Chapter 4

The Canadian Grain System

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Canada is the second largest wheat exporter, following the United States. The wheat produced is mainly hard red spring, which is high in protein. Canadian wheat has a reputation for being high quality and very uniform.

A number of institutions and institutional relationships influence the quality of Canadian wheat. These include the Canadian Wheat Board (CWB), the Canadian Grain Commission, and the variety release and control procedure. These interrelated influences have a significant impact on the quality of grain exported from Canada. *

*This chapter is based on findings of an OTA study team consisting of Dr. Colin A. Carter, Dr. Andrew Schmitz, Mr. David M. Orr, and Mr. Robert A. Zortman.

OVERVIEW OF PRODUCTION AND MARKETING

Production

Wheat contributes more to farm cash receipts in Canada than any other commodity. Beef is a close second. It is largely for climatic and agronomic reasons that wheat completely dominates the Canadian cereal grain industry. Normally about 29 million hectares are cropped each year in Canada and close to 40 percent of this is sown to wheat. Most of it is grown in the western "prairie" provinces of Alberta, Saskatchewan, and Manitoba (figure 4-1). In contrast, corn production takes place largely in the eastern province of Ontario. Almost all the wheat is grown under dryland conditions, with a very short growing season, The farms are quite large in western Canada (average size per producer is about 275 hectares) and the trend is towards even larger and more mechanized operations. Annual precipitation in the prairie regions ranges from 350 to 550 millimeters. The predominant crop is spring wheat rather than winter wheat. The planting season for spring wheat is in May and the harvesting takes place in late August through early October.

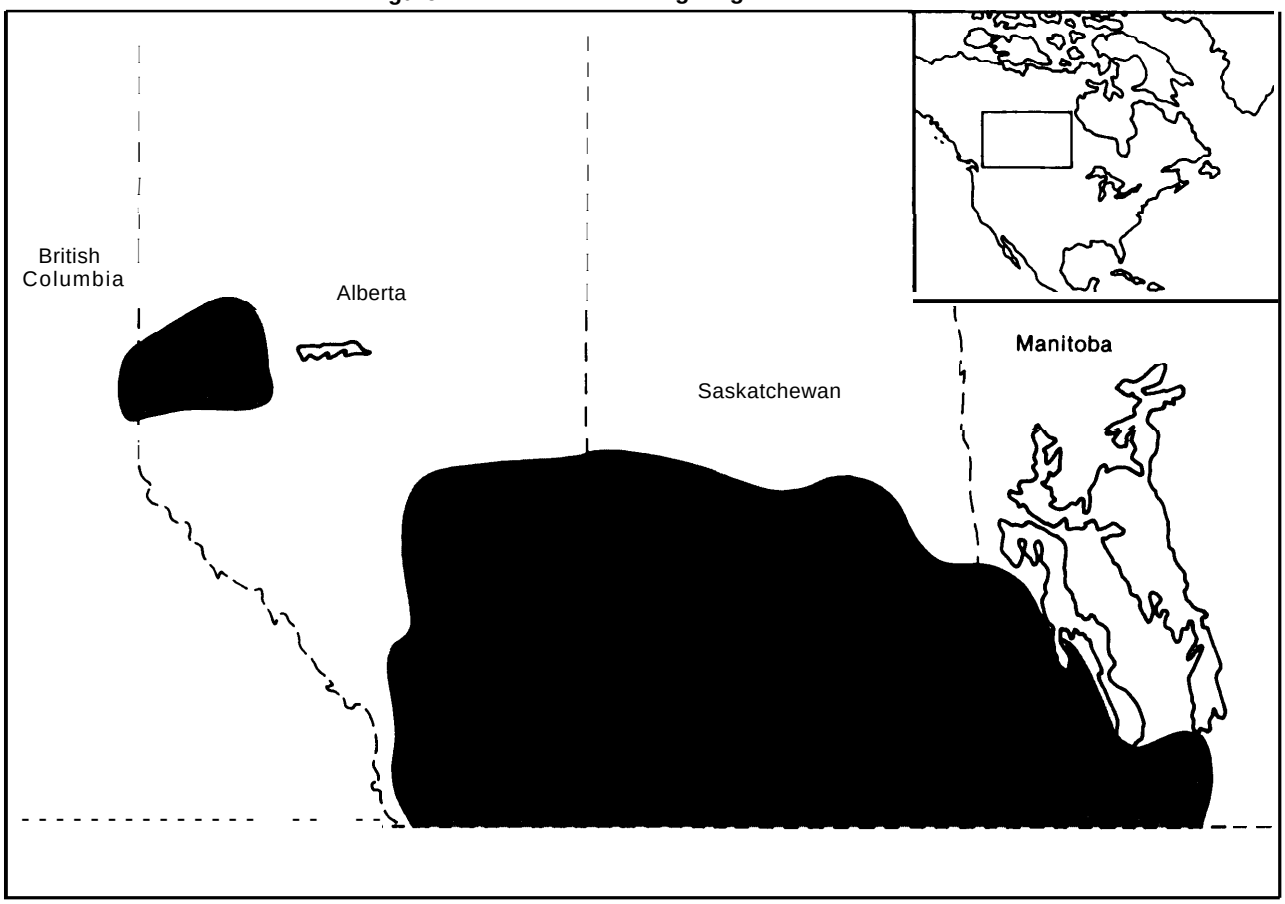
Measured by volume, the major grains/oilseeds produced are wheat, barley, corn, oats, and canola (table 4-1). In terms of value, the order of importance is wheat, canola, barley, and corn. Normally about 75 percent of the wheat, 50 percent of the canola, and 50 percent of the barley is exported.

