4 Land

Canada is the second largest country in the world, spanning an area of 998,467,000 hectares. Of this area, 89,116,300 hectares (7.6%) is covered by freshwater and the remaining 909,350,700 hectares is land of various types (Natural Resources Canada 2001a) (table 4.1). Forests cover the largest portion of the total land area (45%), while tundra—treeless, level or rolling ground in the arctic—covers 23%. The smallest type of land cover is urban space, which accounts for less than 1% of all land in Canada[24] (figure 4.1).

Despite Canada's enormous size, its climate prevents a majority of the land base from being economically functional and there are conflicts over land that is useful. One concern is human encroachment upon wilderness areas, especially ecologically sensitive zones like wetlands. Other concerns include urban expansion into agricultural areas, the sustainability of agricultural practices, and the environmental impact of biotechnology.

This section will first examine agriculture with a special focus on "biotech" foods grown in Canada. It will then look at the status of Canada's protected lands, especially wetlands.

Agriculture

It has been estimated that 11% of Canada's land is capable of supporting some form of agriculture and 5% can support crops (Environment Canada 1996b). Virtually all the land that is amenable to agriculture is either in use today or has been built upon.

From 1941 to 1991, the total number of farms in Canada fell by approximately half while the average size of farms increased by about 150% (Environment Canada 1996b). In 1996, the average size of Canada's 276,548 farms was 246 hectares and 98% of farms are family owned and operated.

Canada's agricultural and agri-food industry, which includes farmers, suppliers, processors, transporters, grocers and restaurant workers, is the third largest employer in Canada, with approximately 2 million workers or 14% of total employment (CFA). The agri-food industry generated 8.5% of the Canadian GDP in 1997 and over $95 billion in domestic retail and food service sales (Agriculture Canada 2001).

Trends in agriculture

The major crops grown in Canada are wheat, canola, barley, oats, corn, and soybeans. As well as crops, livestock production is an important sector and has been expanding in the last decade. Between the agricultural census in 1991 and that in 1996, cattle and hog numbers increased 15% and 8%, respectively. In 1999, there were 12.9 million head of cattle and 12.4 million hogs (USDA 2001).

Between 1971 and 1996, the total area of agricultural land remained relatively constant but became more intensively worked so that, on average, more is being produced per unit of land area. For instance, cropland[25] has increased 25.6% and the amount of land not worked for at least a year—summerfallow—has decreased by 42%.[26] According to a study by the United States Department of Agriculture, the Canadian agricultural sector was 206% more productive at the end of the 1980s than at the beginning of the 1960s (USDA 1994).

Although there has been little change in the total amount of agricultural land on the national level, provincial data show that there is variation from region to region. The largest decrease in agricultural land during this period was in Ontario (a decrease of 644,845 hectares or 10.3%), followed by Quebec (a decrease of 552,732 hectares or 13.8%) and New Brunswick (a decrease of 80,761 hectares or 17.3%) (Statistics Canada 1997: 70) (table 4.2). Since most of the agricultural land in Quebec and Ontario is located along the densely populated shores of Lake Erie, Lake Ontario, and the St. Lawrence River, some of this decrease can be attributed to urban development.

Soil quality

One of the major issues in Canadian agriculture is the maintenance of soil quality[27] and the reduction of erosion. Erosion is a natural process that removes topsoil and lowers the level of organic matter in the soil. When organic matter is lost, the soil structure breaks down and becomes less permeable to air, water, and nutrients. As

soil fertility and productivity drops off, greater inputs (e.g. fertilizers) are needed to produce a crop. Eventually, the soil reaches an unproductive state. Many farming practices contribute to erosion including summerfallow, which leaves soil unprotected, and conventional tillage, which loosens the earth and makes it more susceptible to all types of erosion. Some results of erosion are poorer crop yield, more soil crusting, more runoff in the spring, higher soil pH, clogged drainage ditches, and the decline of downstream water quality due to the addition of nutrients, pesticides, and bacteria.

Between 1981 and 1996, the risk[28] of all three types of erosion—water, wind and tillage—was significantly reduced in Canada (Agriculture Canada 2000). The general trend of decreasing risk reflects the degree to which changes have been made in cropping systems and tillage practices. A combination of reduced tillage, decreased summerfallow, and the removal of marginal lands from production all contributed to lower erosion rates.[29] The Prairies, where two-thirds of the land is at moderate to severe risk of wind erosion, saw a 30% decline in its risk of wind erosion during this time.

Tillage erosion is caused when plows, hoes and other implements loosen soil and move it downslope with the help of gravity. Over time this results in large losses of soil from the tops of hills and knolls and the accumulation of soil downslope, often mixed with less-productive subsoil. From 1981 to 1996, the overall risk of tillage erosion dropped by 24% in Canada[30] (Agriculture Canada 2000). In 1996, almost half the cultivated land in Canada was under some type of reduced tillage and about 15% was under no-till or direct seeding methods (Agriculture and Agrifood Canada 2000). Adoption of conservation tillage and no-till practices have been made possible by the advent of direct-seeding equipment and a wide array of herbicides to control weeds on untilled fields.

