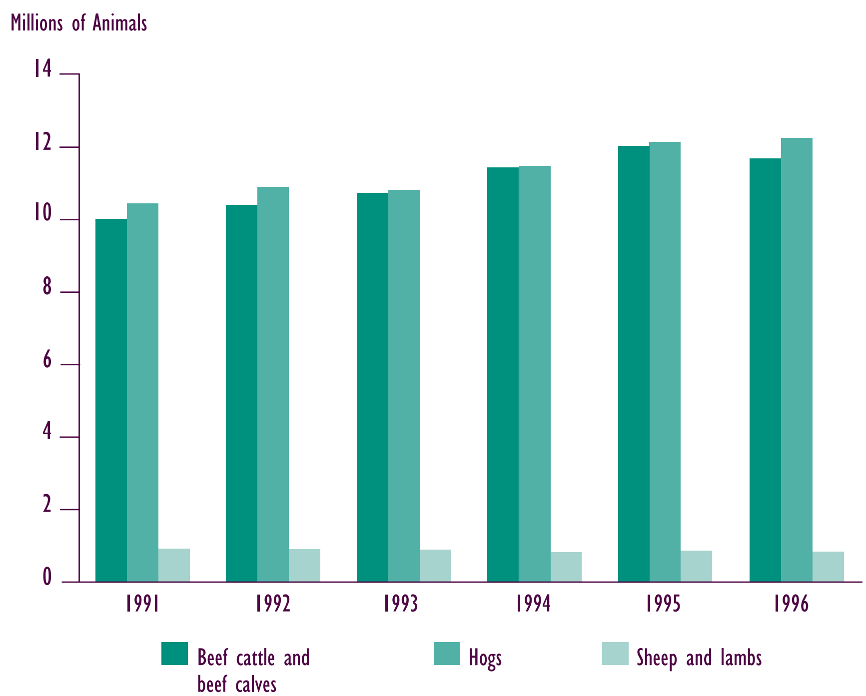
Canada's red meat production, including beef cattle, hogs, lamb, veal, and mutton, generated about $7 billion in farm cash receipts in 1995. Beef cattle and beef calves represented about 36.7% of total farm cash receipts from livestock, followed by the hog sector, which accounted for about 17.8%.

The principal environmental concerns associated with red meat production stem from surplus or improperly managed manure. If properly handled and applied to land at appropriate rates, manure is a valuable soil amendment, as well as a source of plant nutrients. Poor management, however, can cause water pollution by nutrients and bacteria, produce offensive odours, and generate emissions of greenhouse gases, such as nitrous oxide and methane. Environmental risks are influenced by the concentration of animals in relation to the availability of sufficient land on which to spread manure, the method of manure storage, and the timing and method of manure application. For example, beef and sheep production on open rangeland pose few environmental risks related to manure management, but can involve such impacts as the trampling of riparian areas and potential conversion of wilderness areas to pasture and rangelands. Rangeland production offers opportunities for recycling nutrients in soils and increasing the carbon-sequestering potential of grasslands. However, both intensive hog production in confined facilities and beef production in large feedlots require careful management and disposal of manure.

Figure 4 illustrates trends in red meat production in Canada between 1991 and 1996. As with grains and oilseeds, there are important regional differences in production across Canada.

Figure 4

Beef Cattle and Beef Calf, Hog, Sheep and Lamb Inventories in Canada, 1991–1996



Source: Statistics Canada, 1992c, 1996c.

Distribution and production trends are as follows (these numbers are taken from Agriculture and Agri-Food Canada, 1996d and Statistics Canada, 1992c, 1992d, 1996c):

- In 1996, about 11.6 million beef cattle were recorded in Canada (beef cattle, beef heifers, slaughter heifers, steers, bulls, and beef calves), a slight increase from the 10.3 million animals recorded in 1971. The major change has been the shift in production from eastern to western Canada. The Prairie share of the national beef cattle inventory went from 68% in 1976 to 75% in 1996, while the share in Ontario and Quebec decreased from 26% to 18%. The share in the Atlantic provinces remained unchanged at 2%, and the B.C. share increased from 4% to 6%. Alberta, with its vast rangelands and relatively inexpensive hay and feed, now dominates production. Canadian beef cattle inventories have expanded since 1988, peaked in 1995, and are expected to decrease through to 1999. Inventories are expected to be at around 11 million in 2000.
- About 10 million hogs were reported on 30,000 farms in the 1991 Census of Agriculture, twice the hog population recorded in 1961. However, the number of farms producing pigs dropped by 85% in this period, suggesting more specialized and concentrated production. In 1996, the total hog inventory had reached 12.2 million animals; about 55% were located in Quebec and Ontario, 42% in the Prairie provinces (mainly in Alberta and Manitoba), 2.8% in the Atlantic region, and 1.6% in B.C. As with beef, growth in the west, partly attributed to the relatively low feed costs in this region, has gradually shifted production from east to west. Hog inventories are expected to increase slightly, reaching about 12.6 million in 2000. Western herd expansion (especially in Manitoba) is projected to continue to outpace eastern herd expansion.
- The number of sheep and lambs in Canada peaked in 1931 at 3.6 million, and had fallen by 1986 to around 701,000. From 1986 to 1996, sheep numbers increased to 838,100. Another trend has been the shift in sheep populations from east to west. In 1911, 85% of sheep were found in eastern Canada, whereas in 1996, 52% of sheep were in western Canada, primarily Alberta. This shift can be partly attributed to the availability of western grazing land.

c. Dairy

The dairy industry is Canada's third-ranking primary agricultural sector, with 13% of total farm cash receipts in 1995. It is most important in central and eastern Canada, particularly Quebec and Ontario, which together account for 71% of Canada's total dairy farm cash receipts and more than 73% of the nation's dairy cow population. About 26,000 dairy producers in Canada generated $3.5 billion in 1995 (Canadian Federation of Agriculture, 1995).

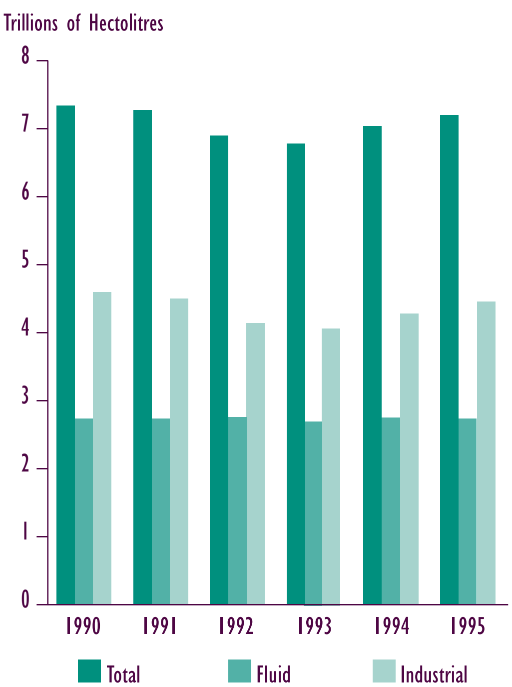
The main environmental risks associated with dairy production include water pollution from milkhouse wastes, animal manures, and herbicides used on field crops; soil degradation associated with production of annual row crops; and potential trampling of riparian areas by cattle. However, there is good opportunity for managing risks because dairy farms typically occupy a relatively large land base and grow forage crops, thus allowing for recycling of manure nutrients through soils and for practising sound agronomic practices, such as rotating row crops with forages.

Figure 5 illustrates trends in Canadian milk production. Because milk is a supply-managed commodity, production has remained relatively stable at around 7.2 trillion litres of milk per year since 1990. Cow productivity increased by 75% between 1971 and 1991, meaning that fewer cows are needed to meet the demand. There were about 2.8 million dairy cattle (including dairy cows, dairy heifers, slaughter heifers, and dairy calves) in Canada in 1996, about 22% fewer than in 1976. These gains in productivity per animal translate into relative environmental gains as well: less methane emitted and manure generated per unit of milk produced. In 1996, about 54.6% of the dairy animal population was located in Ontario and Quebec, 35% in the Prairies, 5.9% in B.C., and 4.5% in the Atlantic provinces (Statistics Canada, 1992c, 1992d, 1996c). Corresponding numbers for 1976 were 60%, 32%, 4%, and 4%, denoting a slight shift in animal populations from east to west. The number of dairy farms has also dropped (by 73% between 1971 and 1991) but there are now more animals per farm on average.

The evolution of dairy production will be shaped by recent policy changes, such as the WTO Agreement and the gradual elimination of the federal dairy subsidy. As a result of the WTO Agreement, import quotas for dairy products from other countries have been replaced by tariff equivalents ranging from 237% for skim milk powder to 350% for butter. The WTO Agreement is not expected to lead to major structural changes in the industry. The impact of the elimination of the dairy subsidy will depend to some extent on whether or not producers can recoup lost revenue from the marketplace (which would translate into higher prices for consumers, less demand for dairy products, and possibly to some restructuring in the industry).

Figure 5

Milk Production in Canada, 1990–1995



Source: Statistics Canada, CANSIM Database

d. Horticulture

Horticulture products include potatoes, vegetable crops, tree fruits, berries, and floriculture and nursery products. Horticulture generated about 10.4% of total farm cash receipts in 1995, making it the fourth-largest sector of primary agriculture.

The environmental risks associated with horticulture can vary widely, depending on the type of crop grown. In general, however, some horticultural products (such as vegetables) have higher requirements for fertilization and pest management, resulting in more intensive use of pesticide and fertilizer inputs than is the case with some other crops. Some crops, such as potatoes (which are grown on a larger scale than other horticultural crops), provide a low degree of residue cover on soil, which can increase the risk of soil degradation. Some greenhouse and nursery operations still use the fumigant methyl bromide, an ozone-depleting substance that is being phased out under international controls. Environmental risks in horticultural production can be reduced through practices such as Integrated Pest Management, crop rotations, and growing winter cover crops to protect soil from erosion and to capture excess nutrients.

Less than 1% of Canada's cropland is devoted to horticulture, but because the industry is highly concentrated, regional land use can be significantly higher. Figure 6 illustrates recent trends in Canadian horticultural production.

Distribution and production trends are as follows (these numbers are taken from Statistics Canada 1992c, 1992d, 1996d and Agriculture and Agri-Food Canada, 1996d):

- Area in vegetables, of which 83% is in the provinces of Quebec and Ontario, increased marginally on a national basis from 103,033 ha in 1971 to 116,411 ha in 1995.
- Area in tree fruits, of which 66% is in Ontario and Quebec and 24% in B.C., decreased nationally from 54,511 ha in 1971 to 41,151 ha in 1996.
- Area in berries and grapes, of which 44% is located in Ontario and Quebec, 39% in the Atlantic provinces, and 16% in B.C., increased nationally from 22,338 ha in 1971 to 50,153 ha in 1995.
- Area in vegetable production under glass and plastic increased from 3.7 million m^2 in 1971 to 9.5 million m^2 in 1994. About 65% is located in Ontario and Quebec and 21% in B.C.
- For potatoes, a key trend has been the concentration of production on fewer farms. In 1971, 12,400 farms reported 109,000 ha of potatoes grown for sale; in 1991 4,700 farms reported 122,000 ha. In 1995, about 144,700 ha were seeded to potatoes in Canada. P.E.I. reported the largest area under potato production (43,700 ha), followed by Manitoba (24,300 ha), New Brunswick (21,900 ha), Quebec (19,000 ha), Ontario (15,500 ha), and Alberta (12,100 ha). By 2000, potato production is forecasted to reach 4.1 million tonnes, an increase of 44% from 1991.
- Area in mushrooms was about 664,049 m^2 in 1995.

Figure 6

Horticulture Production in Canada, 1990–1995

Source: Statistics Canada, 1996a, 1992c.

e. Poultry and Eggs

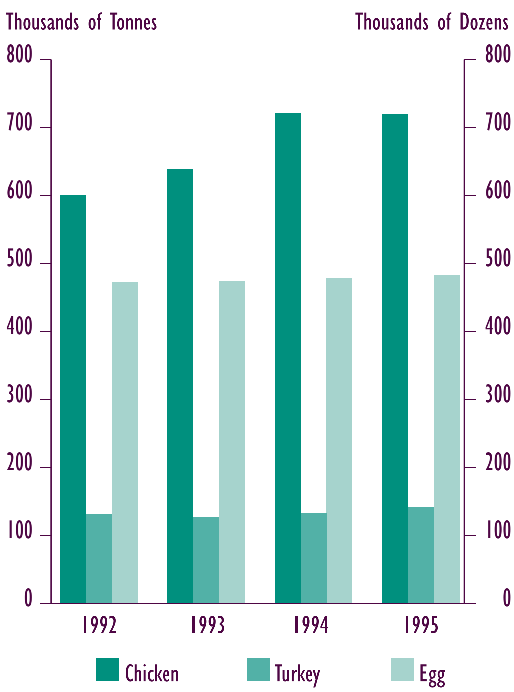
The poultry and egg sectors constitute the fifth most important sector of primary agriculture in Canada. In 1995, this sector represented about $1.9 billion in farm cash receipts.

