

# CANADA'S FORAGE RESOURCES

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## ABSTRACT

Canada is the second largest country in the world and stretches 5,500 km east to west and 4,600 km north to south. About 90% of Canada is uninhabited with 90% percent of the population living within 500 km of the Canadian-American border. About 60% of Canadians live in southern Ontario and Quebec. The grazing industry is located primarily in western Canada with British Columbia, Alberta, Saskatchewan and Manitoba having 84% of the national beef herd. Ontario and Quebec have 73% of the national dairy herd. The majority of harvested forage, dehydrated alfalfa and forage seed crops are grown in western Canada. The forage-based livestock industry makes a significant contribution to the national economy.

## KEYWORDS

Forage, grass, legume, hay, pasture, cattle, beef, dairy.

## INTRODUCTION

Canada is the world's second largest country covering approximately 10 million km<sup>2</sup> (Willms and Dormaar, 1993). It extends 5,500 km between the Atlantic and Pacific Oceans and 4,600 km north from the United States border to the Arctic. Canadians have a wealth of natural and agricultural resources; from the spectacular mountains of the west, through the grain and grazing areas of the prairies, to the forests and rivers of the Canadian Shield and finally to the historic farmlands of eastern Canada. The variable topography, the Great Lakes, and the surrounding oceans influence climate, vegetation, and demographics. About 90% of Canada is uninhabited with 90% percent of Canadians living within 500 km of the American border. About 60% of Canadians live in southern Ontario and Quebec (Statistics Canada, 1994).

Canada's forage resources include both native rangelands and cultivated crops. The area used by both wildlife and livestock exceeds 700 million ha or 70% of Canada's land base (Horton, 1994). It stretches from the vast arctic tundra of the far north to the grasslands of the southern prairies, and from the forests of British Columbia through the boreal forests of central and western Canada to the deciduous forests of eastern Canada (Fig. 1). Only 7% or 68 million ha of Canada's land base is used for

agriculture, an area about three times the size of Great Britain.

Agriculture is one of Canada's primary industries. It is the third highest contributor to the gross domestic product after mining and oil (Statistics Canada, 1994). The agri-food industry contributes approximately 8% of Canada's annual gross domestic product. Agriculture's primary importance varies across the country. Agriculture is most important economically to the province of Saskatchewan.

The forage resource used for livestock grazing and production of forage crops covers over 36 million ha of Canada's land base (3.6%) (Horton, 1994). This compares to 25 million ha in grain and oilseed crops. This is divided into 72% native range (26 million ha), 11% cultivated pastures (4 million ha) and 17% forage crops (6 million ha) (Table 1).

Forage production is the foundation of Canada's beef and dairy industries. The beef and dairy industries are the second and third ranking primary agriculture sectors after the grain sector (Statistics Canada, 1996). It is estimated that two-thirds of the feed protein in Canada comes from hay, grazing of forages and fodder corn production (McQueen and Buchanan-Smith, 1993). Canada's cold-temperate climate dictates winter feeding of livestock with preserved forages for periods as long as October to May depending on location and annual weather.

Cultivated forages have been widely adapted to various regions of Canada with significant production coming from lands not suited to annual crops. Forages are frequently grown in rotation with cereal and oilseed crops. Cereals are grown on the majority of cultivated lands but the farm value of forage conserved as hay and silage accounts for 40-60% the value of feed grain crops (McQueen and Buchanan-Smith, 1993). Important cultivated forage species include alfalfa (*Medicago sativa*), red, white and alsike clover (*Trifolium pratense*, *T. repens* and *T. hybridum*), bird's-foot trefoil (*Lotus corniculatus*), smooth brome grass (*Bromus inermis*), creeping red fescue (*Festuca rubra*), timothy (*Phleum pratense*), orchardgrass (*Dactylis glomerata*) and crested wheatgrass (*Agropyron cristatum* and *A. desertorum*).

The majority of the forage-based livestock industry is situated in western Canada. Forage management in

western Canada integrates rangeland resources with cultivated forages. The four western provinces have 96% of the 26 million ha of Canadian rangeland used for livestock production with 36% in British Columbia, 29% in Alberta, 24% in Saskatchewan and 8% in Manitoba (Table 1). The western provinces also have 82% of the nation's cultivated pasture, 64% of the nation's forage crop area, and 84% of the nation's beef cow herd. Most farmers produce their own forages in Canada, with less than 15% of forage produced being sold on commercial markets.