Besides the decline in erosion rates, other indicators also demonstrate improvements in soil quality. Whereas the levels of organic matter in Canada's uneroded agricultural soils had declined by 15% to 30% since cultivation began, they are now being maintained or improved in many Canadian croplands (Acton & Gregorich 1995: 40, 45).

Biotechnology and food crops

Canadians enjoy a safe, inexpensive, and plentiful food supply. In the past few years, however, concern over the environmental and health ramifications of biotechnology foods—otherwise known as genetically modified foods or transgenic foods—have become a major issue in Canada. Biotechnology is defined by the Canadian Environmental Protection Act as "the application of science and engineering in the direct or indirect use of living organisms, or parts or products of living organisms, in their natural or modified forms" (Food Biotechnology Communications Network [FBCN] 2000).

Biotechnology has been used to create new food products with many different traits. Many of the crops currently approved were developed to be resistant to herbicides, allowing farmers to take advantage of no-till soil conservation practices to control weeds. With herbicide-resistant crops, farmers can control a wider range of weeds in a single application of herbicide, which benefits the environment and lowers the farmers' costs. Similarly, some types of potatoes have been modified to be resistant to insects, particularly the Colorado potato beetle. Since the amount of pesticide used is greatly reduced, consumers, farmers, and the environment benefit.

Trends in biotechnology

It is estimated that the area of biotechnology foods planted around the world in 2000 was 44.2 million hectares, an all-time high equivalent to twice the area of the United Kingdom (James 2000). The increase in area from 1999 to 2000 was 4.3 million hectares (11%), only a quarter of the increase from 1998 to 1999 of 12.1 million hectares (44%). From 1996 to 2000, the global area of biotechnology crops has increased by more than 25-fold and the number of countries growing them has more than doubled, from six in 1996 to 13 in 2000. Roughly three-quarters of the crops are grown by developed countries and one-quarter are grown by developing countries (figure 4.2)

In 2000, 36% of the 72 million hectares of soybeans grown worldwide wee derived from biotechnology, 16% of the 34 million hectares of cotton, 11% of the 25 million hectares of canola, and 7% of the 140 million hectares of corn. Overall, 16% of the 271 million hectares of crops planted globally were the result of biotechnology (figure 4.3).

According to international statistics, four countries had 99% of the area planted in biotech crops in 2000: United States (30.3 million hectares), Argentina (10 million hectares), Canada (3 million hectares) and China (.5 million) (James 2000) (figure 4.4). Each of these countries except Canada saw increases in the area planted in 2000 except Canada.

According to domestic statistics, in 2000 Canadian farmers planted approximately 2.67 million hectares of genetically modified canola (55% of the total national

crop) (Ag-West Biotech 2000). This was a contraction of approximately one million hectares from 1999, a decrease attributed to a decline in the national harvest of canola, competition from mutation-derived herbicide-resistant varieties of canola, and a low price for canola that may have prompted farmers to decrease their costs by planting conventional varieties. About 250,000 hectares of genetically modified soybeans were planted in 2000 (30% of total crop) (Cooper 2001) and approximately 316,000 hectares of genetically modified corn (Hough 2001).

Politics and biotech foods

In recent years, activist groups opposed to biotechnology have made it their purpose to block the development of food derived from biotechnology. Some of these groups oppose biotechnology on a philosophical level, believing that all advanced technology is unnatural and a simple back-to-the-land ethic is the only sustainable way of living. Other groups are against biotechnology foods because they are concerned about the effects upon the environment and human health and claim that insufficient testing has been conducted.

However, biotechnological foods go through rigorous regulatory procedures before receiving approval in Canada. Health Canada and the Canadian Food Inspection Agency both have a hand in conducting safety experiments and risk assessment. They determine the potential risks to the human, plant and animal health and to the environment. Since 1988, over 5,000 field tests have been conducted with biotechnology foods in Canada. There are currently 49 different types of these crops approved for use in Canada, though only a fraction of these are actually grown in the country (Webb 2001).

Biotechnology—still a relatively new industry—promises to deliver many benefits to society. Evidence shows it has already helped reduce the amount of pesticide used in the United States. Data from the United States Department of Agriculture shows that from 1996 to 1998, biotechnology crops were responsible for a reduction as large as 19 million acre-treatments (the number of acres multiplied by the number of applications per year) of pesticides (Hunter 2001).

Biotechnology is also being used to develop foods and medicines that will have huge benefits to the developing world. For instance, "golden rice" produces beta carotene in its seeds and could thus prevent blindness in half a million to three million poor children a year and alleviate vitamin-A deficiency in some 250 million people in the developing world (Centrone 2000). Scientists are also working to develop edible vaccines contained in fruit such as bananas for diseases like cholera and measles. This simple, nutritious, and effective way of delivering vaccinations would reach infants too young for inoculations and eliminate the related costs of storage and injection that are often insurmountable in the developing world (FBCN 2000).