As with red meat production, the main environmental risks arising from poultry and egg production relate to manure management and include water pollution, odour, and emissions of greenhouse gases. Environmental risks are influenced by methods to store, handle, and dispose of manure. Manure management can be a particular challenge, as much of Canadian production is concentrated on farms that have a small land base.

Figure 7 illustrates trends in Canadian poultry and egg production. As with milk, poultry and egg production is controlled by a supply management system. In 1991, 94.9 million hens and chickens were recorded on farms in Canada. Distribution was roughly as follows: 60% in Ontario and Quebec, 20% in the Prairie provinces, 12% in B.C., and 8% in the Atlantic region. About 8.1 million turkeys were recorded on farms in 1991; 41% were located in Ontario, 23% on the Prairies, 21% in Quebec, 10% in B.C., and 5% in the Atlantic provinces (Statistics Canada, 1992c, 1992d, 1995).

Figure 7

Poultry Production in Canada, 1992–1995



Source: Statistics Canada, 1995.

Over the past decade, demand for poultry meat has been rising. In 1996, production of poultry meat (chicken and turkey) reached about 851,000 tonnes. The number of farms reporting raising chicken for meat dropped from about 100,000 in 1971 to about 24,000 in 1991, indicating that chicken farms have grown much larger and more specialized. The number of farms reporting raising turkeys dropped from 13,413 in 1971 to 8,462 in 1991.

The number of farms producing eggs declined by more than 25% between 1986 and 1991; in 1991 28,000 farms reported having laying hens. Egg consumption has also declined, from an average of 23 dozen per person in 1960 to about 14.4 dozen per person in 1995, a figure that has remained relatively stable since 1990.

The future of the poultry and egg sector will be influenced by some of the same external forces that may affect dairy, including the WTO agreement. The production of shell eggs is forecasted to remain essentially the same through to 2000; the only growth will be in processed eggs, projected to increase by about 3% annually. Production of chicken meat is forecasted to reach about 805,000 tonnes by 2000. Production of turkey meat is projected to increase slightly to about 149,000 tonnes by 2000 (Agriculture and Agri-Food Canada, 1996d).

f. Forages

Forages can be defined as any cultivated grass or legume crop that has been or will be cut for hay or ensilage. Forage species include alfalfa, red and white clover, alsike, birdsfoot trefoil, brome grass, creeping red fescue, timothy, and crested wheat grass. Forage crops are grown for their benefits in crop rotations, for seed, and as feed for animals.

Forage crop production has several agronomic and environmental benefits. Because forage crops provide a dense and continuous vegetative cover over soil, lands under forages are at low risk of soil erosion. Forages also help build soil organic matter, improve soil structure and water-holding capacity, and provide nesting habitat for some species of wildlife. Leguminous forage crops, such as alfalfa, can fix and store nitrogen in the root system, reducing nitrogen application needs for subsequent crops. For these and other reasons, crop rotations with forages are a recommended agronomic practice.

Area under forage crop production in Canada was estimated at approximately 6.5 Mha in 1995, an increase of about 10% from 1991. Canadian exports of forages have also increased. In 1991, the Prairie provinces accounted for about 60% of the area under forage crops (some of which was under irrigation), followed by Ontario (18%), Quebec (15%), B.C. (4%), and the Atlantic provinces (3%) (these statistics exclude forages grown on improved or unimproved pasture) (Statistics Canada, 1992a, 1996f).

Although no definitive forecasts are available, area under forage crops may decrease in some areas in the short term due to the current profitability of some annual crops (e.g., corn, wheat). Over the longer term, area under forage crops may expand in some areas, such as the eastern Prairies, due to the elimination of the *Western Grain Transportation Act* and increases in beef production.

g. Organic Agriculture

Organic agriculture is a production system that relies on natural products and processes to foster crop growth, maintain or improve soil quality, control pests, and encourage biodiversity. Standards for organic food production have been developed in several jurisdictions in Canada and are being developed nationally. These address various aspects of food production and typically require a program to sustain or increase soil organic matter (using beneficial practices such as rotations of annual and perennial crops) and restrictions on certain "conventional" practices, such as the use of synthetic chemical fertilizers, synthetic chemical pesticides, and synthetic growth promoters for livestock.

Because of its emphasis on soil health and prohibited use of certain chemical inputs, organic agriculture can make an important contribution to sustainable agricultural production. It is estimated that organic agricultural products represent one-half to one percent of Canada's agricultural output, and the sector is growing quickly. There are organic producers in most provinces and in every agricultural commodity group, such as grains, fruits, vegetables, livestock, specialty crops, and processed products. There are currently about 1,575 certified organic units (producers, processors, or distributors) in Canada: 51% are located in central Canada, 30% in the prairie region, 15% in B.C., and 4% in the Atlantic region.

h. Alternative Livestock Farming

Alternative livestock farming has been slowly expanding in Canada for many years, with more than 1,000 alternative livestock farms now estimated in operation across Canada. The industry farms many species, the most common being deer, elk, and bison, but also llama, alpaca, wild boar, ostrich, and emu. Many of these animals are born in Canada, but a large number are imported to supply the demand.

Environmental concerns related to alternative livestock farming include the introduction and transmission of diseases and parasites, the preservation of indigenous wildlife resources and wildlife habitat, predator control, and the creation of barriers to the overland movement of wild animals.

3. Food and Beverage Processing

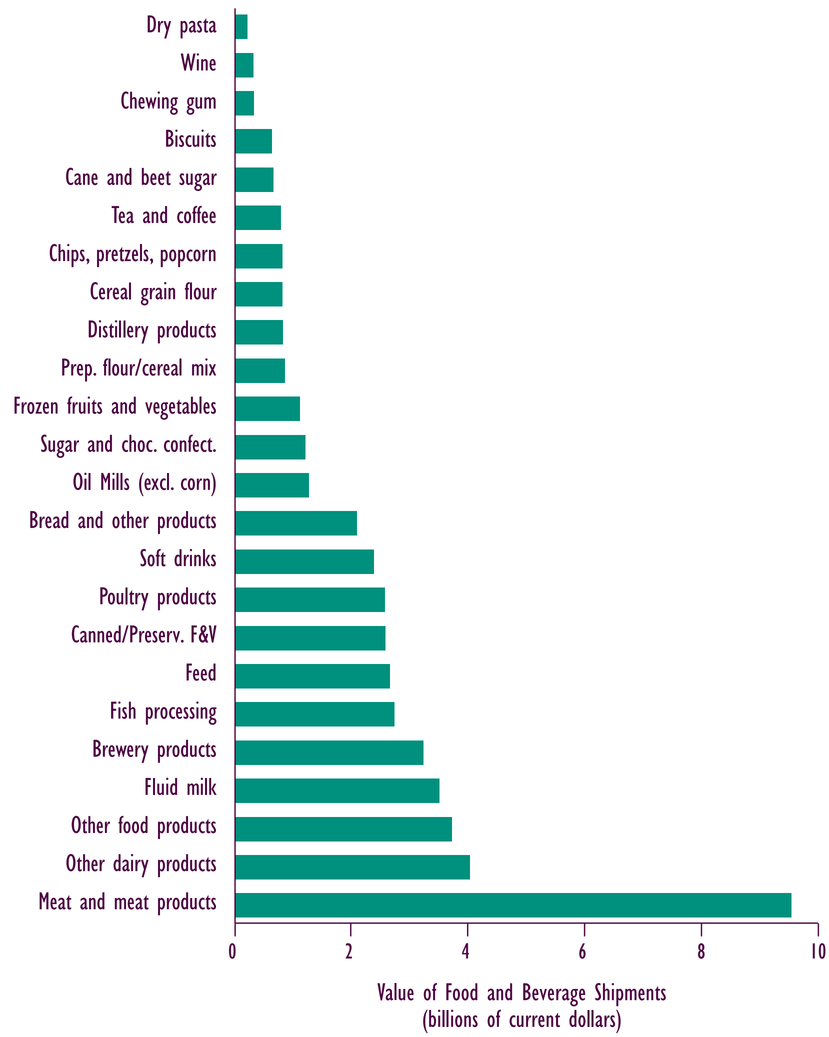
The food- and beverage-processing industry is Canada's third-largest manufacturing industry. The industry comprises approximately 3,200 food- and beverage-processing establishments and provides 215,500 jobs, or 13% of total manufacturing employment. The value of shipments was $51.3 billion in 1995, accounting for 13.2% of all manufacturing shipments. The sector is present in all regions but is heavily concentrated in central Canada; about 43% of total value-added food and beverage processing is located in Ontario, 23% in Quebec, 17% in the Prairies, 9% in the Atlantic provinces, and 8% in B.C (Agriculture and Agri-Food Canada, 1996e).

This diverse industry comprises firms involved in transforming agricultural, fish, and other raw materials into processed foods and beverages for human and animal consumption, as well as for non-food uses. The value of shipments by sub-sector is shown in Figure 8: meat and meat products, dairy products, and "other" food products (mainly, these include tertiary processed products) are the three largest categories, followed by brewery products, processed fish, feed, processed fruits and vegetables, poultry products, soft drinks, and bread and other products. The food- and beverage-processing industry serves retailers, food service firms and other food processors (by providing inputs for their products).

Overall, the Canadian food- and beverage-processing industry remains oriented towards the domestic market, which is the destination for 84% of sales; however, exports of processed products are growing, with about 76% going to the U.S. market.

Figure 8

Value of Canadian Processed Food and Beverage Shipments by Sub-sector (three-year average, 1993–1995)



Source: Statistics Canada, Business and Integrated Database.

The main environmental issues associated with the food- and beverage-processing industry are disposal of packaging wastes, quality of effluents and emissions released into air and water, and input use and efficiency. Effluent and emission releases from the food and beverage industry are regulated by federal, provincial, territorial, and/or municipal statutes. Strategies to prevent and control pollution include effluent treatment technology and use of "clean technology" in manufacturing processes. Packaging wastes are reduced through the re-design of packaging materials, changes in packaging procedures, and consumer efforts to recycle and reuse packaging. Environmental and economic considerations also affect the types of inputs used in production processes, such as restrictions on the use of methyl bromide (an ozone-depleting substance) in fumigation, and economic incentives to use resources, such as energy and water, more efficiently.

4. Agricultural Land Use

The agri-food production activities described above affect the use of Canada's farmland. It is important to understand the nature of agricultural land use and the associated environmental implications. Land use change is described below nationally and by region. Major categories of land use, and their environmental significance, are identified in Table 1.

a. British Columbia

British Columbia accounts for about 3.5% of Canada's farmland. The Peace River region is located in the Boreal Plains ecozone and focuses largely on grain, oilseed, and forage production. The Lower Mainland region is located in the Pacific Maritime ecozone, has a mild coastal climate, and focuses largely on dairy, poultry, hogs, and horticultural crops. Agriculture in the Montane Cordillera ecozone, where the climate is mild and relatively dry, focuses mainly on cattle ranching and tree fruits (Acton, 1995).

Agricultural land uses and trends in British Columbia from 1971 to 1991 were as follows (the following numbers are taken from Statistics Canada, 1992a):

- Total farmland area increased by 2% and was about 2.4 Mha in 1991.
- Land under crops and summerfallow increased by 20% to 614,245 ha in 1991.
- Improved pasture land increased by 50% to 241,004 ha in 1991.
- Unimproved land for pasture increased by 23% to about 1 Mha in 1991.
- Other agricultural land area decreased by 40% to 506,497 ha in 1991.