### THE CANADIAN LANDSCAPE

Canada's natural vegetation is simply classified as 24% tundra, 71% forest and 5% grassland (Horton, 1994). Plant geography classifies major terrestrial communities into biomes based on climate and natural vegetation. Canada may be divided into arctic tundra, boreal forest, deciduous forest, grassland and mountain cordillera biomes (Fig. 1). Overviews of Canada's landscape with agricultural and livestock perspectives have been described by Willms and Dormaar (1993), Horton (1994) and the Ecological Stratification Working Group (1995).

**Arctic Tundra.** The Arctic Tundra covers about 24% (240 million ha) of Canada's land base (Horton, 1994). It stretches east from the Yukon in a southern arc to northern Quebec and north to include the Arctic Islands (Fig. 1). This biome experiences long, cold winters and short, cool summers. It was described as the "barren lands" by the first European visitors; however, spring and summer can bring a sudden greening of the landscape (Ecological Stratification Working Group, 1995). It is characterized by dwarf shrubs, perennial herbs, cryptogams and a generalized absence of trees. The terrain consists of rolling uplands and lowlands underlain by Precambrian granite bedrock. A variety of large to small mammals are present including caribou (*Rangifer tarandus*), bears (*Ursus* spp.), wolves (*Canis* spp.) and moose (*Alces alces*). While the area is sparsely inhabited, there is increasing ecotourism to the Arctic Tundra. The largest caribou herd in the world roams the eastern Arctic. Caribou can travel up to 9,000 kilometers in a year in their search for forage (Ryan, 1996). It is estimated that there are over 800,000 caribou in the eastern Arctic herd. In addition, there are eight other nomadic herds with populations exceeding 100,000 head in other parts of the Arctic. The Inuit hunters that traditionally have used the caribou as a source of food and shelter are very concerned about the long-term survival of these vast herds due to the lack of suitable grazing reserves. In addition to caribou, there are large herds

of bison (*Bison bison*) and reindeer (*Rangifer tarandus*) which are commercially managed.

**Boreal Forest.** The Boreal Forest is Canada's largest biome covering 53% (520 million ha) of Canada's land base (Horton, 1994). It extends from the Yukon in a southeasterly arc to Newfoundland (Fig. 1). The area is dominated by trees, rivers, lakes and the Canadian Shield bedrock which surrounds Hudson Bay. The climate consists of long, cold winters and short, warm summers as influenced by continental climatic conditions. Average annual precipitation ranges from 330 to 1000 mm depending upon location (Willms and Dormaar, 1993). The main vegetation consists of white and black spruce (*Picea glauca* and *P. mariana*), aspen poplar (*Populus tremuloides*), balsam fir (*Abies balsamea*), and jack pine (*Pinus banksiana*). White spruce grows in upland areas along with aspen poplar, while black spruce is found on wetter soils. Balsam fir and jack pine are found in the central and eastern parts, while alpine fir (*Abies lasiocarpa*) and lodgepole pine (*Pinus contorta* var. *latifolia*) occur in the western areas.

Wheatgrass and northern porcupine grass (*Agropyron-Stipa*) communities are interspersed in this forest biome in northern British Columbia and Alberta. Caribou, moose, beaver (*Castor canadensis*), deer (*Odocoileus* spp.), wapiti or elk (*Cervus* spp.), coyote (*Canis latrans*) and bears are prominent mammals in the Boreal Forest. The whooping crane (*Grus americana*), one of Canada's most well known endangered species, nests in this biome.

While most of the Boreal Forest is not suited for agriculture about 5 million ha are cultivated in Alberta, Saskatchewan, Manitoba and the isolated clay belt of northern Ontario (Willms and Dormaar, 1993). The soils of the Boreal Forest range from Gray Luvisols on the interior plains to organic soils on the lowlands of Hudson Bay and the Podzols of the Canadian Shield. Soil fertility is low. Livestock operations are found on the southern edges of the Boreal Forest where it meets the prairie grasslands and in the clay belt of northern Ontario.

**Deciduous Forest - Eastern Canada.** The deciduous forest biome of eastern Canada covers about 5% (45 million ha) of Canada's land base (Horton, 1994) (Fig. 1). It can be divided into two ecozones; the mixed wood plains ecozone and the Atlantic Maritime ecozone.