Although the use of biotechnology is beneficial to the environment, its use is still controversial. Some groups have crossed over the line of voicing their concerns through protest and have taken to committing acts of vandalism and sabotage. The Earth Liberation Front burned down a laboratory at Michigan State University in December 1999, destroying years of work and causing $400,000 (US) in property damage (Bailey 2001). In June of 2000, the Anarchist Golfing Association wrecked experimental grass plots in Oregon causing about $500,000 (US) in damage. Canada has also seen incidents of vandalism. In October 1999, a group called Reclaim the Genes destroyed 500 trees at the University of British Columbia and another group chopped down nearly 3,000 trees at a forestry center near Victoria (Pemberton and Sandler 2001). In August of 2000, a group called Democraseed attacked a plot at the Central Experimental Farm in Ottawa, setting back the project one year and causing $50,000 in damage (Bronskill 2001). Ironically, the field was not testing biotechnology crops at all but was developing corn that would be resistant to root worm. The Canadian Security Intelligence Service reported that "[t]he fact that Democraseed mistakenly attacked a regular corn plot obviously was not of concern to the group" (Bronskill 2001: A4).

Many scientists around the world are concerned that political pressure from activist groups will impede the progress biotechnology is making. As of April 1, 2002, over 3,330 scientists, including Nobel Prize winners James Watson and Norman Borlaug, had signed a declaration, drafted by Professor C.S. Prakash of Tuskegee University.[31] The declaration calls biotechnology a "powerful and safe means for the modification of organisms," and says that biotechnology "can contribute substantially in enhancing quality of life by improving agriculture, health care, and the environment."

Protected areas

Banff, Canada's first national park, was created in 1885. Today in Canada, there are over 60 different types of protected areas enclosing more than 100 million hectares of

land. These include, among other types, parks, wildlife areas, ecological reserves, and migratory bird sanctuaries. Parks Canada, the Canadian Wildlife Service and provincial environment ministries are the key government managers of Canada's protected areas. Non-governmental organizations such as Ducks Unlimited Canada, the Wildlife Habitat Foundation Canada and the Nature Conservancy of Canada also play an important role. Between 1987 and 1996, groups such as these were responsible for creating over 70% of the protected sites in the Atlantic provinces (Statistics Canada 2000b).

Trends in protected areas

Canada's total protected land grew exponentially from 1900 to 2000. Protected areas are found in all provinces and territories and vast tracts of protected land is located in the Northwest Territories and Nunavut (figures 4.5 & 4.6 and table 4.3).

The first comprehensive effort to compile a database of all of Canada's protected lands under all the various designations is currently being undertaken by a division of Statistics Canada. The Canadian Conservation Area Database, which was in a draft state at the time of this publication, attempts to capture all of the federal, provincial and non-governmental managed lands by size, category, latitude and longitude, and year of establishment. As this database is developed, its usefulness as an indicator of Canada's protected lands will increase.

Recently, Canada has begun to turn its attention to protecting its marine environments as well as its terrestrial ones. In 1998, the governments of Canada and Quebec jointly created the Saguenay-St. Lawrence Marine Park. Canada is currently working towards establishing a national park in each of the 39 natural regions defined by the *National Park System Plan* (1990) and marine conservation areas in each of the 29 marine regions defined by *Sea to Sea to Sea, Canada's National Marine Conservation Areas System Plan* (1995) (Federal Provincial Parks Council 2000).

Wetlands

Wetlands are areas where water and land meet and which are wet for an ecologically significant part of the year. Environment Canada defines wetlands to include bog, fens, swamps, marshes and shallow open water. Wetlands may be temporally flooded each day, as tidal marshes are, or be filled seasonally with water from melting snow. In the past, wetlands were under-valued and intentionally destroyed. Today they are considered valuable features of our landscape and efforts to preserve and restore them have seen considerable results.

Functions of wetlands

Wetlands have often been described as the kidneys of the landscape because of the role they play in water cycles. They act as filtration systems, breaking down nutrients and neutralizing disease-causing pathogens. Wetlands also protect the land from flooding and shorelines from erosion and provide habitat for a wide range of species. Canadian prairie wetland, for instance, provides habitat for 50% of North America's waterfowl (Environment Canada 1991c:[17]10).

In the past, wetlands were considered waste areas and were drained and converted to agriculture and other economically productive activities. It is estimated that about one-seventh (about 20 million hectares) of Canada's pre-settlement wetlands were drained (Rubec 2001). In some areas, wetland conversion to agriculture has been considerable: 70% of wetlands in southern Ontario, 71% in the Prairie provinces and 80% of the Fraser River Delta in British Columbia (Environment Canada 2001).

Farming subsidies and other government policies, such as the Maritime Marshland Rehabilitation Act (1943), contributed to the destruction of wetlands. Until recently, the Canadian Wheat Board Act determined grain delivery quotas based on the total areas seeded and left fallow. This encouraged farmers to cultivate marginal land rather than leave it in its natural form (Environment Canada 1991c:[26]6).