Much of the change in land use in B.C. from 1971 to 1991 likely resulted from the conversion of other agricultural land into unimproved pasture land, cropland, and, to a lesser extent, improved pasture land. These changes can be attributed in part to the increase in beef and sheep production on pasture and rangeland and the production of grain and oilseed crops in the Peace River region. In the southern coastal region, urbanization of agricultural land is a major issue. Despite the existence of the Agricultural Land Reserve, the area in agricultural production is decreasing, resulting in a greater concentration of production on the remaining land base.

b. Prairie Provinces

The Prairie provinces account for about 82% of Canada's agricultural land. Most agriculture takes place in the prairie ecozone, which is composed mainly of semi-arid grasslands and sub-humid aspen parkland. Large farming areas also occur in the southern part of the cool, sub-humid, aspen forests of the Boreal Plain ecozone, which extends from the Peace River region

Table 1
Environmental Significance of Agricultural Land Uses

Land Use	Definition	Environmental Significance
Total Farmland	Sum of all land owned or rented by farmers.	Depends on specific land use.
Cropland	Total area of field crops, fruits, vegetables, nursery products, and sod.	Most intensively used and productive land, relatively greater use of pesticides and fertilizers, higher risk of soil degradation, less suitable as habitat.
Summerfallow	Land that is not cropped for at least one year.	Higher risk of soil erosion, organic matter loss (oxidation), sedimentation of waterways, lower suitability for wildlife.
Improved pasture	Pasture area improved by seeding, draining, irrigating, fertilizing, and brush or weed control, not including area where hay, silage, or seeds are harvested.	Less intensively used than cropland but more intensively used than unimproved pasture, greater and virtually continuous soil cover, low risk of soil degradation, more suitable as habitat for some species, some application of fertilizer.
Unimproved pasture	Area of native pasture, native hay, rangeland, grazable bush, etc.	Least intensive agricultural land use, greater and continuous soil cover, virtually no risk of soil degradation, higher value as habitat for some species, no application of fertilizer/pesticides.
Other land	Farmland area occupied by farm buildings, lanes, woodlots, bogs, marshes, brush, improved idle land, tree windbreaks, etc.	Depends on specific land use.

of B.C. to central Manitoba (Acton, 1995). Agricultural land uses and trends in the Prairie provinces from 1971 to 1991 were as follows (the following numbers are taken from Statistics Canada, 1992a):

- Total farmland area increased by 2% to about 55.4 Mha in 1991.
- Land under crops increased by 25% to about 27.5 Mha in 1991.
- Summerfallow area decreased by 27% to about 7.8 Mha in 1991.
- Improved pasture land increased by 44% to about 3.2 Mha in 1991.
- Unimproved land for pasture increased by 4% to about 13.8 Mha in 1991.
- Other agricultural land area decreased by 47% to about 3.1 Mha in 1991.

As in B.C., much of the change in land use that occurred in the Prairie provinces from 1971 to 1991 likely resulted from the conversion of other land and summer-fallowed land into cropland, improved land for pasture, and unimproved land for pasture. Increased cropland and reduced summerfallow result from increases in area planted to wheat, canola, specialty crops, and flax. Increased pasture area can be partly attributed to enrollment in the Permanent Cover Program in the early 1990s.

c. Central Canada

Ontario and Quebec account for about 13% of Canada's farmland. Most agriculture takes place in the Great Lakes basin and the St. Lawrence lowlands (also referred to as the Mixed Wood Plains ecozone). The climate is relatively humid and temperate to warm (Acton, 1995). Pockets of agriculture extend into the central-northern regions of both provinces, but factors such as a poorly developed transportation and marketing infrastructure and wet soils limit farming capacity. Agricultural land uses and trends in Ontario and Quebec from 1971 to 1991 were as follows (the following numbers are taken from Statistics Canada, 1992a):

- Total farmland area decreased by 18% to about 8.9 Mha in 1991.
- Land under crops and summerfallow increased by 1% to about 5.1 Mha in 1991.
- Improved pasture land decreased by 60% to 0.7 Mha in 1991.
- Unimproved land for pasture increased by 14% to about 1 Mha in 1991.
- Other agricultural land area decreased by 36% to about 2.1 Mha in 1991.

The most striking changes in land use in this region between 1971 and 1991 are the decline in total farmland area by about 2 Mha and the decline in improved pasture. The decline in total farmland is likely due in part to the abandonment of farmland in fringe areas and losses of land to urban expansion. The decline in improved pasture land can be partly attributed to conversion to unimproved pasture and to cropland. Total land in crops increased only slightly by about 65,000 ha, but, because this occurred on a shrinking agricultural land base, production has intensified in parts of the remaining farmland area. Within cropland area, substitution of corn and soybeans for other crops occurred. Area in unimproved pasture increased by 126,000 ha.

d. Atlantic Provinces

The Atlantic provinces account for about 1.6% of Canada's farmland. Farming takes place mainly on the rolling coastal lowlands but also on river terraces and peatlands in some provinces. The climate is both humid and temperate and the region has much hilly land (Acton, 1995). Agricultural land uses and trends from 1971 to 1991 were as follows (the following numbers are taken from Statistics Canada, 1992a):

- Total farmland area decreased by 24% to about 1.1 Mha in 1991.
- Land under crops and summerfallow increased by 2.2% to 393,000 ha in 1991.
- Improved pasture land decreased by 43% to 79,655 ha in 1991.
- Unimproved land for pasture increased by 34% to 98,428 ha in 1991.
- Other agricultural land area decreased by 38% to 508,074 ha in 1991.

Trends in land use in the Atlantic provinces between 1971 and 1991 are similar to those in Central Canada. The most striking change was the decline in total farmland area (340,000 ha), which seems to have resulted largely from conversion of about 313,000 ha of agricultural land to non-agricultural land uses. Unimproved land for pasture increased by 25,000 ha and land under crops by 14,300 ha.

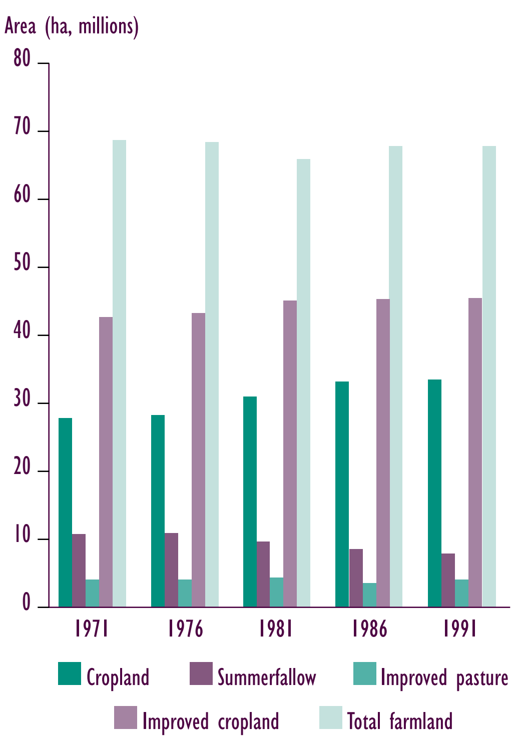
e. Canada

As illustrated in Figure 9, between 1971 and 1991 the total area of farmland remained relatively constant, suggesting that agriculture has not encroached significantly on non-agricultural land outside of the agricultural land base, such as forests or other natural areas. However, important changes in land use occurred within the agricultural land base, such as a decline in summerfallow area and an increase in the cropland proportion of total farmland, signalling more intensive agricultural land use in some areas. Some agricultural lands were converted to non-agricultural uses, particularly near urban centres. New lands brought into production may be of lower quality for agriculture and thus more susceptible to degradation. Key national land use trends from 1971 to 1991 were (the following numbers are taken from Statistics Canada, 1992a):

- Total farmland area decreased by 1% to about 67.8 Mha in 1991.
- Land in crops increased by 20% to about 33.5 Mha in 1991.
- Summerfallow area decreased by 27% to about 7.9 Mha in 1991.
- Improved land for pasture remained virtually stable and was around 4.1 Mha in 1991.
- Unimproved land for pasture increased by 6% to about 16 Mha in 1991.
- Other agricultural land decreased by 42% to about 6.2 Mha in 1991.

Figure 9

Use of Farmland in Canada, 1971–1991



Source: Statistics Canada, 1992a.

Much of the increase in land under crops can be attributed to the reduction in summerfallow area on the Prairies and to other changes in land use on agricultural lands. The loss of some 4.5 Mha of other agricultural land was likely a result of the conversion of some farmland to non-agricultural uses and to other changes in land use within the agricultural land base.

A key question from an environmental perspective is whether the increase in cropland area occurred on marginal land or resulted from the use of "good" land that had been underutilised as pasture or some other form of land use. It is not possible to answer this question precisely from the data currently available.

C. Environmental Issues Associated with Farm-level Agricultural Production

This section profiles environmental issues faced by the agriculture and agri-food sector, particularly biophysical issues, such as soil quality, water quality, biodiversity, and climate change. Environmental challenges are identified and progress in addressing these is assessed.

1. Use and Management of Agricultural Inputs

Inputs of commercial fertilizers, pesticides, manure, and energy are used in agriculture to optimize production and minimize the risks of crop failure from diseases and pests. There are, however, environmental risks associated with their excessive or otherwise inappropriate use, such as water pollution, soil degradation, impacts on biodiversity, and increased greenhouse gas emissions. These risks can be managed through sound management practices that improve efficiency of use.

a. Nutrients

Structural changes in agricultural production, driven largely by economics and new technologies, can contribute to nutrient surpluses and associated environmental risks, such as declining water quality. Examples of such changes include specialization into crops with higher nitrogen requirements (such as corn and potatoes), the separation of crop-growing areas from livestock-growing areas, and the concentration of livestock production in intensive operations, as has occurred with hogs, poultry, and beef feedlots. Such operations often have a very limited land base for manure disposal. In areas where such changes occur, even under conditions of proper fertilizer use, nutrient levels build up in the agroecosystem and, under some climatic and soil conditions, losses occur. Conversely, under-fertilization of soils (i.e., fertilization below actual crop requirements) can, over time, deplete soil nutrient reserves and organic matter.

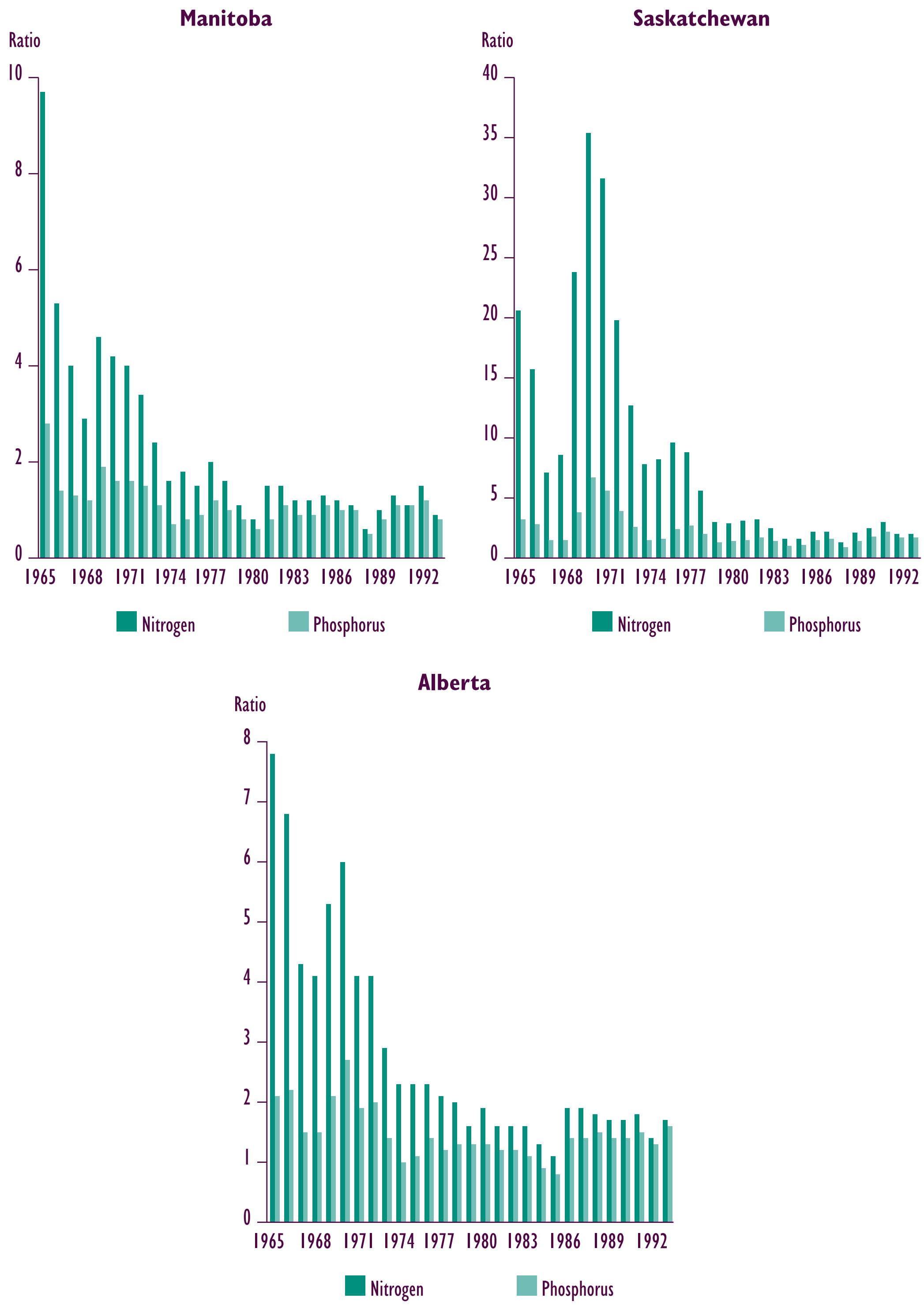
In the prairie region, under-fertilization of soils resulted in significant depletion of soil reserves of nitrogen, phosphorus, and potassium during the 1960s and 1970s, adversely affecting soil fertility and organic matter. Increased use of fertilizers had, by the early 1990s, restored an approximate balance between fertilizer additions and crop removals of nitrogen and phosphorus in Manitoba. Saskatchewan, and Alberta had a deficit for both nutrients, but progress in reducing this deficit has also been made (Fig. 10). The deficit for potassium increased over this period (Doyle and Cowell, 1993). The Prairie provinces, however, have areas where nutrient surpluses can arise from intensive livestock operations.