The mixed wood plains ecozone stretches from the Great Lakes of southern Ontario and east along the St. Lawrence River of southern Quebec (Ecological Stratification Working Group, 1995). Its waterways, gentle topography, fertile soils, warm growing season, abundant rainfall and early settlement have made it Canada's most populated area with 60% of the nation's people (Willms and Donnaar, 1993). The climate is warm in summer, cool in winter with mean temperatures ranging from 16-18°C in summer and -10 to -20°C in winter. Annual precipitation ranges from 720-1000 mm.

One-hundred-and-fifty years ago this area was heavily forested with more tree species than any other region of Canada (Ecological Stratification Working Group, 1995). Less than 10% of this area remains forested today. Deciduous trees with their fall colors are a major tourist attraction. Important tree species include sugar maple (*Acer saccharum*), red maple (*Acer rubrum*), beech (*Fagus grandifolia*), American elm (*Ulmus americana*), trembling aspen and birch (*Betula* spp.).

Forages constitute the single largest crop grown in Ontario with seeded pastures (0.4 million ha) and hay land (1 million ha) accounting for 40% of the crop land in Ontario (Clarke et al., 1993). This equals the land area used for winter wheat (*Triticum aestivum*), soybeans (*Glycine max*), and grain corn (*Zea mays*) in Ontario. Livestock production dominates Ontario's agriculture with 36% of farm income derived from ruminant livestock and 56% of all farm cash receipts coming from all livestock products in general.

Quebec ranks first for the number of milking cows (Petit, 1993). Over 60% of Quebec's farm land (3.4 million ha) is in forage production with approximately 0.7 million ha in pasture (20% of the forage area). Principal forage species are timothy and white clover.

The Atlantic maritime ecozone covers the provinces of New Brunswick, Nova Scotia and Prince Edward Island and parts of southeastern Quebec (Ecological Stratification Working Group, 1995). The climate is moist and temperatures are moderate ranging between 13-16°C in summer and about -10°C to -20°C in winter. Annual precipitation varies from 900 mm inland to over 1500 mm near the coast: Forest vegetation is mixed stands of conifers and deciduous species of red spruce (*Picea rubens*), balsam fir, birch, sugar maple and pine (*Pinus* spp.).

About 15% of the soils in Nova Scotia, 20% in New Brunswick and 60% in Prince Edward Island are of high agricultural value with some areas specializing in potato production (Willms and Dormaar, 1993).

Approximately 80,000 ha are utilized as pasture with another 388,000 ha used for cultivated crops (Papadopoulos et al., 1993).

Cultivated grasses such as timothy, orchardgrass, tall fescue (*Festuca arundinacea*), reed canarygrass (*Phalaris arundinacea*) and legumes such as white clover can increase pasture productivity in the region and reduce seasonal fluctuations in dry matter yield associated with native swards (Papadopoulos et al., 1993). Improved swards gradually revert to native species due to competition under grazing. Supplemental pasture crops including annual ryegrass (*Lolium multiflorum*) and mustards (*Brassica* spp.), extend the productive grazing season from approximately 4 to 7 months.

**Mountain Cordilleras - Western Canada.** Western Canada is dominated by a series of mountain ranges. The effect of the Pacific Ocean combined with varying altitudes, slopes, and aspects of the cordilleras creates more diversity in climate and vegetation than is found in any other region of Canada (Meidinger and Pojar, 1991). The area provides an extensive grazing resource for wildlife and commercial cattle and horse producers.

The Pacific Cordilleran, or Coast Forest, extends from the Gulf of Alaska to northern California along the coast of the Pacific ocean (Fig. 1). It covers about 3% (26 million ha) of Canada's land base, but due to the rugged terrain has limited use for beef production (Horton, 1994). Major species include western red cedar (*Thuja plicata*) and western hemlock (*Tsuga heterophylla*), with sitka spruce (*Picea sitchensis*) in the north and coastal areas, and Douglas fir (*Pseudotsuga menziesii* var. *menziesii*) in the south. The area receives from 1500-3000 mm of annual precipitation due to the influence of the Pacific Ocean (Ecological Stratification Working Group, 1995).

The Rocky Mountain Cordilleran stretches from southeastern British Columbia and southwestern Alberta through central British Columbia into the Yukon (Horton, 1994) (Fig. 1). It covers approximately 9% (92 million ha) of Canada's land base. The forage resources of the Rocky Mountain Cordilleran are important for guide-outfitting and ecotourism enterprises.

The Interior Cordilleran located in southcentral British Columbia covers 2% (17 million ha) of Canada's land base (Horton, 1994) (Fig. 1). The climate of the zone ranges from subarid to humid at low and mid-elevations and cold at high elevations.