As more is discovered about the function and value of wetlands, it is becoming clear that they play a reinforcing, rather than a strictly competing, role in agriculture and urban development. For example, wetland preservation can help conserve and purify ground water and protect against drought and soil erosion. Wetlands in southern Canada also have direct economic benefits, producing wild rice, forest products, fresh water, cranberries, horticultural peat and sphagnum mosses. They also provide shoreline protection, erosion control, flood-peak reductions, as well as many socioeconomic functions such as hunting, trapping, fishing, tourism, and recreation.

Trends in wetlands

Wetlands are extensive in Canada, covering approximately 148 million hectares or 16% of our country's land base (Rubec 2001). Canada contains nearly 25% of the world's wetlands (Environment Canada 1991c:[26]7). They are

found across the country but are concentrated in northern Ontario, northern Alberta, the Northwest Territories and Manitoba.

Canada has adopted and supported many conservation programs over the last two decades in recognition of the ecological and economic importance of wetlands. In 1981, Canada became a contracting party to the Ramsar Convention, an intergovernmental treaty to preserve wetlands. In 1990, the Canadian government established the North American Wetlands Conservation Council and, in 1991, Canada adopted the Federal Policy on Wetland Conservation, making it the first nation to formalize wetland policy on a national level.

A *List of Wetlands of International Importance* has been developed through the Ramsar Convention, which covers more than 1,000 sites globally. It lists 36 sites in Canada, which make up just over 16% of the total wetland area designated world-wide under the convention, though this is only about 9% of the wetlands in Canada (Rubec 2001). Canada's Ramsar sites cover a surface area of more than 13 million hectares and are diverse in type and size, ranging from 244 hectares to over 6 million hectares.

The most important efforts to conserve wetlands, however, have been made through the North American Waterfowl Management Plan (NAWMP), which Canada and the United States created in 1986 and Mexico joined in 1994. Through joint ventures between public and private agencies, this billion-dollar-plus program has identified the key habitats necessary to protect waterfowl populations and has developed plans for the restoration and protection of these areas. Of the 2 million hectares targeted in Canada under the NAWMP, 800,000 hectares have been protected thus far, which includes both wetlands and upland habitat associated with waterfowl (Rubec 2001). Though some of this land belongs to the Crown, the majority of it is protected through programs with private landowners.

Private conservation organizations have made a significant contribution to wetland protection efforts. The two largest stewards of Canada's non-governmental conservation lands are Ducks Unlimited Canada and the Nature Conservancy of Canada. Ducks Unlimited Canada manages 1.5 million hectares directly and has conserved over 6 million hectares through agreements with governments and individuals (Cicierski 2001). The Nature Conservancy has conserved 675,800 hectares on over 1,000 properties, largely through deals with private landowners (Rehman 2001).

Industry has also been an active player in protecting key areas. Shell Oil gave a large holding in British Columbia to the Nature Conservancy in 1992; MacMillan Bloedel donated Cathedral Grove on Vancouver Island in the 1940s; and New Brunswick's Bowater-Mersey Forest Products Limited has entrusted areas of ecological importance, including wetlands, to governmental and non-governmental conservation groups (Environment Canada 1996c).

Recent changes to the federal tax code through the Ecological Gifts Program have given individuals and companies an increased incentive to give land to governmental or private organizations. Over 200 gifts of land have been made since 1995: 50 of these gifts were donated in 2000 alone and 60% have been wetlands (Rubec 2001).

Summing up the land covered under the NAWMP, Parks Canada, National Wildlife Areas, Migratory Bird Sanctuaries, private organizations and other initiatives, it is estimated that 15 million hectares of wetlands in Canada are protected. That means that roughly 10% of Canadian wetlands are under some status secured for conservation efforts. The major thrust of conservation efforts is currently on working with private landowners in southern Ontario, the Prairies, and some coastal areas where wetlands are most vulnerable.

A recent conservation effort has been Natural Legacy 2000, a program administered by the federal government's Canada Millennium Partnership Program, which involved the World Wildlife Fund Canada, the Nature Conservancy of Canada, Ducks Unlimited Canada and the Canadian Nature Federation. Ducks Unlimited Canada secured 182,000 hectares under various conservation programs while the Nature Conservancy preserved 24,400 hectares under conservation easements, land donations, and planned gifts.

Table 4.1: Area of land and freshwater in Canada and the provinces

	Total Area (hectares)	Land (hectares)	Freshwater (hectares)	Percent of total area in Canada
Canada	998,467,000	909,350,700	89,116,300	100.0%
Newfoundland	40,521,200	37,387,200	3,134,000	4.1%
Prince Edward Island	566,000	566,000	0	0.1%
Nova Scotia	5,528,400	5,333,800	194,600	0.6%
New Brunswick	7,290,800	7,145,000	145,800	0.7%
Quebec	154,205,600	136,512,800	17,692,800	15.4%
Ontario	107,639,500	91,774,100	15,865,400	10.8%
Manitoba	64,779,700	55,355,600	9,424,100	6.5%
Saskatchewan	65,103,600	59,167,000	5,936,600	6.5%
Alberta	66,184,800	64,231,700	1,953,100	6.6%
British Columbia	94,473,500	92,518,600	1,954,900	9.5%
Yukon	48,244,300	47,439,100	805,200	4.8%
Northwest Territories	134,610,600	118,308,500	16,302,100	13.5%
Nunavut	209,319,000	193,611,300	15,707,700	21.0%

Source: Statistics Canada 2001.