In non-prairie agricultural regions, a nutrient surplus is the case in many areas. Although no comprehensive analysis is as yet available, the following examples illustrate the nature of the problem:

- In Quebec, approximately 308,000 ha (or 63%) of soils under annual crops (such as corn) were considered over-fertilized in 1990 (Tabi et al., 1990), and the amount of manure generated from livestock (mainly hogs) exceeds the absorption capacity of the available agricultural land in some municipalities located in the Assomption, Chaudière, Yamaska, and Richelieu river basins. In the Assomption river basin, a moratorium on pork production put in place in 1987 was lifted in 1996 due to the adoption of corrective measures. The requirement that special measures be adopted was

Figure 10

Ratio of Nutrients Removed by Crops to Nutrients Added by Fertilizers in the Prairie Provinces, 1965–1993



Note: It is assumed that nutrients are removed by grain only, i.e, straw is returned to soil.

Source: Doyle and Cowell, 1993; L. Cowell, pers. comm.

also extended to the Chaudière and Yamaska basins. To expand operations producers must possess sufficient land on which to spread manure, transport excess manure outside of the affected municipalities, or use government-approved practices for treating surplus manure, such as composting or drying (R. Fortin, pers. comm.).

- In the Abbotsford aquifer region of B.C., nitrogen additions (from manure, inorganic fertilizer, and the atmosphere) exceeded nitrogen removals (through crops and denitrification) by 200, 258, and 330 kg N per hectare in 1971, 1981, and 1991, respectively. This corresponds to a 65% increase in the N surplus during this period (Zebarth and Paul, 1995). The nutrient surplus results from structural changes in agricultural production, not to changes in total additions of nitrogen to the soil, which actually decreased slightly in the reference period (see Table 2). These structural changes include a shift away from dairy and beef operations (which require a local land base for feed crop production and grazing) to increased poultry production (which does not require a land base) and a reduction in area under high-nitrogen-removal crops and an increase in area devoted to small fruit crops, which have a low nitrogen-removal value.
- In the intensively cropped potato-growing regions of New Brunswick and P.E.I., nitrate levels in tile drainage water from potato fields are typically in the range of 15–20 ppm, considerably above the drinking water standard of 10 ppm (Reynolds et al., 1995).

Table 2

Agricultural Nitrogen Balance in the Abbotsford Aquifer of British Columbia, 1971–1991 (tonnes)

	1971	1981	1991
N additions			
Inorganic fertilizer	505	391	269
Manure	555	622	701
Atmospheric	342	351	344
Total	1,402	1,364	1,314
N removals other than leachings			
Crop removal	641	441	278
Denitrification	28	31	35
Total	669	472	313
Balance	733	892	1,001
Cropped land (ha)	3,662	3,459	3,035
Balance (kg ha^{-1})	200	258	330

Source: Zebarth and Paul, 1995.

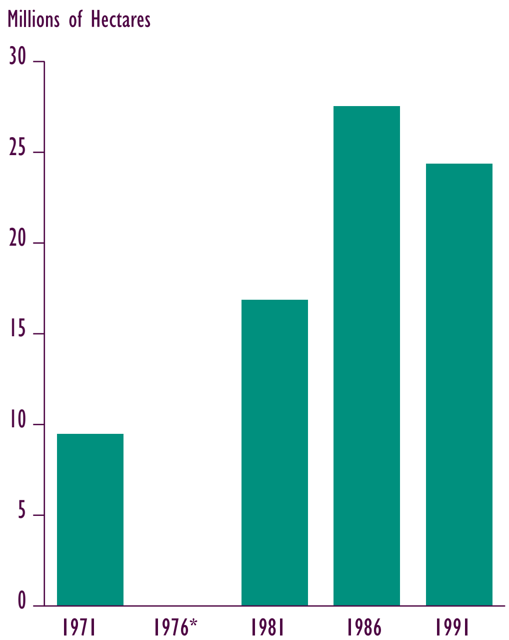
b. Pesticides

Trends in agricultural pesticide use are influenced by such factors as pest pressure, local growing conditions, prices of pest control products, cropping patterns, and grower preferences. Newly developed pesticide products are generally more selective, less persistent, and less toxic to non-target organisms. Environmental issues centre on potential impacts, such as water pollution and effects on non-target species.

Available information suggests a levelling off or decline in pesticide use in several regions since the mid-1980s. Nationally, the proportion of farmers using herbicides declined from 59% in 1985 to 49% in 1990 (Statistics Canada, 1992b). About 24.3 million ha of farmland were treated with pesticides (herbicides, insecticides and fungicides) in 1991, an 11% decrease from the area treated in 1986 (Fig. 11; Statistics Canada, 1992a). In Ontario, pesticide use declined from 7,200 tonnes of active ingredient in 1988 to 6,200 tonnes in 1993, a drop of 13.3% (Hunter & McGee, 1994). In Quebec a phytosanitary strategy adopted in 1992 includes an objective to

Figure 11

Farmland Area Treated with Pesticides in Canada, 1971–1991



* 1976 data are not available

Source: Statistics Canada, 1992a.

reduce agricultural pesticide use by 50% by 2000. Between 1992 and 1994, pesticide use (kilograms of active ingredient) had declined by 13% (R. M. Duchesne, pers. comm.).

c. Management of Farm Inputs

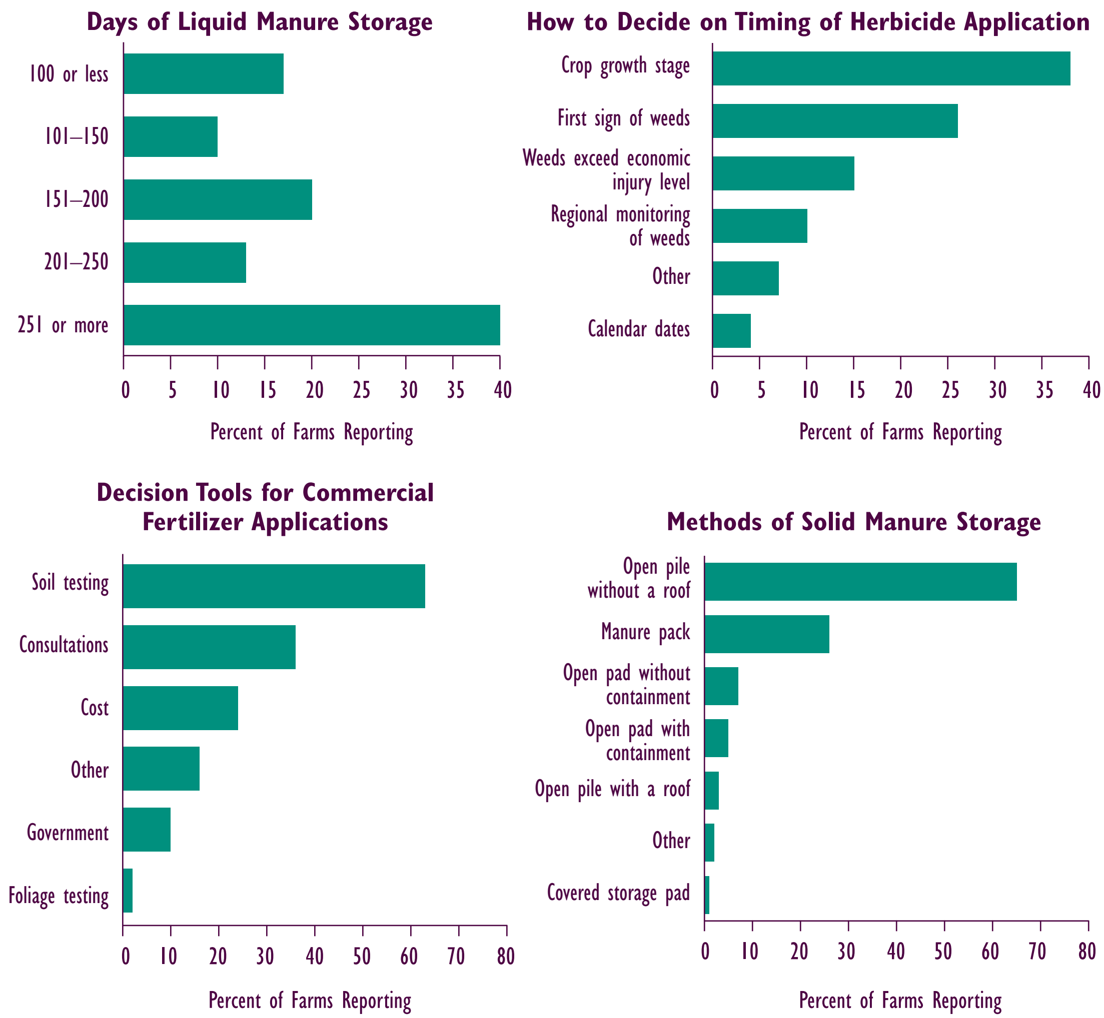
How farm inputs of fertilizer, pesticide, and manure are used and managed has important environmental implications. Improper use and application can adversely affect on-farm soil and water resources and off-farm environmental quality. Through environmentally sound management practices, however, environmental risks from farm inputs can be managed and they can contribute to a safe food supply, agricultural productivity, and farm financial security.

The results of a recent national survey offer some insights into how these inputs were managed on Canadian farms in 1995 (Statistics Canada, 1996e). Figure 12 presents selected results of the survey, highlighted as follows:

- 60% of Canadian farms reported storing manure; 95% of these farms reported storing it in a solid or semi-solid state; 11% stored manure in a liquid state.
- About 65% of farms with solid or semi-solid manure stored it in an open pile without a roof. This storage system may be acceptable under some conditions, but the risks of run-off and leaching of nutrients and bacteria are generally much higher than with other systems, such as a covered storage pad.
- About 40% of producers storing liquid manure had the capacity to store for more than 250 days, 13% could store for 201 to 250 days, 20% for 151 to 200 days, and the remainder (27%) lacked the capacity to store for more than 150 days. The minimum storage time to allow for safe and timely disposal varies by region, length of growing season, and soil type. The Canadian Pork Council (1996) recommends a 180- to 240-day storage capacity for hog manure; *Livestock and Poultry Waste Management,* produced by Agriculture Canada and the Ontario Ministry of Agriculture and Food (1992) has suggested an optimal range of 200 to 240 days, whereas the *Ontario Environmental Farm Plan* identifies more than 250 days as best, 180 to 250 days as good, less than 180 days as fair, and less than 90 days as poor.
- About 60% of producers conducted soil tests, the most accurate means used to determine the amount and type of fertilizer to apply; 35% of these conduct soil tests on an annual basis, and 40% do so every 2–3 years.
- Of the 35% of farm operators who applied both manure and fertilizer to their land, 83% reduced the quantities of commercial fertilizers on land on which manure was applied.

Figure 12

Selected Examples of Input Management on Canadian Farms, 1995



Source: Statistics Canada, 1996e.

- About 65% of farm operators reported application of herbicides to crops; 38% of these decided the amount and type of herbicide to apply based on the crop growth stage, 26% sprayed at the first sign of weeds, and 15% sprayed when weed populations had been determined to exceed economic injury levels.
- About 31% of farms reported application of insecticides on crops and 19% reported use of fungicides; 20% applied insecticides or fungicides at the first sign of pests or disease, and 17% applied them when pests or diseases had been determined to exceed economic injury levels.

Additional analysis is under way to break down the survey results by region (province, ecozone), by farm type (hog, beef, grain/oilseed, etc.), and by other variables, such as gross farm receipts. Overall, the survey suggests that many producers follow recommended agronomic practices, such as soil tests for field fertilization, and that there are opportunities for improving management of farm inputs in a number of areas, such as storage of solid and liquid manure.