The rain shadow created by the coastal mountains results in some of the driest areas in Canada. Other regions can receive 1500 mm of annual precipitation (Ecological Stratification Working Group, 1995). The vegetation is floristically diverse ranging from bunchgrass associations in valley bottoms with dry to wet forest communities at mid-elevations to high elevation alpine communities (Wikeem et al., 1993). Ponderosa pine (*Pinus ponderosa*) grows in the southern parts while Douglas fir, lodgepole pine and trembling aspen grow elsewhere. Many ranchers use these area for beef cattle grazing.

Commercial forest operations have been established throughout the area along with mining. Ecotourism is of great importance as many national and provincial parks have been established for recreational use and as a wildlife preserve. About 5% of the region is suitable for agriculture (Willms and Dormaar, 1993). Farming and ranching occur in the valleys and on the plateaus. Cultivated crops are often grown under irrigation with fruit orchards, berry production, and vineyards located in heavy concentrations in the southern valleys.

**Grassland Biome - The Canadian Prairie.** The Grassland Biome in Canada is a continuation of the Great Plains of central North America (Fig. 1). This biome covers about 5% (45 million ha) of the Canadian land base and most of the cattle grazing in Canada takes place in this region (Horton, 1994). It stretches from the Canada United States border in a tear drop arc from Alberta, through Saskatchewan and into southern Manitoba. These grass plains are comparatively flat and were home to the buffalo prior to settlement. Native grasslands have been extensively ploughed and cultivated for grain production over the last 100 years. Today most of Canada's wheat, oilseeds and beef production are centered in the grassland biome.

The continental climate ranges from semiarid in the south to subhumid in the north (Ecological Stratification Working Group, 1995). Winters are long and cold; summers are short and hot with high evaporation. Annual precipitation ranges from 250 mm in the arid southern grasslands of Alberta and Saskatchewan to 700 mm in parts of Manitoba.

The natural plant communities of the Canadian grassland biome have been described by Moss (1944), Moss and Campbell (1947), Coupland (1950), Coupland and Brayshaw (1953), Moss (1955), Coupland (1961), Blood (1966), Looman (1969), Scoggan (1978), Looman (1981) and Willms and Jefferson (1993). This biome can be classified

into four associations; Aspen Parkland, Fescue Prairie, Tallgrass Prairie and Mixed Prairie.

The Aspen Parkland forms the northern edge of this biome and is an ecotone with the Boreal Forest biome. It is an association of trembling aspen and balsam poplar (*Populus balsamifera*) groves with interspersed grasslands. The Aspen Parkland has expanded with the suppression of wild fires associated with European settlement and policy (Anderson and Bailey, 1980; Bailey, 1995). The region is highly productive with wheat, barley, oilseeds, specialty crops, alfalfa seed and dehydration products and beef cattle being of primary importance. Since settlement in the Parkland, most native grassland has been replaced by cultivated crops. Many areas unsuitable for sustained crop production have become government-operated community pastures consisting of brome-grass-bluegrass (*BromusPoa*) complexes. Many wetlands suitable for duck and geese nesting are scattered throughout the region.

The Fescue Prairie mostly found between the Aspen Parkland to the north and the Mixed Prairie to the south (Willms and Dormaar, 1993) stretches in an arc from the Alberta foothills through central Alberta, Saskatchewan and into western Manitoba. Foothills rough fescue (*Festuca campestris*) can be found in the Alberta foothills, while plains rough fescue (*Festuca hallit*) grows primarily on the Black Chernozemic soils of central Alberta, Saskatchewan and southern Manitoba. The comparatively good moisture and rich soils of the Fescue Prairie has made it a very productive crop area. As a result, this association has been extensively cultivated and only limited areas remain of the original Fescue Prairie.

The Mixed Prairie is the driest portion of the Canadian grassland biome (Willms and Jefferson, 1993; Ecological Stratification Working Group, 1995). It extends across the southern prairies from the foothills of the Rocky Mountains to the Manitoba-Saskatchewan border. Soils range from Brown Chernozems in the southcentral region to Dark Brown Chernozems further north. Major species include northern and western wheatgrass, needle-and-thread (*Stipa comata*) and blue grama (*Bouteloua gracilis*). Much of the original wheatgrass-junegrass (*Agropyron-Koeleria*) communities along with portions of porcupine grass and northern wheatgrass (*Stipa-Agropyron*) communities have been converted to cereal and cultivated forage production. Only 6.5 million ha or 31% of the total area remains with native vegetation.