Table 4.2: Total agricultural land in Canada by province, 1976–1996 (millions of hectares)

	1976	1996	Percent change
Newfoundland	0.03	0.04	35.3%
Prince Edward Island	0.3	0.27	–10.4%
Nova Scotia	0.49	0.43	–13.4%
New Brunswick	0.47	0.39	–17.3%
Quebec	4.01	3.46	–13.8%
Ontario	6.26	5.62	–10.3%
Manitoba	7.7	7.73	0.4%
Saskatchewan	26.51	26.57	0.2%
Alberta	20.21	21.03	4.1%
British Columbia	2.45	2.53	3.3%
Total	68.43	68.06	–0.5%

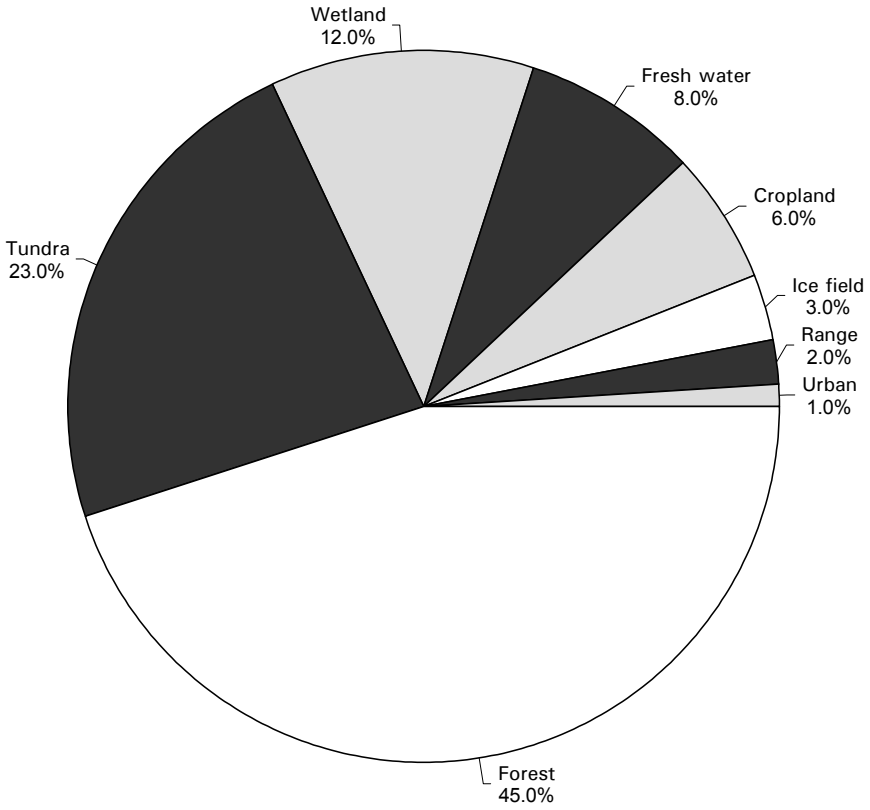
Source: Statistics Canada 1997: 70.

Table 4.3: Protected areas by jurisdiction (hectares)

	Federal	Provincial or Territorial	Private or non-governmental organization	Other	Total	Percentage of province or territory under protected status
British Columbia	3,380,477	10,517,050		360,284	14,257,811	15.04%
Alberta	6,378,884	2,035,308		321,300	8,735,492	13.22%
Saskatchewan	1,397,497	3,904,466	15,955	1,391,899	6,709,817	10.29%
Manitoba	1,460,363	6,880,825	13,165	23,000	8,377,353	12.87%
Ontario	263,037	9,591,201	7,834	91,812	9,953,884	9.31%
New Brunswick	62,957	358,046		1,200	422,203	5.78%
Prince Edward Island	2,310	8,082		24,831	35,223	6.16%
Nova Scotia	142,701	476,575			619,276	11.06%
Newfoundland	221,527	634,820		988,594	1,844,941	4.54%
Yukon	4,279,336	1,419,800		973,628	6,672,764	13.82%
Northwest Territories	12,129,247	14,770		7,907,355	20,051,372	17.11%
Nunavut	27,290,083	10,850		8,146,926	35,447,859	15.73%
Total in Canada	57,008,419	35,851,793	36,954	20,230,829	113,127,995	10.25%
Percentage of protected land under jurisdiction in Canada	50.2%	31.9%	4.6%	17.9%	100%	