In summary:

- Structural changes in the intensity, concentration, and specialization of agricultural production have created nutrient surpluses, particularly of nitrogen, in many of the humid and intensively farmed agricultural regions of Canada. To address this problem, improvements in nutrient management practices and technologies will be required. For example, further efforts are required to:
  - strengthen land use planning and waste management in highly stressed watersheds;
  - properly account for the nutrient content in manures;
  - improve manure storage facilities to ensure their optimum utilization;
  - apply nutrients in suitable amounts and at appropriate application rates and times relative to crop and soil requirements;
  - increase the use of practices such as soil testing, split fertilizer applications, and the planting of cover crops that capture nitrogen;
  - further develop and use precision farming technologies to improve the efficiency of nutrient use.
- Available information suggests that pesticide use in agriculture has levelled off in Canada since the mid-1980s. Although new pesticide products generally pose fewer environmental risks, concerns remain about the potential environmental impacts of pesticides, such as on non-target species and water quality. New biotechnologies, such as the development of pest-resistant crops, and techniques such as Integrated Pest Management, offer opportunities to manage environmental risks from pesticides.
- Many producers are using and managing farm inputs of fertilizer, manure, and pesticides in an environmentally sound manner. However, opportunities exist to further reduce environmental risks through improved management of inputs.

2. Use and Quality of Water Resources

Although water quality is affected by other activities and sectors, water pollution has emerged as a major environmental and human health issue for agriculture. Surface water quality can be affected directly by livestock or by sediment, nutrients, pesticides, and bacteria that move off agricultural land in surface run-off. Groundwater can be polluted when rain water, irrigation water, or snowmelt move through the soil, carrying more nutrients, pesticides, or bacteria than the soil material can retain (Government of Canada, 1996). Nutrients and bacteria occur naturally in water, but under certain conditions agriculture can elevate their levels above safe limits. Factors that influence the risks of water pollution by agriculture include the type and intensity of agricultural production; irrigation intensity; practices to manage crops, land, and inputs; type and amount of agrichemicals used; weather; soil characteristics; and regional hydrogeology (Reynolds et al., 1995).

Available data are insufficient to allow for a comprehensive assessment of agriculture's impact on water quality. However, recent water quality surveys in agricultural areas across Canada allow for a partial assessment. These reveal that, where present, pesticides are usually found in concentrations that are below the limits recommended in the *Canadian Water Quality Guidelines* (Canadian Council of Resource and Environment Ministers, 1987), but nutrients and bacteria originating from natural and/or agricultural sources are often found in concentrations that exceed acceptable limits.

- Aquifers underlying agricultural land in south coastal British Columbia often contain nitrate levels above the safe limit (Reynolds et al., 1995). In the Abbotsford aquifer, for example, nitrate concentrations have been increasing since 1955, and about 60% of samples taken from a sensitive region of the aquifer exceeded the drinking water standard of 10 ppm (Liebscher et al., 1992). Pesticide concentrations have also been detected, usually in concentrations considered within safe limits.
- In the dry prairie region, the risks of water pollution from agriculture are considered lower due to the drier climate, low intensity of agriculture, soil characteristics, and lower use of inputs. A review survey by the Prairie Farm Rehabilitation Administration (1996) suggests that, although water contamination from agri-chemicals occurs to some degree on the Prairies, there is no clear evidence of widespread contamination of surface- and ground-water from non-point source agricultural activities (animal feedlots are excluded from this definition). The risk of declining water quality can be significant, however, under certain conditions, such as heavily fertilized or manured soils, and in some areas, such as high-density feedlot areas and areas under irrigation (Chang and Entz, 1996; Chang and Janzen, 1996; Hill et al., 1996; Miller et al., 1994). For example, a 1992–1994 survey in southern Manitoba found elevated levels of nitrate in the sub-soils of fields that were heavily fertilized and/or manured and were cropped to cereal grains or horticultural crops. The potential for this nitrate to enter the groundwater is high (Reynolds et al., 1995; Prairie Farm Rehabilitation Administration, 1996).
- In Ontario, a survey of 1,300 farm wells in the main agricultural regions of the province found that 37% contained bacteria or nitrate levels exceeding the *Ontario Drinking Water Objectives* (Goss and Fleming, 1993).
- In Quebec, a study of 70 wells in Portneuf county revealed that eight had nitrate levels higher than the drinking water standard (10 mg/l); 18 were contaminated with bacteria and eight were contaminated with the pesticide aldicarb (Gouvernement du Québec, 1993). Monitoring of several rivers located in intensive corn-producing areas revealed pesticide concentrations (particularly atrazine) that sometimes exceeded water quality objectives (Berryman and Giroux, 1994). Eutrophication is a concern in several of the main agricultural tributaries of the St. Lawrence (e.g., Boyer, Yamaska, Assomption, Richelieu, and Chaudière rivers; Gouvernement du Québec, 1993).
- In New Brunswick, a study conducted between 1975 and 1990 of 47 private wells in three intensive potato-producing areas showed that a substantial portion of the wells in two of the three regions sampled had nitrate concentrations above the drinking water standard. In the most intensive agricultural region, 39% of the wells exceeded the standard

(Richards et al., 1990). However, concentration trends had not increased over the time covered by the study.

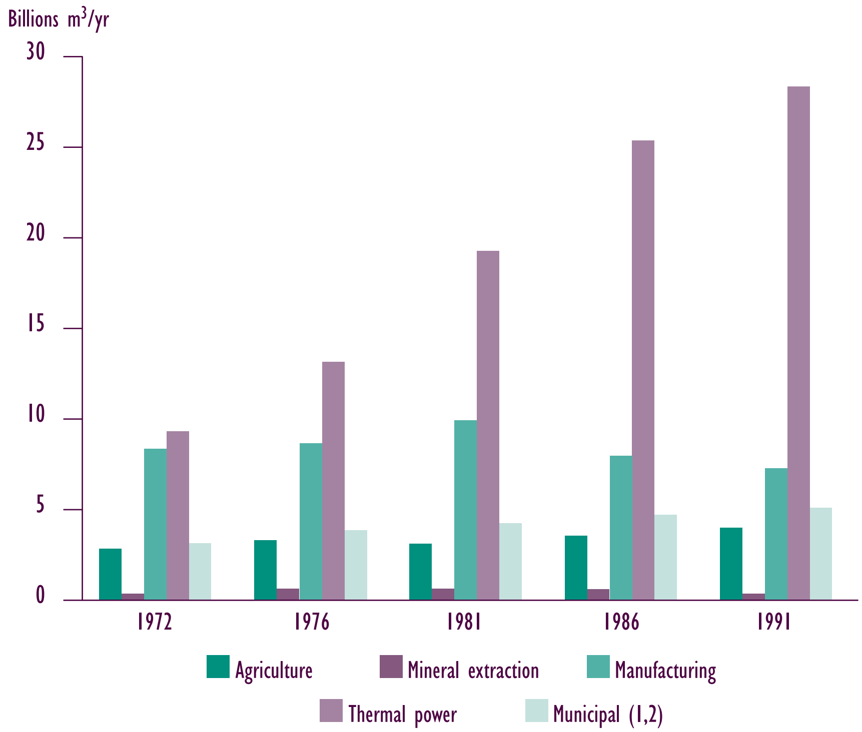
- In Nova Scotia, a survey of farm wells in Kings County, where most of the province's potatoes and corn are grown, showed that 41% had detectable levels of pesticides, although none exceeded safe limits. Bacteria above guideline levels were detected in 9% of the samples, and 13% exceeded the safe limit for nitrate (Reynolds et al., 1995).

On a national basis, primary production agriculture is a relatively small user of water when compared to other sectors, such as thermal power generation or manufacturing (Fig. 13). Between 1971 and 1991, agricultural water use increased by about 38% to 4 billion m^3/year. This rate of growth is considerably less than for the thermal power and municipal sectors, but more than that of manufacturing, which decreased by 13%. However, unlike other water users, agriculture consumes much of the water it uses, mainly through irrigation.

Water quantity issues are of greatest concern in parts of the prairie region and the B.C. interior, where the bulk of agricultural irrigation is used and where water availability is often limited. Water development and allocation are important issues where agriculture competes for water with other in-stream water users, such as wildlife, and sometimes for groundwater with other users such as municipalities. A related issue is water pricing, as the costs of providing water to producers are not fully internalized in the prices charged for the resource (full-cost internalization is also not completely implemented in other sectors). There are also non-environmental issues in the more water-abundant regions of Canada

Figure 13

Water Intake for Five Sectors in Canada, 1972–1991



Notes:
1. Excludes water supplied to industry.
2. Includes estimates for rural residential water use.
3. Data may not add due to rounding.

Source: Tate and Scharf, 1992, 1995; Environment Canada, 1986.

(e.g., New Brunswick and Ontario) associated with the allocation of water among competing users, such as agricultural irrigation and municipal water use.

Nationally, the total area under irrigation increased by 20% between 1980 and 1984 (596,000 ha vs. 715,000 ha), but has remained constant since then (Organisation for Economic Co-operation and Development, 1995). Increases in water use efficiency may be required to sustain agricultural production, given public resistance to large-scale water development projects, demands from other water users, and potential climatic changes that could result in less water availability in some regions.

In summary:

- Nitrate used in agriculture is present in nearly all groundwater underlying the principal agricultural regions of Canada, but levels are usually below the safe limit. However, levels are increasing and already exceed the safe limit at times during the year in some areas under intensive agriculture in the non-prairie region (Reynolds et al., 1995). Bacteria are also sometimes detected at elevated levels, but pesticides are usually within acceptable limits. The prairie region is generally considered to be at lower risk of water contamination from agriculture. However, water quality risks can be significant in some areas, such as high-density feedlot areas and intensively irrigated soils receiving manure.
- Over the past five years, agricultural research, government programs, and producer actions have collectively placed more emphasis on concern for water quality. However, practices that enhance the efficiency of nutrient and pesticide use and that improve livestock waste management, need further development and application. Further controls of soil erosion will also benefit water quality.
- Issues of water use are most significant in the prairie region of Canada. Several factors, such as public resistance to new, large-scale water development projects, enhanced agricultural production, and possibly climate change and variability suggest that efforts to further promote efficiency of water use are required.

3. Management and Quality of Soil Resources

Land management factors that influence agricultural sustainability include land use, cropping patterns, and soil conservation practices.

National and regional trends in agricultural land use are reviewed in section B.4. The annual cultivation of marginal prairie agricultural land (Canada Land Inventory classes 4–6) remains a concern. Despite the removal of about 555,000 ha of such lands from annual crop production through the Permanent Cover Program (Prairie Farm Rehabilitation Administration, 1992), about 4.9 Mha continued to be cultivated annually on the Prairies after the program ended, posing the risk of soil degradation.

Cropping patterns can affect environmental risks, because different crops provide varying amounts and types of residue cover on soil. In general, some annual row crops, such as tobacco and potatoes, afford less protection (by residue cover) to soil than forage crops or most small grain crops. However, by incorporating low-tillage practices, winter cover crops, and other soil conservation practices into cropping systems, soil degradation risks can be reduced considerably.

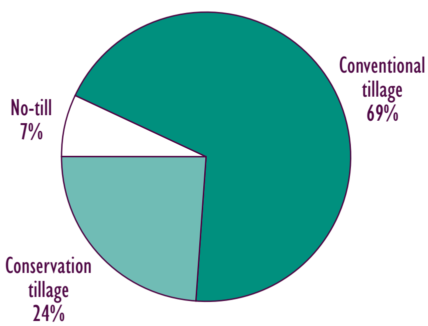
Over the past 15 years, the use of soil-conserving practices and systems on agricultural land has increased considerably. Many producers, motivated by both economic and stewardship interests, have adopted erosion control practices (Table 3) and conservation tillage, including no-till (Fig. 14) on their farms. In 1991, some form of soil erosion control or soil conservation practice was used on 85% of seeded cropland in Canada. Conversely, 15% (4.5 Mha) of cropland received no erosion control and was not tilled using a conservation tillage technique, although not all of these lands required erosion control (Trant, 1993).

A key question is whether the appropriate land use and soil conservation practices were adopted in areas and on soils most at risk of degradation. The results of recent research offer partial answers to this question:

- Between 1981 and 1991, the risk of soil erosion by wind in the Prairie provinces decreased by about 7% (Fig. 15). The use of conservation tillage accounts for about two-thirds of the decrease; the remainder is the result of changes in cropping systems, especially the reduction in summerfallow area (Wall et al., 1995).
- Under 1991 management practices, about 15% (5 Mha) of prairie cultivated land had soil wind erosion rates that exceeded the tolerable annual limit. About 75% of these lands are in the Brown and Dark brown soil zones of southern Alberta and Saskatchewan (Wall et al., 1995).
- Between 1981 and 1991, the risk of soil erosion by water decreased by 11% nationally (Table 4). Conservation tillage and changes in cropping practice contributed about equally to this

Figure 14

Tillage Practices Used to Prepare Land for Seeding in Canada, 1991



Source: Dumanski et al., 1994.

Table 3

Erosion Control Practices in Canada, 1991 (percent of farmers reporting)

Provinces	Forages	Winter Cover Crops	Grassed Waterway	Strip-Cropping	Contour Cultivation	Wind Breaks
British Columbia	23	11	10	2	5	13
Alberta	43	7	17	10	11	29
Saskatchewan	22	6	12	21	18	35
Manitoba	35	7	13	5	13	37
Ontario	60	20	15	4	7	21
Quebec	52	4	4	3	4	8
New Brunswick	44	10	9	5	8	8
Nova Scotia	34	12	8	3	8	7
Prince Edward Island	72	9	11	4	10	16
Newfoundland	37	7	4	1	7	12
Canada	**42**	**10**	**13**	**9**	**10**	**15**

Source: Dumanski et al., 1994.