In southcentral Manitoba, there is a small northerly extension of the larger Tallgrass Prairie to the south (Willms and Dormaar, 1993). It is characterized by needle-and-thread and prairie dropseed (*Stipa-Sporobolus*) and bluestem and indiangrass (*Andropogon-Sorghastrum*) communities. Big bluestem (*A. gerardi*) is widespread and comprises 50 to 90% of the vegetation.

#### **THE CANADIAN BEEF INDUSTRY AS IT RELATES TO FORAGES**

Canada's beef industry has close to 4.5 million beef cows and the beef industry accounts for close to 25% of total farm receipts (Statistics Canada, 1996). The prairie provinces of Alberta, Saskatchewan and Manitoba have 78% of the national beef herd, Ontario and Quebec 14%, British Columbia 6% and Atlantic Canada 4% (Table 1). Alberta with its vast rangelands and feed supplies dominates Canada's beef production. Cattle inventories have been shifting from eastern Canada to western Canada.

A large proportion of cattle in western Canada graze on government land managed by federal and provincial government land agencies. Many cattle producers lease government lands for long-term grazing in addition to owning their own land. Governments in western Canada have facilitated community pasture grazing programs where local cattle producers communally graze a limited number of head on a common pasture for a yearly fee. The grazing season for many of these areas traditionally extends from late May to October depending upon location.

Western Canada has 96% of the Canadian rangeland used for beef production, 82% of Canada's cultivated pasture area and 83% of the national beef cow herd (Table 1). From an ecological perspective, the Grassland Biome and Interior Mountain Cordillera are the most important areas for the beef industry in western Canada (Horton, 1994). A strategic challenge facing the Canadian beef cattle industry is how to proactively interact with the increasing number of nonagricultural interests who are also using Canada's grazing lands.

The feedlot industry is mainly located in southern Alberta. Beef producers normally wean their spring-born calves in the fall at 200-250 kg. These calves are then fed throughout the winter on forage-based rations to approximately 400 kg at which time they go onto a high grain finishing ration. Cattle are normally slaughtered at 16-18 months of age and at 550 kg liveweight. Some large Alberta feedlots have a capacity of up to 100,000 head on feed at any one time.

#### **THE CANADIAN DAIRY INDUSTRY AS IT RELATES TO FORAGES**

The Canadian dairy industry has a total of 1.3 million cows and accounts for 13% of total farm cash receipts (Statistics Canada, 1996). Over 70% of Canada's dairy industry is in Quebec and Ontario. Dairy farming generated \$3.9 billion CDN in cash receipts for milk (1995) which is equivalent to 14.5% of total farm cash receipts (Canadian Agricultural Research Council, 1996). Dairy products shipped from processing plants are valued at approximately \$8 billion.

In Canada there are two markets for milk. Fluid milk used as table milk and fresh cream accounts for 40% of the milk produced, while the balance is used for manufacturing of dairy products such as butter, milk powder, cheese, yogurt and ice cream. Production of milk is regulated by a quota system.

In addition to the revenue from milk and dairy products, the industry also generates an estimated \$500 million CDN of farm gate receipts from the sale of slaughter cattle and calves (Canadian Agricultural Research Council, 1996). The genetic merit of Canadian dairy cattle has resulted in vibrant domestic and export market in cattle, semen and embryos, with an annual revenue of about \$200 million CDN. Exports represent 50-60% of total income from semen sales by Canadian-owned organizations.

In 1995, there were approximately 26,000 dairy farms in Canada, 78% were in Quebec and Ontario, 16% in the West and 6% in the Atlantic Provinces (Canadian Agricultural Research Council, 1996). Total milk production from these farms was approximately 70 million hectolitres (Dairy Farmers of Canada, 1995). Although the number of farms has steadily declined in the last 20 years, as has the number of cows, the amount of milk produced has remained fairly stable. The trend is toward fewer and larger farms. The average dairy farm now has 50-60 milking cows and replacement heifers, double the number reported 15 years ago, and the average cow gives almost twice as much milk (5.6 kilolitres) as 25 years ago, due to better feeding, disease control, improved management techniques and genetic advances.

Smaller herds are housed in tie stalls or stanchion barns, while larger herds are housed in free-stall barns with milking parlours (Christensen and Fehr, 1993). Most farms are owned and operated by a single family, while some large operations are incorporated businesses. Pasture may be used to a limited extent during the grazing season, but total confinement and total mixed rations are prevalent.