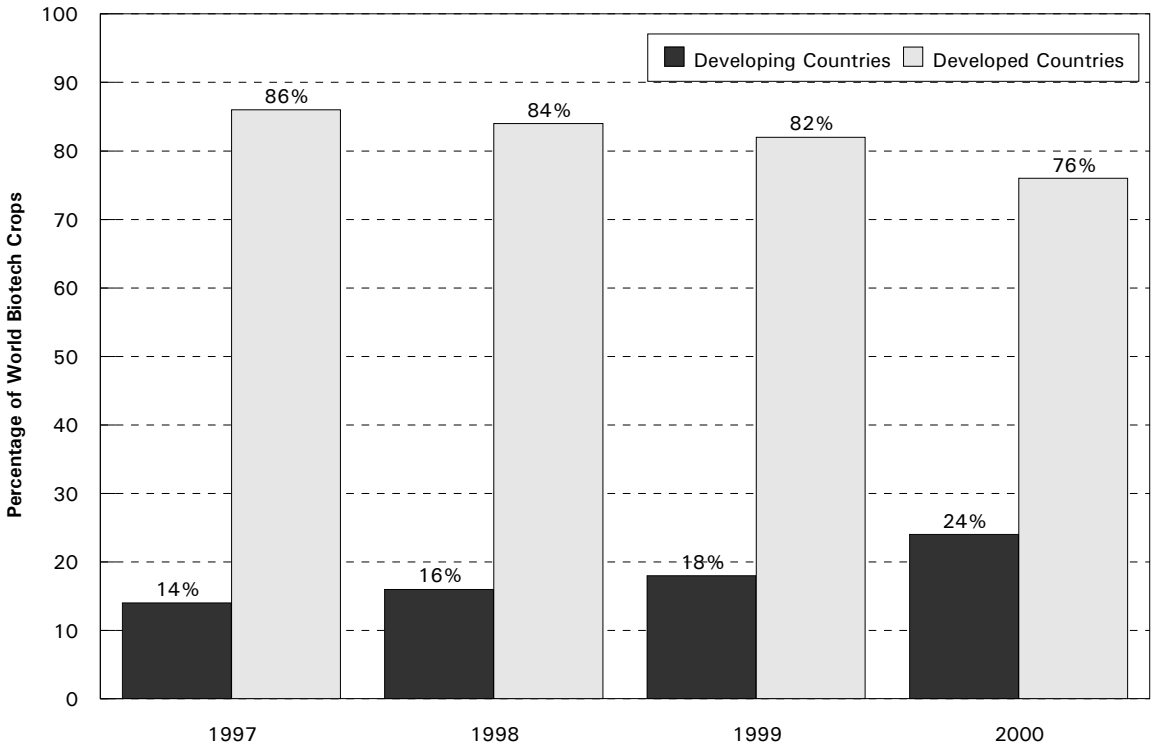
Source: Canadian Conservation Area Database 2001. Note that the Canadian Conservation Area Database is under construction and that data for Quebec are absent as Quebec's Ministry of the Environment has not broken down data into jurisdictions in a format compatible with this table.

Figure 4.1: Land cover in Canada



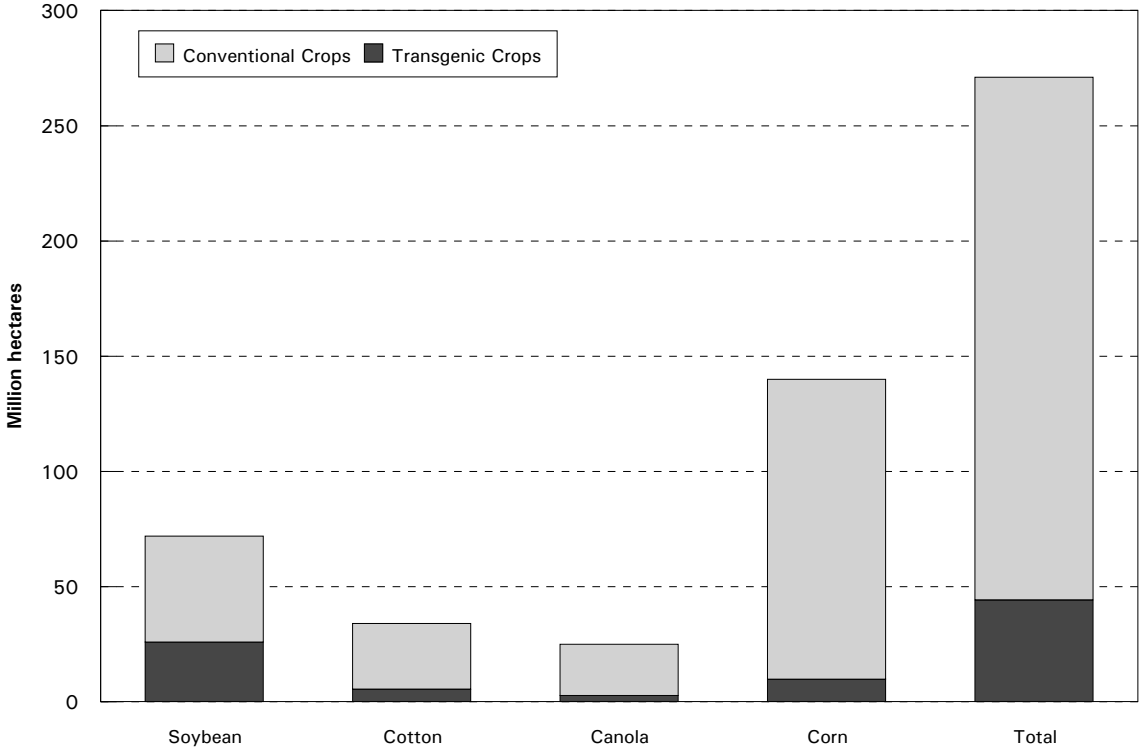
Source: Statistics Canada 1996: 7.