Table 4

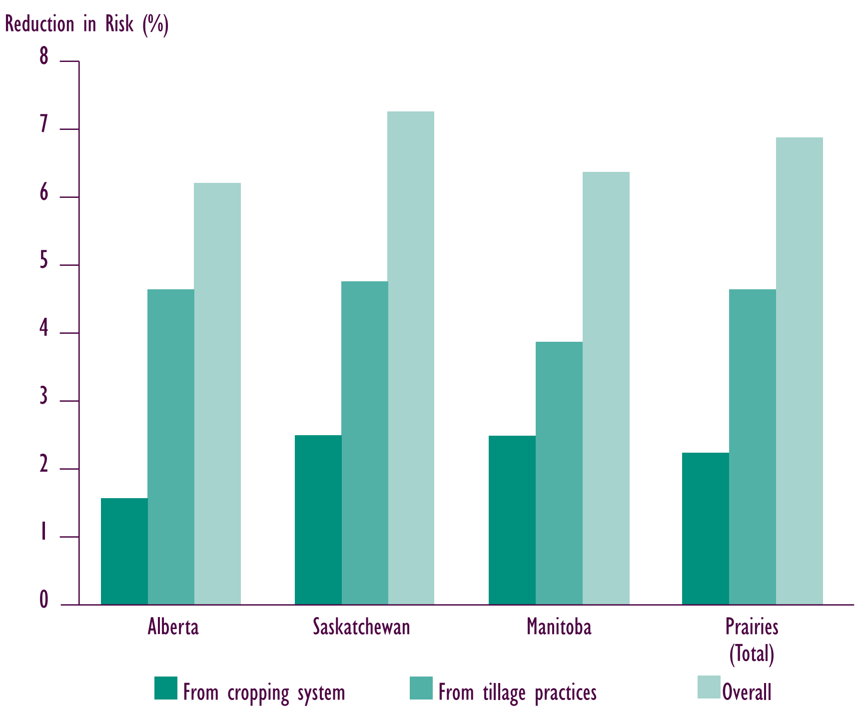
Reduction in the Risk of Water Erosion between 1981 and 1991

Province	Cultivated land in 1991 (Mha)	Erosion reduction (%) Resulting from cropping practices	Resulting from tillage practices	Total
British Columbia	0.61	7	10	17
Alberta	11.06	5	8	13
Saskatchewan	19.17	5	3	8
Manitoba	5.06	6	9	15
Ontario	3.48	10	11	21
Quebec	1.65	3	3	6
New Brunswick	0.12	2	4	6
Nova Scotia	0.11	-3	3	0
Prince Edward Island	0.16	-9	3	-6
Canada	**41.42**	**5**	**6**	**11**

Source: Wall et al., 1995.

Figure 15

Reduction in the Risk of Wind Erosion in the Prairie Provinces between 1981 and 1991



Source: Wall et al., 1995.

improvement. Regionally, the risk of water erosion decreased by 11% in the Prairie provinces and 16% in Central Canada and increased only slightly, by 0.5%, in the Maritime provinces. The calculation for the Maritimes does not account for risk reductions where terraces and grassed waterways have been installed (Wall et al., 1995).

- Under 1991 management practices, about 95% of cultivated land in the Prairie provinces and about 40% of cultivated land in Ontario were at tolerable risk of water erosion. About 5% of prairie cultivated land and 60% of cultivated land in Ontario require further implementation of soil conservation practices (Wall et al., 1995). Similar analyses for Quebec, the Maritime provinces, and British Columbia are in progress.
- Losses of organic matter in Canada's agricultural soils since initial cultivation are typically in the 15–30% range. However, losses are greatest in the initial 10 years of cultivation, and soil organic matter is

now being maintained in many Canadian croplands because of improved management. Recent research suggests that conservation tillage and appropriate levels of soil fertilization with nitrogen are required to maintain or enhance soil organic matter (Gregorich et al., 1995).

- Most prairie farmland (61% in Manitoba, 59% in Saskatchewan, and 80% in Alberta) had a low chance of increasing salinity under 1991 land management practices (Eilers et al., 1995). Between 1981 and 1991, the risk of salinity for the majority (92%) of prairie agricultural land had not changed, whereas less than 7% had a lower risk, and about 0.5% had a higher risk in 1991 (Eilers et al., in press).
- Soil structural degradation, such as compaction, is a significant problem in some regions and is more pronounced in central and eastern Canada than in the Prairies. Available information suggests that many soils in the St. Lawrence lowlands and the potato belt in northeastern New Brunswick are structurally degraded due to compaction (Topp et al., 1995). In Quebec, for example, about 429,000 ha of land under monoculture were identified as suffering from structural degradation (Tabi et al., 1990).

In summary:

- Most of the land in Canada suited to agriculture is already in production. Although the total amount of agricultural land is holding steady, important changes in land use have occurred, such as reduced summerfallow area, shifts in cropping patterns, more intensive production in some areas, and conversion of some prime agricultural land to non-agricultural uses. About 4.9 Mha of marginal prairie agricultural land continue to be cultivated annually.
- The development and use of soil-conserving practices have increased significantly since 1981. As a result, some agricultural soils are improving in quality and becoming less susceptible to erosion and other damaging forces. However, this general improvement is a small one overall and does not apply to all soils. Adoption by farmers of soil conservation practices is far from complete, and many areas remain at high risk of erosion by wind and water and are affected by other degradation processes, such as soil compaction (Gregorich and Acton, 1995).
- Soil quality is holding steady or improving in areas where conservation practices have been tailored to local degradation problems but will continue to decline in areas of intensive cropping and marginal land where appropriate conservation practices are not used (Gregorich and Acton, 1995).

4. Agroecosystem Biodiversity

Biodiversity has emerged as an important national and international issue in recent years. Biodiversity and agricultural production interact at the genetic, species, and ecosystem levels.

Genetic resources provide the base for crop and livestock improvement, thus their preservation is essential if agriculture is to retain a capability to adapt to changing environmental and market conditions. Although crop and livestock breeding have provided tremendous benefits to producers and society, there is concern that selective breeding for increased productivity and uniformity has narrowed the genetic base of animals, plants, and microorganisms used in agriculture (Agriculture and Agri-Food Canada, 1995). Human activities and changing environmental conditions have also contributed to narrowing of the genetic base by affecting wild relatives of agricultural crops and animals that can provide desired genetic traits.

At the species level, agriculture can benefit from the presence of numerous organisms. Soil microfauna, such as bacteria and fungi, break down organic matter, help maintain the quality of soils, and recycle nutrients. Some arthropods, mainly insects, spiders, and mites, pollinate crop plants and fruit trees and prey on agricultural pests. However, some wild flora and fauna (such as pest species) are often incompatible with agriculture, because they compete for the same resource lands and cause economic damage to field crops and livestock. Agricultural practices and development have had negative impacts on wild floral and faunal biodiversity through conversion of marginal lands and habitat to croplands, drainage of wetlands, and improper management of agricultural inputs and wastes. The challenge for agriculture is to effectively manage pest pressures and sustain production while ensuring that impacts on non-pest species are minimal.

At the ecosystem level, there is a growing recognition within the agricultural community of the importance of maintaining healthy agroecosystems and conserving and enhancing wildlife habitat. For example, farm shelterbelts and woodlots can attract beneficial insects or predators that feed on agricultural pests. Although these and other practices are being implemented, the sector has been widely criticized by conservationists for its role in transforming rural landscapes, and there is no doubt that large-scale restructuring has occurred historically. For example, Rubec (1994) attributed 85% of the decline in Canada's original wetland area to drainage for agriculture, and much other original habitat, such as short grass prairie, tall grass prairie, and mixed grass prairie, has been significantly altered (Gauthier and Henry, 1989).

Over the past 10 years, awareness of biodiversity in agriculture has increased, along with the realization that information on the relationship between agriculture and biodiversity is sparse. Quantitative data describing the nature and location of critical species, the impacts of agriculture on non-target species, and areas at risk of biodiversity loss are frequently lacking. For example, no comprehensive, regularly updated national inventory exists of changes to wetlands and woodlands in agroecosystems. At the species level, available information is focussed on a small number of animals, such as waterfowl. Understanding about critical or threshold levels of biodiversity and the linkages between biodiversity, agricultural productivity, and various farming systems and practices is also wanting. Consequently, it is not possible at this time to fully assess the nature of biodiversity issues in agriculture or of progress in addressing such issues.

Efforts are under way to enhance biodiversity, ranging from initiatives to conserve genetic material in situ and ex situ to participation by producers in habitat restoration programs such as the North American Waterfowl Management Plan. Biodiversity benefits are also being derived from programs aimed primarily at soil and water conservation, such as the Green Plan Sustainable Agriculture Initiative and the Permanent Cover Program, and from improved pest management technologies and systems, such as Integrated Pest Management.

Biodiversity issues in agriculture are being addressed through several mechanisms, such as the United Nations *Convention on Biological Diversity*, the *Canadian Biodiversity Strategy*, and provincial biodiversity action plans (such as those prepared by Quebec and British Columbia). Agriculture and Agri-Food Canada is also developing a departmental action plan for agricultural biodiversity. The action plan identifies the key biodiversity challenges for the department and goals as well as actions to address them.

In summary:

- Agriculture depends on biological resources to ensure a diverse genetic base for crop and livestock improvement. The erosion of genetic material may limit agriculture's ability to adapt to environmental and economic change.
- Agriculture has adversely affected biodiversity at the species and ecosystem levels through restructuring of landscapes and use of chemicals, but it also contributes to the preservation of biodiversity through practices such as planting shelterbelts and maintaining farm woodlots and rangelands.
- Biodiversity benefits can be derived from programs and farm practices designed to improve soil and water management, such as conservation tillage. However, the information base required to more thoroughly understand and assess agriculture's relationship with biodiversity is often lacking.
- Agricultural efforts to conserve biodiversity will be addressed by Canada's commitments to the United Nations Convention on Biological Diversity, the Canadian Biodiversity strategy, provincial action plans, and other initiatives.

5. Climate Issues

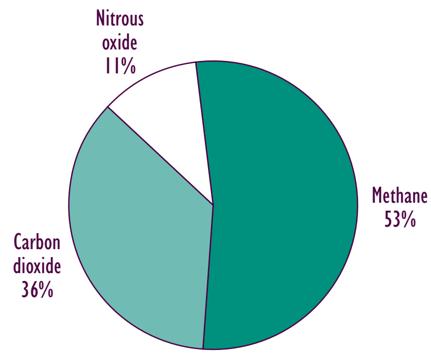
The relationship between climate and agriculture involves both mitigation and adaptation issues. Few industries are as vulnerable to changes in climate as agriculture. Crop damage by frost and ultra-violet radiation, over-winter survival, frequency and severity of drought, pest and disease infestations, and irrigation demand are just some of the climate-driven influences on agriculture. Although programs such as crop insurance have been developed to provide some protection against yield losses from natural events, there is concern about the industry's ability to adapt to potential future changes in climate, especially extreme events.

Climate change and variability is influenced by a variety of natural factors, such as sunspot cycles and volcanoes. Recently, concern about the contribution of human activity to climate change has mounted. From an agri-environmental perspective, concerns centre around agriculture's contribution to global warming potential and to stratospheric ozone depletion.

Sources of agricultural greenhouse gases (GHG) include carbon dioxide from the use of fossil fuels and oxidation of soil carbon; nitrous oxide from nitrogen fertilizers, soils, and manure; and methane from livestock and manure. The most recent estimates from Environment Canada's national GHG emissions inventory (Jaques et al., in press) indicate that agriculture contributed about 39.2 million tonnes of carbon dioxide equivalent in 1995 (Fig. 16), which represents a 12% decrease from the 1990 level. This reduction is due mainly to a decrease in emissions of carbon dioxide from agriculture. As a proportion of Canada's total emissions, agriculture's contribution decreased from about 8% in 1990 to about 6.3% in 1995. About 53% of the 1995 total is methane from domestic animals and manure, 29% is carbon dioxide from fuel combustion, 6% is carbon dioxide from soils, and 11% is nitrous oxide from fertilizers. These estimates exclude several

Figure 16

Estimated Greenhouse Gas Emissions from Agricultural Sources, 1995



Agriculture estimates include:
Carbon dioxide (CO_2) — soils, fuel combustion
Methane (CH_4) — animals and manure, fuel combustion
Nitrous oxide (N_2O) — nitrogen fertilizers, fuel combustion

Source: Jacques et al., in press.

agricultural sources of greenhouse gases, such as emissions of nitrous oxide from soils and manure. Work to quantify these sources is under way, but results are not yet available for inclusion in the official estimates.