Rations consist mainly of barley grain and barley silage in western Canada and corn grain, corn silage and alfalfa in Ontario and Quebec.

#### **OTHER LIVESTOCK USERS OF FORAGES**

Canada has a relatively small sheep industry with a total of 436,000 breeding females (Statistics Canada, 1996). Alberta and Ontario produce about one-half of the Canadian production followed by Quebec. The number of sheep farms is increasing due to a greater demand for lamb from the ethnic community and low initial cost of sheep farming compared to other livestock enterprises. The horse industry, another user of forage, has about 350,000 head with one-third centered in Alberta. Most light horses are used for sport and recreational riding, including the quarter horse used for cattle ranching and rodeo events. As well, there are competition jumping horses and thoroughbred and standard-bred race horses. Recently, there has been a renewed interest in heavy draft horses for show-ring competition. In western Canada there is a pharmaceutical industry where estrogen is extracted from pregnant mare's urine (PMU) and used to produce estrogen-containing drugs. Other uses of Canada's forage resource are wildlife rearing on commercial farms. Bison, reindeer, fallow deer (*Dama dama*), red deer and wapiti are the most common species being farmed. These animals are sold internationally for breeding stock, for the production of antler velvet used in oriental medicine, and for game meat production. There is great interest in using pasture to feed these exotic livestock.

#### **CONSERVED FORAGES**

Canadian production of silage, hay and fodder corn is about 43 million tonnes (McQueen and Buchanan-Smith, 1993). In addition to corn and cereal grain silage, grass and legume crops are also used for stored feed. Alfalfa alone or in grass mixtures of timothy, bromegrass and orchardgrass are grown in areas where winter survival, soil and moisture conditions permit. Unfortunately alfalfa will only persist for an average of two to three years where it is not well adapted.

Since livestock are usually fed on stored forage during the winter (late October to early May), most forage is conserved as round bale hay, round bale silage or chopped silage that is stored in horizontal or tower silos. Oats, barley and corn are other primary crops that are ensiled for winter feed. The average annual yield of most forage crops on productive lands is 4 tonnes of dry matter per hectare, while in southern regions of eastern Canada, where heat units

are higher and growing seasons longer, 8-10 tonnes of dry matter per hectare can be obtained from corn, or maize, silage crops.

Weather conditions at harvest time dictate the storage system used by producers. In eastern Canada where frequent rainfall interrupts hay harvesting, round bale and chopped silage systems prevail. Silage is usually harvested at 55-65% moisture. It is ensiled in towers or horizontal bunker silos, in large plastic bags or in individually wrapped or multiple round bales covered with heavy plastic. Hay drying agents and bacterial silage inoculants and enzymes are used by a limited number of producers. Presently, hay harvesting equipment is being designed that can greatly enhance field drying times. These machines involve mechanically shredding the stems to allow faster drying in one to two days. Work is also being done on the development of dryers to remove moisture from baled hay destined for export markets.

Canada has seen significant growth in its double-compressed, or densified hay industry, which now boasts over 300,000 tonnes processing capacity. Hay processing plants exist in several provinces across Canada, but most of the densified hay is currently produced in Alberta. High quality baled hay is typically harvested in conventional small, square bales and then compressed into twice normal density for shipment to foreign markets around the world. Pure timothy hay is the standard for this industry, but alfalfa, alfalfa/timothy, and oat hay may also be compressed. The moisture content of compressed hay is maintained under 14% to control condensation and moulding during transit in shipping containers. Increasingly, the industry is building hay dryers to improve quality by eliminating spoilage.

Over 90% of the compressed hay produced in Canada is exported, mainly to Japan. In 1996, Canada exported over 100,000 tonnes of compressed hay to diverse countries in Asia, Europe and the Americas, with an estimated value of over \$26 million. Another \$10 million of hay was shipped from Canada to the United States in 1996, but most of this hay would be standard density round or square bales.

#### **THE CANADIAN ALFALFA-PROCESSING INDUSTRY**

Canada is the world's largest exporter of alfalfa pellets and next only to the United States as an exporter of alfalfa cubes (Canadian Dehydrators Association, 1996). Canadian farmers value alfalfa in their crop rotations as alfalfa adds nitrogen to the soil and contributes greatly to soil conservation. The

alfalfa industry produces two main products: dehydrated alfalfa pellets and sun-cured alfalfa pellets. Most alfalfa dehydration plants are located in Saskatchewan and Alberta where 85-90% of the production goes into export markets in Asia.