Western Canada can be divided into four soil zones, which correspond closely to climatic and productions patterns: brown, dark brown, gray wooded, and black (figure 4-2). Low precipitation is the restrictive factor affecting crop production in the brown and dark brown soil zones. The gray wooded zone has a very short frost-free period (often less than 80 days) and low natural soil fertility. The black soil zone is very fertile and it usually receives more precipitation than the other soil zones (average 4100+ millimeters). Its frost-free period may exceed 100 days. The wheat yields in the black soil zone are generally higher and less variable than in other areas of western Canada. But the protein content of this wheat is typically low (figure A-3) compared with the wheats grown in the brown and dark brown soil zones. Protein content is important to the producer since it is a factor in the grading of No. 1 and No, 2 Canadian Western Red Spring (CWRS) wheat.

Normally Saskatchewan produces over 60 percent of the wheat in western Canada. The province of Alberta produces around 23 percent and Manitoba, approximately 15 percent. The yields in Manitoba and Alberta average about 2 metric tons per hectare (MT/ha), while in Saskatchewan the wheat yields average 1.8 MT/ha.

About 85 percent of Canada's production is Hard Red Spring wheat, which is high in both protein content and baking strength, both

Figure 4-1.—Wheat-Growing Regions of Canada



• Each dot represent 500,000 metric tons.

SOURCE: Adapted from U.S. Department of Agriculture, *Major World Crop Areas and Climatic Profiles,* Agriculture Handbook 664, 1987.

desirable characteristics for pan bread. In contrast, the dominant wheat in the United States is Hard Red Winter and in Australia, white wheat. Four major classes of wheat are grown in Canada: Hard Red Spring (HRS), Red Winter (HRW), Soft White Spring, and Amber Durum. The red spring wheats are used around the world to blend with softer, weaker wheats (from other countries) for bread flour. All-purpose flour for rolls, cakes, and muffins is milled from the red winter wheat and the soft white wheat. Durum wheat, some 10 percent of production, is used for pasta products.

It is worth noting that production has increased considerably over the last 15 years, from 9 to 24 million metric tons (MMT). Much of the increase is due to increased area rather than to yield improvements. There are year-to-year yield fluctuations in each exporting region but, on average, Canadian wheat yields have not increased significantly since the early 1970s (figure 4-4). This is in sharp contrast to the case in the United States and the European Community (EC). To statistically measure the growth of wheat yields in each major exporting region, yield was regressed on time for the 1970-84 period. According to the estimated equations, the growth of yields in Canada and Australia is not statistically different from zero. Alternatively, yields in the EC have grown annually by 121 kilograms per hectare (kg/ha). U.S.