Canada has set an objective to stabilize GHG emissions by 2000 at 1990 levels. Agricultural opportunities for contributing to this objective include sequestering carbon in soils and managing agricultural sources of greenhouse gases. Measures to promote these were identified by the National Agriculture Environment Committee (1995) and include:

- increasing crop yields;
- reducing area in summerfallow;
- reducing tillage of soils;
- reducing use of fossil fuels;
- improving manure handling and storage;
- enhancing efficiency of nitrogen fertilizer use;
- improving feeding technology for ruminant livestock.

In addition to helping control agricultural GHG emissions, many of these practices will provide other environmental benefits, such as improved soil and water quality. However, the capacity of soils to sequester carbon is of finite duration and magnitude, as the system eventually comes to equilibrium (Campbell, 1996). This suggests that measures to control GHG emissions from agricultural sources can play an important role.

Agriculture can be affected by, as well as contribute to, stratospheric ozone depletion. The principal ozone-depleting chemical used in agriculture is the fumigant methyl bromide, used to deal with infestation problems in large facilities (e.g., ship holds, milling and warehouse operations, greenhouses, and plant nurseries). In 1991, Canadian agriculture used approximately 246 tonnes of this substance, about 0.2% of the world total (L. Dunn, pers. comm.).

Methyl bromide has recently been identified at the international level for elimination by 2010. Canada is participating in this process, and the agri-food sector is working to cap production and consumption at 1991 levels, and to further reduce use by 25% by 1998. Research to develop alternatives to methyl bromide is in progress.

In summary:

- Agriculture can contribute to, and may be affected by, global climate change, and can be a source of, and a sink for, greenhouse gases. Agricultural emissions of greenhouse gases decreased by about 12% from 1990 to 1995. The sector contributed about 6% of Canada's net GHG emissions in 1995, but this estimate excludes emissions of nitrous oxide from soils and manure.

- Agriculture can contribute to Canada's national GHG stabilization target by adopting appropriate practices to manage land, inputs and waste. Many of these measures will also benefit soil and water quality. Because the capacity of soils to sequester carbon is limited, measures to control gross GHG emissions from agriculture can play an important role.
- Agricultural production can be adversely affected by stratospheric ozone depletion. Efforts are under way to reduce the use of methyl bromide, an ozone-depleting substance, as well as to develop environmentally acceptable alternatives to methyl bromide use.

6. Other Issues

Other agri-environmental concerns include local air pollution from livestock waste and the potential long-range transport of air pollutants from agricultural sources, such as pesticides and nitrogen-based fertilizers.

Odour from livestock wastes is an important local issue in several areas where livestock are concentrated near populated centres. In some areas of Quebec and Ontario, the siting and/or expansion of hog farming has been prohibited, and some municipal governments have enacted zoning restrictions that preclude agricultural operations. This has prompted some jurisdictions, such as Quebec, to consider or pass "right-to-farm" legislation. The Quebec legislation (*Loi sur la protection du territoire et des activités agricoles*) seeks to reconcile the right of producers to farm on agriculturally zoned land with the responsibilities of municipalities to ensure a clean environment for their citizens. Mechanisms are expected to facilitate and encourage a process of dialogue and partnerships between local groups and interests.

In Canada, agriculture has generally not been associated with the long-range transportation of air pollutants or the generation of persistent organic pollutants (POPs). However, nitrogen fertilizers are a source of substances that contribute to acid rain and ground-level ozone, such as nitrous oxide and ammonia. Many persistent organic pollutants are pesticides, but most of these, such as the pesticides DDT, chlordane, and toxaphene, are no longer used in Canada.

Strategies for controlling acid emissions have focussed largely on major point sources of oxides of sulphur and nitrogen, such as power generation plants and automobiles. The Priority Substances List II under the *Canadian Environmental Protection Act* has identified ammonia as a substance that will undergo an assessment and, if necessary, a strategic options process to identify actions required to address problems.

However, the risks from substances transported through the air cannot be reduced by domestic actions alone, as other countries are also key sources. The most advanced international agreement for regulating these substances is the Long-Range Transport of Air Pollutants Convention, under the auspices of the U.N. Economic Commission for Europe, of which Canada is a party. Discussions are under way to arrive at a binding international agreement to control POPs. Recommended controls range from bans to restrictions on certain uses to controlling emissions. Activities to control emissions of certain nitrogen oxides and related substances (including ammonia) will also be discussed in this forum over the next couple of years. Another international initiative relevant to Canadian agriculture is the United Nations Environment Program Global Plan of Action for the Protection of the Marine Environment from Land-Based Activities, for which Canada is developing a National Plan of Action that includes an agriculture component.

The relative importance of Canadian agriculture as a source of acidifying substances and persistent organic pollutants requires further investigation. It will also be necessary to ensure that Canadian views are well represented in international processes to address these issues.

In summary:

- Environmental concerns, such as local air pollution can stem from, or be associated with, agricultural production. Local air quality concerns related to odour affect agriculture in several areas where animals are produced near population centres. Processes and technologies, such as land use planning, enhanced dialogue between farm and non-farm groups and improved methods of storing and handling livestock waste, can contribute to their resolution.
- Initiatives related to the long-range transport of air pollution can also affect agriculture. There is a need to improve understanding of these issues in the context of Canadian agriculture, and to ensure that Canadian interests are represented in international forums.

D. Environmental Issues Associated with Food and Beverage Processing

Environmental issues are important to the food- and beverage-processing industry for both ecological and economic reasons. The key challenges are reduction of packaging wastes sent to landfill sites; efficient use of production inputs; minimization of pollutant discharges to air, water, and land; and compliance with regulations and standards governing the release of specified substances into the environment. Industry has responded to these challenges through a series of voluntary measures, as well as by complying with government regulations. Quantitative national data are limited; however, available information suggests that progress has been made in reducing packaging waste, energy intensity, and carbon dioxide emissions.

The food industry recognizes that environmental resources, such as abundant supplies of clean fresh water, contribute to its competitiveness and comparative advantage. A positive public environmental image can help create market opportunities with consumers who value healthy, wholesome food, including "green" products. More efficient use of resources and reduced generation of wastes can have economic and environmental benefits. Superior environmental performance can help avoid the costs, lost time, and resources that can be associated with litigation and remediation of environmental impacts.

Reducing packaging waste has received considerable attention in the food and beverage industry. Good packaging is vital to maintaining food quality and safety, but consumer, environmental, and other groups have voiced concerns about the amount of packaging waste being sent to landfill sites. Waste management is under provincial, territorial, and municipal jurisdiction, and various regulations aimed at reducing solid waste from packaging have been established. Several levels of government, industry, and consumer groups have worked together to respond to concerns while ensuring the safety of Canada's food supply.

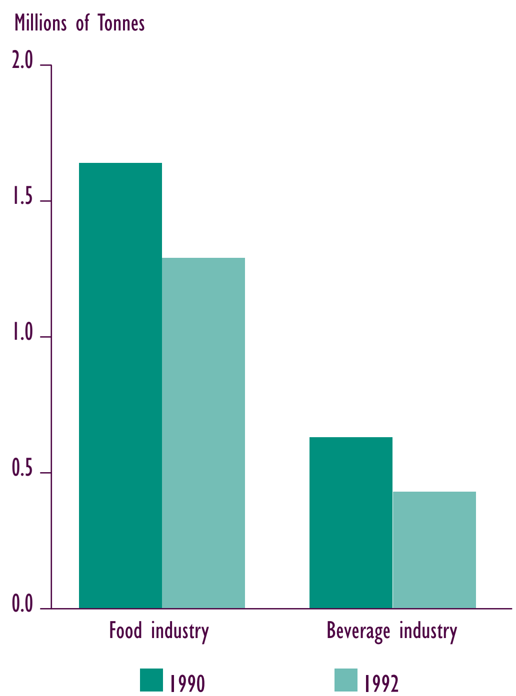
In 1989, the Canadian Council of Ministers of the Environment (CCME) approved the National Packaging Protocol (NaPP), which sets targets for reducing the amount of packaging waste sent to landfill sites to 50% of 1988 levels by the year 2000. The CCME also established the National Packaging Task Force, whose members represent industry, consumer groups, and federal, provincial, territorial, and municipal governments. The role of the Task Force is to coordinate activities needed to meet the NaPP targets. Although about 80% of packaging waste was determined to come from food, Task Force members recognize that no one group is responsible for waste management and that all must work together on the reduction efforts. The food industry is active on the Task Force and has contributed to meeting the 50% reduction goal. The 1992 interim target of 20% was met. The amount of packaging material sent to disposal from food and beverage products declined by 21% and 32%, respectively, between 1990 and 1992 (Fig. 17). In 1992, the largest amounts of packaging waste sent to disposal were from fruit and vegetable, soft drink, and retail grocery products. Preparatory work for measuring the 1996 target of 35% is under way. A sub-committee of the group is developing a packaging stewardship model that will be national in scope but recognize regional sensitivities.

For energy use efficiency, both the food industry and the beverage industry recorded improvements between 1990 and 1992. Energy intensity (defined as energy consumed per dollar value of shipments) decreased over this period by 10% for the food sector and 25% for the food and beverage sectors (Fig. 18). This can be attributed to energy conservation efforts as well as to growth in product sales.

Between 1981 and 1991, both the food and beverage industries recorded slight decreases in total water intake (Fig. 19), despite overall growth in product shipments.

Figure 17

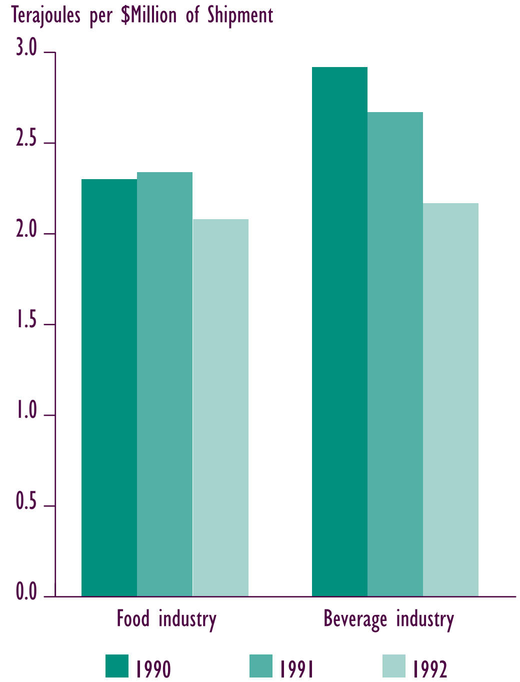
Packaging Disposed by the Food- and Beverage-processing Industry, 1990 and 1992



Source: Marbek Resource Consultants, 1995.

Figure 18

Energy Intensity of Food and Beverage Processing, 1990–1992

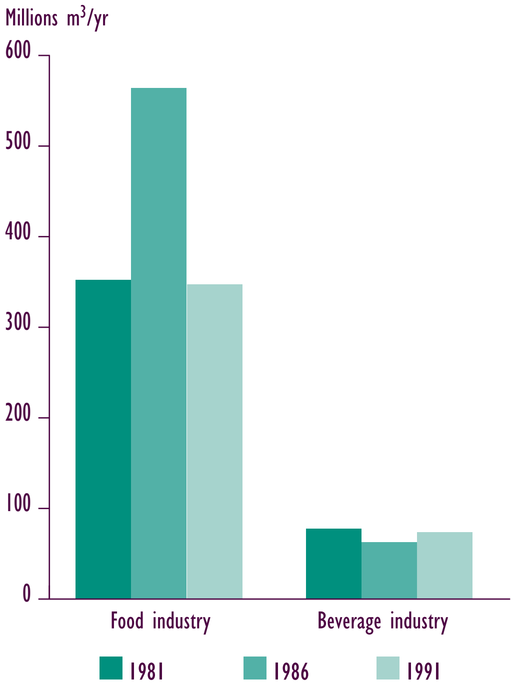


Source: Marbek Resource Consultants, 1995.

Effluent discharges to water are regulated by provincial, territorial, or municipal governments. Facilities discharging into a municipal sewer or watercourse typically require a discharge permit and may be subject to monitoring or control requirements. If limits on certain substances are exceeded, surcharges may be levied that can pose a significant cost to food and beverage processors. Parameters typically measured are biochemical oxygen demand, suspended solids, grease and oils, and total nitrogen. Control of pH is a concern for some sectors. The sectors most affected by requirements to abate water pollution are the meat, poultry, fish, fruit, and vegetable processors. However, few national data exist to illustrate trends in releases of such substances or of compliance with regulations.

Figure 19

Water Intake by the Food- and Beverage-processing Industry, 1981–1991



Source: Tate and Scharf, 1985, 1992, 1995.