Dehydrated alfalfa pellets (dehy) are processed by drying chopped alfalfa in natural gas dryers. The dried alfalfa is then ground and pelleted. The rapid heating and drying process preserves the nutrients in the alfalfa and reduces the solubility of the protein. This heating process changes approximately 60% of the protein into the bypass form, which leads to more efficient use and digestion of the protein.

Sun-cured alfalfa pellets are produced from alfalfa that has been naturally dried in the field at the late bud to early bloom stage. After field drying, the alfalfa is moved to the plant for final drying and pelleting. Sun-cured alfalfa is dried at a lower temperature and contains less bypass protein than dehy.

The industry also produces the larger alfalfa hay cubes. Cubes retain a longer fibre length and a larger particle size and can be used as the only forage source for cows. Canadian alfalfa cubes offer many advantages over traditional roughage in the long form due to the reduced size for shipping.

In 1994-95, Canada produced 750,000 metric tonnes of alfalfa pellets (Canadian Dehydrators Association, 1996). About 60% is produced in Alberta with Saskatchewan producing most of the remainder. More than 80% of Canadian processed alfalfa products are exported. Japan is the largest market followed by South Korea, Taiwan and the United States. Initially production was mainly dehydrated alfalfa pellets for domestic use and export to Japan. In recent years, cubes and sun-cured pellets have grown in importance. The industry's experience in producing a consistent, high quality product and getting it to market successfully are important factors in the success of this industry.

#### **THE CANADIAN FORAGE SEED INDUSTRY**

The Canadian forage seed industry is based in the northern agriculture areas of Alberta, Saskatchewan and Manitoba and on irrigated areas of central Saskatchewan and Alberta. Most certified forage seed growers grow legume or grass seed in addition to cereal crops. These growers need many years of experience in order to qualify as a certified Canadian Seed Grower. Several major forage seed crops are grown in Canada. Alfalfa is called the 'Queen of the Forages'. It was introduced to Ontario from France in 1871. Both Flemish and Siberian types are grown in Canada. Alfalfa is the primary forage seed crop with

over 20,000 ha grown for certified seed production in 1996 (Canadian Seed Growers Association, 1996). Alfalfa seed production is dependent upon cross-pollination by alfalfa leafcutter bees (*Megachile rotundata*) of Eurasian origin. The seed producer may produce his/her own bees or contract a custom-pollination service. As there is a huge market for leafcutter bees, the income from the sale of bees can be equal to that from the sale of alfalfa seed.

Seed yields of 300-900 kg/ha can be attained under irrigation in the southern prairie regions and 150-300 kg/ha in the nonirrigated regions. In 1994, Canada exported a total of \$7,600,000 CDN or 2,800,000 kg of seed. Ninety percent was shipped to the United States (Statistics Canada, 1995).

Several grass species are of major economic importance to the Canadian seed industry. Timothy was introduced to the eastern United States from seed carried in hay and litter by early European settlers in the early 1700's. It spread from the New England areas of the eastern United States to eastern Canada in the late 1700's. Timothy is a perennial bunchgrass adapted to the cooler, moister areas of Canada. In 1996, 16,600 ha of pedigreed seed were grown in Canada. In 1994, 5,770,000 kg were exported for a value of \$6,600,000 CDN. Forty-five percent was exported to the United States. Major shipments were also made to the Netherlands, United Kingdom, Sweden, Finland and Germany.

Creeping red fescue was introduced to northern Alberta, from Czechoslovakia in 1931. Selections from this introduction resulted in the first Canadian variety being released in 1937. During the early part of World War II, creeping red fescue was used in large quantities as a turf-forming grass for seeding airfield strips. Today it is used extensively for lawns, playgrounds and golf courses. For seed production, the grass is usually grown in solid stands, sown at a rate of 2 kg/ha, harvested by straight cut combining with average yields around 450 kg/ha. The northern area of Alberta is the primary area of production. In 1994, 15,700,000 kg were exported at a value of \$18,600,000 CDN. Eighty five percent is exported to the United States, with other amounts going to United Kingdom, and Netherlands.

Other forage seed crops of export importance are red clover with 4,400,000 kg or \$7,000,000 CDN in export sales, smooth brome grass with 940,000 kg or \$2,500,000 CDN in export sales in 1994. Crested wheatgrass accounted for 3,200 ha of registered seed production in 1996. Meadow brome grass (*Bromus biebersteinii*) and meadow fescue (*Festuca elatior*)

each annually produce about 2,500 ha of pedigree seed. In total, Canada exported 37,000,000 kg of all forage seeds in 1994 for a value of \$54,000,000 CDN (Statistics Canada, 1995).