Figure 4.2: Biotech crops grown worldwide



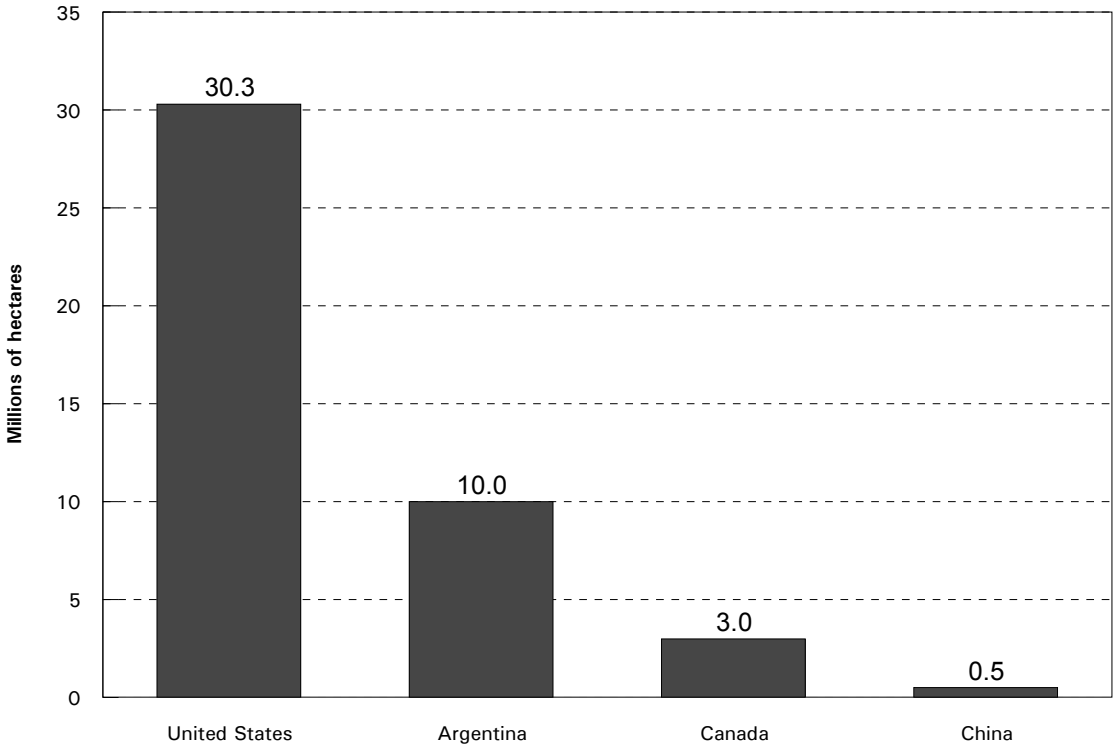
Source: International Service for the Acquisition of Agri-biotech Applications, 2000.