As with water effluent, emissions to air are regulated provincially, territorially, or municipally. Permits are issued to control emissions of particulate and visible emissions, the key parameters. Ozone-depleting chemicals, such as chlorofluorocarbons (CFCs), are used in refrigeration in the food- and beverage-processing industry. Use of these chemicals is controlled internationally by the Montreal Protocol and domestically by the *Canadian Environmental Protection Act*. As an industry that is heavily reliant on refrigeration, the food industry is very much implicated by the Montreal Protocol. As one of about 25 signatory countries, Canada has agreed to phase out all ozone-depleting substances including many refrigerants. CFCs are no longer used and HCFCs will be phased out by 2020. This means that new refrigeration equipment will contain other, less-harmful cooling liquids and that older equipment must have its cooling liquids replaced. Food processors, grocery distributors and retailers, and food service operators are learning about their options, choosing appropriate refrigerants, and replacing equipment and coolants as needed. Processors, distributors, and retailers are switching to alternative refrigerants in accordance with these government regulations. Grocery retailers no longer use either CFC-propelled aerosols or foam trays containing CFCs.

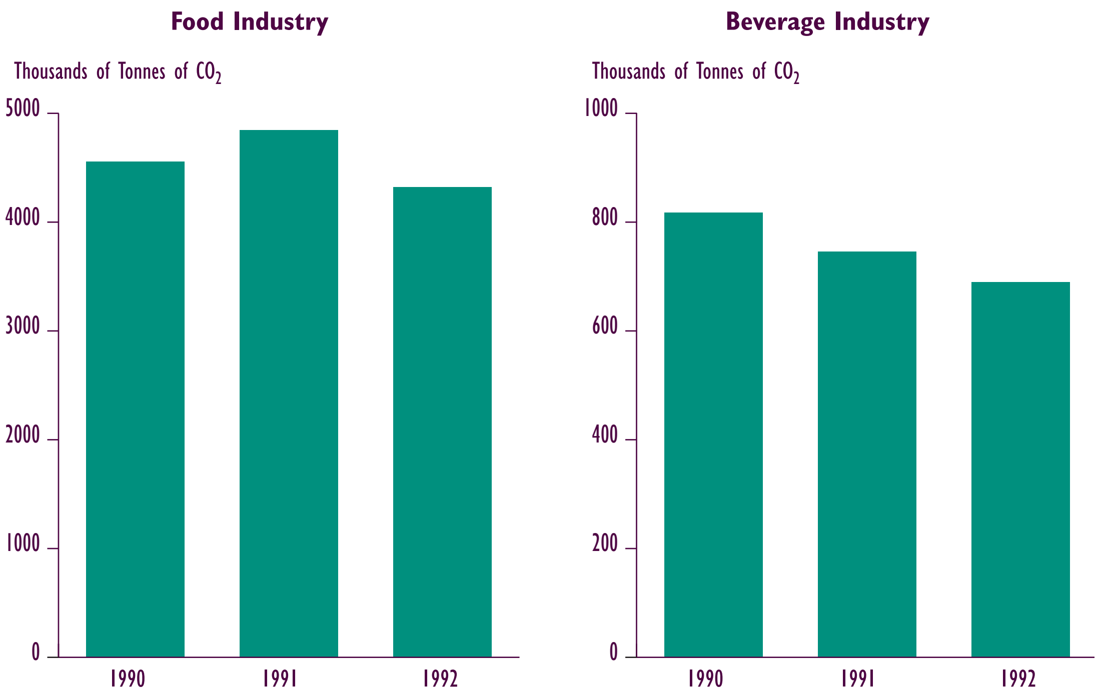
Emissions of GHG are not regulated (save for CFCs, which are also greenhouse gases); the national GHG emissions stabilization objective is being pursued through voluntary measures. Reductions of carbon dioxide emissions have been achieved in the food- and beverage-processing industry due, primarily, to the reductions in energy use intensity noted previously (Fig. 19).

A new set of international standards was designed to address environmental issues at the company and plant level. These ISO 14000 environmental guidelines are appropriate to the food industry. They cover environmental management systems, environmental auditing, environmental performance evaluation, environmental labelling, life cycle assessment, and environmental aspects in product standards. Many larger food companies already include a number of these items in their operations, and industry groups such as the Food and Consumer Products Manufacturers of Canada provide tools for members to use in addressing their environmental responsibilities.

The food industry is also seeking ways to make use of previously discarded by-products of processing and preparing foods for consumption. Activities include

Figure 20

Carbon Dioxide Emissions from Food and Beverage Processing, 1990–1992



Source: Marbek Resource Consultants, 1995.

restaurants participating in composting programs, food processing plants finding non-food use markets for their by-products, and joint distributor–processor facilities handling damaged goods that might previously have been sent to landfill sites and searching for ways of reducing the amount of damage. These activities have the added bonus of greater competitiveness through reduced charges associated with waste haulage, increased income from sales of compost and by-products for non-food uses, and reduction of unsaleable damaged merchandise.

In summary:

- Environmental issues are important to the food- and beverage-processing industry from both economic and ecological perspectives. The key environmental challenges are reduction of packaging wastes sent to landfill sites; efficient use of production inputs; control of pollutant discharges to air, water, and land; and compliance with environmental regulations.
- Various components of the food- and beverage-processing industry have responded to these challenges. For example, it is increasingly common for food- and beverage-processing and distribution companies to include environmental management systems in their operations, and efforts to reduce product packaging waste are under way.
- Comprehensive national information on the environmental risks and performance of the processing sector is lacking. Available information suggests that progress has been achieved in reducing packaging waste, energy intensity, and carbon dioxide emissions.

E. Environmental Outlook

The environmental challenges faced by the agriculture and agri-food sector have historically related primarily to soil quality and use of water. More recently, the sector's environmental challenges have broadened. New ones have emerged that focus primarily on human health and off-farm environmental concerns, particularly water pollution by nutrients and bacteria, solid waste management (e.g., packaging), impacts on biodiversity, control of agricultural greenhouse gas emissions, and adaptation to potential climate change. The nature of these challenges suggests that more effort to deal with off-farm or off-site environmental impacts is required. At the farm level, these concerns can be addressed through an integrated on-farm environmental and resource stewardship approach. At the processing level, environmental challenges can be addressed through clean technologies and comprehensive environmental management systems.

The environmental future for Canadian agriculture and agri-food will be shaped by various social and economic forces, including world food demand, commodity and input prices, federal, provincial and municipal government policies, international trading arrangements, technology, and agricultural research. It is likely that the interaction of these forces will result in the continued restructuring of the sector.

The food- and beverage-processing industry is working to enhance its competitiveness, productivity, and export performance. It will be important to ensure that economic progress is also accompanied by environmental gains, such as compliance with effluent discharge regulations, efficient use of resource inputs, and continued progress in reducing packaging wastes.

Primary production agriculture will need to significantly increase yields on existing cropland if the food and non-food requirements of both domestic and international markets are to be met without encroaching on marginal or non-agricultural lands. This will likely mean continued intensification and concentration of production in both crop and livestock commodity sectors, as well as potentially increased environmental risks. For example, should crop prices rise significantly, so too could the incentive to expand annual crop production on marginal lands, which would increase land degradation risks and adversely affect biodiversity. Competitiveness pressures may further accelerate the trend toward increased concentration of livestock production onto a relatively smaller land base, generating manure surpluses that could adversely affect water quality.

Over the past 15 years, the sector has made considerable progress in adopting more sustainable production systems, technologies, and methods, such as reduced tillage systems and environmental farm plans. However, unless increases in production intensity and concentration are accompanied by sound land use planning, as well as the continued adoption of best management practices and the development of new ones, the future environmental sustainability of agriculture could be compromised. Such a scenario could eventually result in increased regulation and even restriction of agriculture, and thus to limitations on the sector's economic sustainability. The environmental challenges facing agriculture are therefore significant, but manageable. On a regional basis, they can be qualitatively described as follows:

1. British Columbia

- The environmental outlook for British Columbia varies by region. The outlook for the Peace River grain-growing region is similar to that described below for the prairie region.

- In the lower mainland area (lower Fraser Valley and southeastern tip of Vancouver Island), water quality and urbanization of agricultural land are key concerns. There is a risk of increased contamination of surface- and ground-water resulting primarily from two factors: high fertilization of soils and heavy applications of manure from intensive livestock operations, and concentration of production on a smaller land base. There is also a trend towards increasing application of sewage sludge onto agricultural land. Urbanization pressures on farmland may intensify as economic development in the region progresses, although efforts to manage growth and protect farmland are under way.
- In the south-central valleys of British Columbia where agriculture takes place, environmental stresses can result from pesticide use in orchards and vineyards and from over-fertilization of crops under irrigation.

2. Prairie Provinces

- Because 82% of Canada's farmland is located on the Prairies, agricultural developments in this region, such as cropping patterns and farm management practices, will strongly influence the overall direction of change for issues of soil quality, water use, agroecosystem biodiversity, agricultural greenhouse gas emissions, and, on a localized scale, water quality. There are important linkages between all of these issues.
- Future environmental pressures will mainly arise from two sources: increased area seeded to annual crops and expansion of intensive livestock operations.
- Increasing prices for small grains, such as wheat, may result in increased area seeded to annual crops. If this occurs on marginal land or significantly reduces the area in forage crops, the potential environmental costs include reduced soil quality (specifically, soil erosion and loss of soil organic matter), loss of wildlife habitat, and increased emissions of greenhouse gases. Conversely, increased area under small grains may lead to reductions in area seeded to oilseed crops, such as canola, and reduced summerfallow, both of which would reduce environmental risks and impacts. The magnitude of these impacts and benefits depends, in large part, on whether such trends are sustained over time, soil nutrients are replenished through fertilization, soil-conserving practices (such as reduced tillage) are used, and inherent soil and landscape limitations are respected.
- Localized pressures on water quality may increase in areas where intensive livestock production expands, such as parts of Manitoba, Alberta, and Saskatchewan. It will be important to ensure that facilities are properly sited and that provisions for appropriate manure disposal are in place.
- Increases in crop and livestock production may increase demand for water resources. From this perspective, increased efficiency of water use, particularly in irrigation, is an important challenge facing prairie agriculture.

3. Central Canada

- Key agri-environmental issues in Ontario and Quebec will remain water quality, soil quality, and rural–urban interactions, including issues such as application of urban sewage sludge and compost on agricultural land, problems of odour, and the right to farm. Future environmental pressures will arise mainly from continued intensification of production on cropland, continued growth and concentration in the livestock industry, and associated nutrient surpluses.

- Since 1971, area in annual crops such as corn and soybeans has expanded considerably in this region. To manage the environmental risks associated with row crop production, continued use of sound practices to manage nutrients and land (e.g., crop rotations with forages, reduced tillage, and use of fall and winter cover crops) will be required.
- Localized pressures on water quality may occur in areas where intensive livestock production, particularly for hogs, increases. Manure surpluses already exist in several areas, such as parts of Quebec. It will be important to ensure that new facilities are properly sited and that provisions for appropriate manure management and disposal are in place, both for new facilities as well as for existing ones that are expanded.

4. Atlantic Provinces

- Environmental issues in the Atlantic provinces resemble in many respects those in Central Canada (water quality and soil quality) but on a smaller and more localized scale. In some areas, there is the challenge of managing manure better and attending to the environmental impacts of intensified crop production.
- Increases in the production of annual crops, particularly of potatoes, are a key factor. The potential environmental impacts include water pollution from intensive use of agri-chemicals (particularly leaching of nitrate into groundwater) and soil degradation (erosion, compaction, and organic matter loss) resulting from shorter crop rotations, fewer crop rotations with forages, and reductions in soil residue cover. To minimize such risks, sound nutrient use and management practices will be required. It will also be essential that sound land management practices, including crop rotations, be retained in the potato production system, and that cultivation not occur on lands at high inherent risk of degradation.

5. Conclusion

To meet these challenges, agri-food decision makers at all levels must have access to the tools, incentives, and information they require to practice environmentally sustainable agriculture. In this regard there are many needs and opportunities. Examples include the development of new technologies and processes; implementation of environmentally sound policies; the design of an environmentally compatible price structure that internalizes the costs of off-site pollution; improved understanding of inherent environmental risks on local and regional scales; limitations and benefits of various crop and animal production systems; and better information about agriculture's contribution to environmental pressures and benefits relative to that of other sectors and activities.

The key to addressing agri-environmental issues remains an agroecosystem approach. As pointed out by the Federal–Provincial Agriculture Committee on Environmental Sustainability (1990) in its report to Ministers of Agriculture, the same agroecosystem approach that leads to conservation of the agricultural land resource base also effectively addresses concerns for environmental quality off the farm that are so closely linked to management practices, inputs, and technology used on the farm. The land stewardship ethic and infrastructure (e.g., farm conservation clubs) developed over the past decades to address land and soil concerns must continue to evolve toward a broader environmental stewardship ethic.

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