Today Canada has a vibrant forage seed industry. New varieties of forages are being developed at universities, federal and provincial research centres, and private seed companies. Varieties can be protected by Plant Breeders' Rights legislation or released under contractual agreements, whereby the plant-breeding organization receives royalties on the new releases. Before the new varieties can be registered, they must be tested against known varieties for 3 to 4 years at several locations. After proving their merit, the selections are increased as breeder seed by the plant breeder. This seed is then grown as foundation seed by selected forage seed growers who have been certified growers for at least 7 years by the Canadian seed trade. The fields are inspected each year for purity of stand and freedom from weeds. The seed production from the foundation crop is then planted for production of certified seed, which is then sold to farmers. Common seed, of no specific variety, is also produced and sold in Canada.

With the current interest in the use of native plants, efforts are also being made to collect native plant materials by ecological regions in Canada. These collections are intercrossed with little or no selection and released as "ecovars". Little bluestem (*Andropogon scoparius*), blue grama and prairie junegrass (*Koeleria gracilis*) are examples of species for which ecovars are under development. At present, the primary uses for these ecovars are for reseeding native rangelands and disturbed areas for improved grazing and wildlife habitat.

Canadian forage seed producers are interested in growing seed for international markets for Kentucky bluegrass (*Poa pratensis*), tall fescue, meadow fescue, annual rye grass and perennial rye grass (*Lolium perenne*). The world trade for turf seed production is estimated at over \$2 billion CDN and Canada plans on being part of that trade.

#### WHAT ABOUT THE FUTURE?

The Canadian forage and grazing industry will continue to be an important part of the Canadian economy. It is anticipated that beef and forage production will expand in areas not ideally suited for cultivated grain production especially in the northern areas of the agriculture zone. Canada is placing a great deal of emphasis on protecting all land and water sources for the use by future generations. Cultivated forages and native

grasslands can enhance water quality, improve health and productivity of the land and soil, and increase biological diversity. Forages are a key component of Canada's agricultural sustainability in the future.

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**Table 1**

Estimated area ('000 hectares)\* of Canadian forage resources (ranges, cultivated pasture and forage crops) used for cattle production (beef and dairy cow numbers)\*\* by province and Canadian total.

	B.C.***	Alta.	Sask.	Man.	Ont.	Que.	N.B.	N.S.	P.E.I.	Nfld.	Yuk.	N.W.T.	Canada
Range (ha)	9,521	7,596	6,207	1,918	637	375	33	35	16	14	8	2	26,362
National %	36	29	24	7	2	1	0	0	0	0	0	0	100
Cultivated Pastures (ha)	241	1,742	1,076	341	390	271	25	31	19	5	1	0	4,142
National %	6	42	26	8	9	7	1	1	0	0	0	0	100
Grazing Total (Range + Cultivated Pastures) (ha)	9,762	9,338	7,283	2,259	1,027	646	58	66	35	19	9	2	30,504
National %	32	31	24	7	3	2	0	0	0	0	0	0	100
Forage Crops (Fodder+Seed) (ha)	358	1,857	986	749	1,185	902	66	69	52	5	1	0	6,230
National %	6	30	16	12	19	14	1	1	1	0	0	0	100
Forage Total (Grazing +Crops) (ha)	10,120	11,195	8,269	3,008	2,212	1,548	124	135	87	24	10	2	36,734
National %	28	30	23	8	6	4	0	0	0	0	0	0	100
Beef Cow No's ('000 head)	272	1,865	1,070	550	410	230	23	28	12	1	-	-	4,461
National %	6	42	24	12	9	5	1	1	1	1	-	-	100
Dairy Cow No's ('000 head)	75	102	42	56	426	494	23	28	18	5	--	-	1,267
National %	6	8	3	4	34	39	2	2	1	1	-	-	100

\*Adapted from Horton 1994.

\*\*Statistics Canada 1996.

\*\*\*B.C. = British Columbia; Alta. = Alberta; Sask. = Saskatchewan; Man. = Manitoba; Ont. = Ontario; N.B. = New Brunswick; N.S. = Nova Scotia; P.E.I. = Prince Edward Island; Nfld. = Newfoundland; Yuk. = Yukon; N.W.T. = Northwest Territories