Figure 4.3: Transgenic and conventional crop area



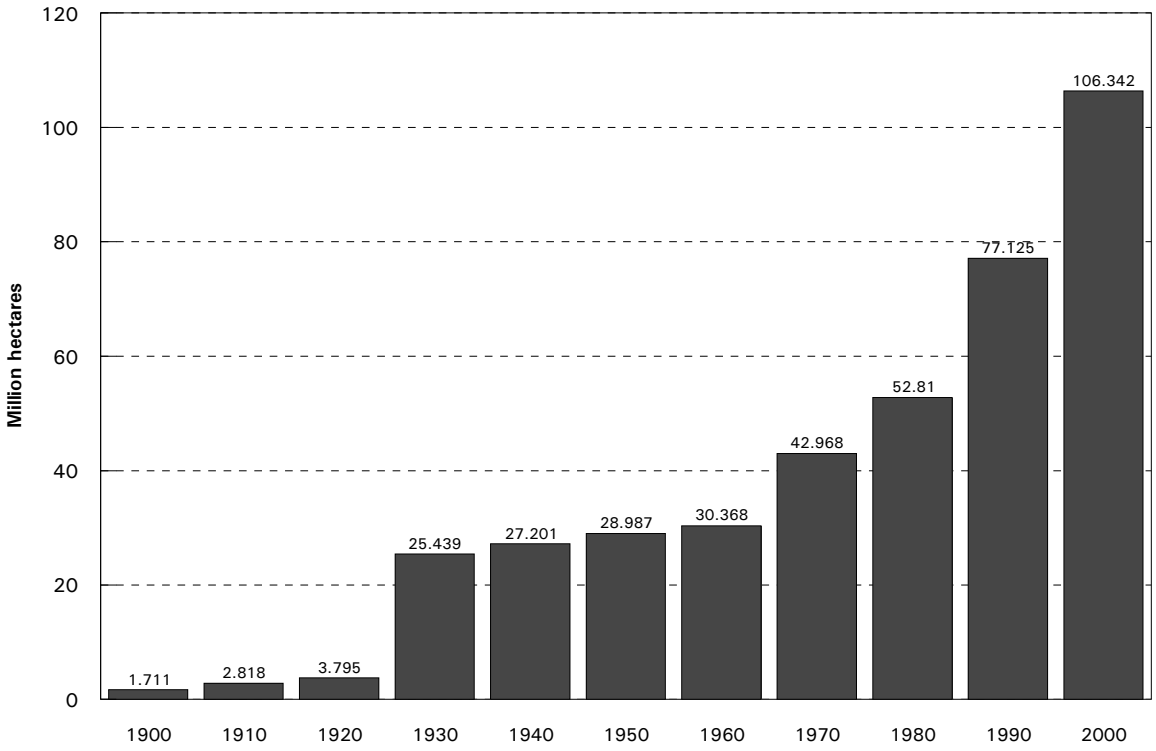
Source: International Service for the Acquisition of Agri-biotech Applications 2000.

Figure 4.4: Largest growers of genetically modified foods, 2000



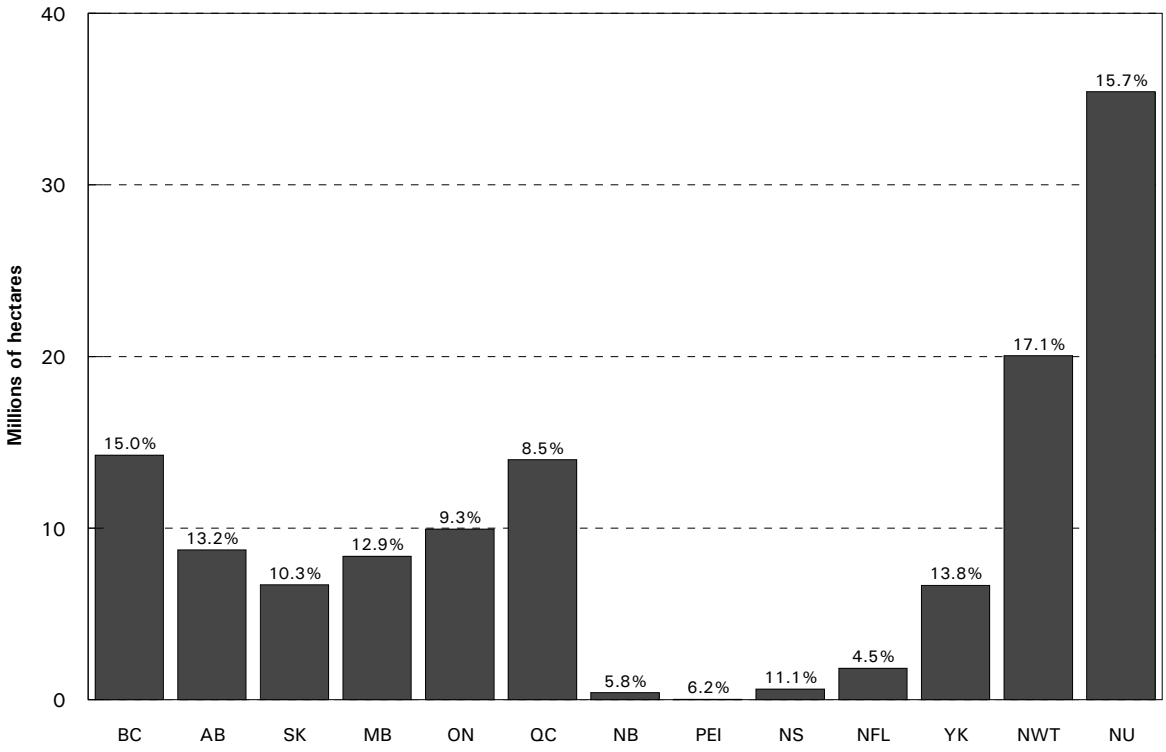
Source: International Service for the Acquisition of Agri-biotech Applications 2000.

Figure 4.5: Protected land in Canada



Source: Canadian Conservation Area Database. Notes: (1) Graph does not include 6.65 million hectares to which the database did not assign a date. (2) When protected sites were enlarged after their initial designation, the total area is captured in the year of formation.

Figure 4.6: Protected land by province (showing percent of total province)



Sources: Canadian Conservation Area Database; data for Quebec from the Quebec Ministry of Environment.
Note: (1) The CCAD is currently under construction. For a discussion of its limitations, see http://www.geogratis.cgdi.gc.ca/.