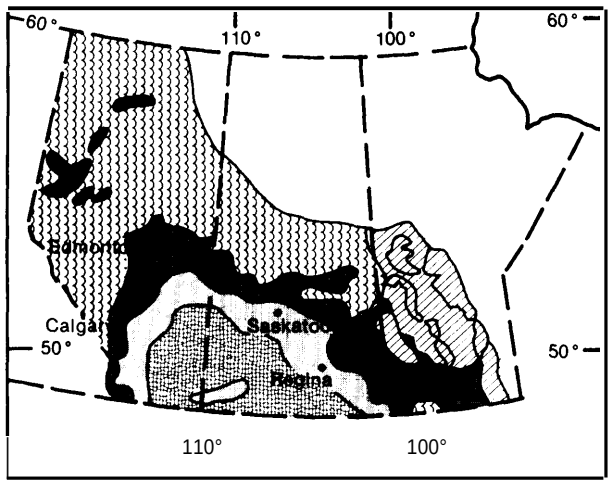
Table 4-1.—Canadian Grain Production and Exports (thousand metric ton)

Grain crop	Crop year (August 1 through July 31) 1982183	1983184	1984/85	Average 1985/86	1986/87	(1982 to 1987)
Wheat:						
Production	26,736	26,505	21,199	24,252	31,850	26,108
Exports	21,367	21,765	17,583	17,714	20,352	19,756
Oats:						
Production	3,637	2,773	2,670	2,997	3,658	3,147
Exports	105	122	18	44	250	108
Barley:						
Production	13,965	10,209	10,296	12,443	**15,030**	12,389
Exports	5,648	5,536	2,781	3,794	**6,528**	4,857
Rye:						
Production	933	828	664	598	658	736
Exports	314	747	376	277	166	376
Flaxseed:						
Production	752	444	694	902	1,057	770
Exports	430	621	560	623	660	579
Rapeseed/Canola:						
Production	2,225	2,609	3,428	3,508	3,949	**3,144**
Exports	1,271	1,498	1,456	1,456	2,126	**1,561**
Corn:						
Production	6,513	5,933	7,024	7,472	6,665	6,721
Exports	(248)	203	(42)	118	N/A	8
Soybeans:						
Production	848	735	944	1,048	**988**	913
Exports	(302)	(219)	(104)	(2)	N/A	(1 5 6)

NOTE: The data for 1988/87 are preliminary.

SOURCE: Canada Grains Council, *Statistical Handbook* '66(Winnipeg, MB: 1986); Canadian Grain Commission, *Canadian* Grain *Exports1986/87* (Winnipeg, MB: 1987)

Figure 4.2.—Soil Zones of Western Canada



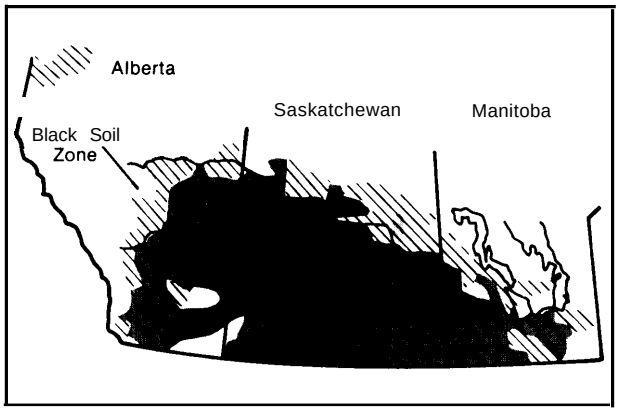
■ Black and tranistional soil zone ❑ Gray wooded soil zone

❑ High lime soil zone ❑ Black soil zone

☐ Dark brown soil zone ▨ Brown soil zone

SOURCE: L.E. Evans, "Spring Wheat Production in the Black and Gray Soil Zones of Western Canada," *Wheat Production in Canada: A Review,* A.E. Slinkard and D.B. Fowler (eds.) (Saskatchewan: University of Saskatchewan Extension Division).

Figure 4-3.—Protein Content of Wheat in Western Canada

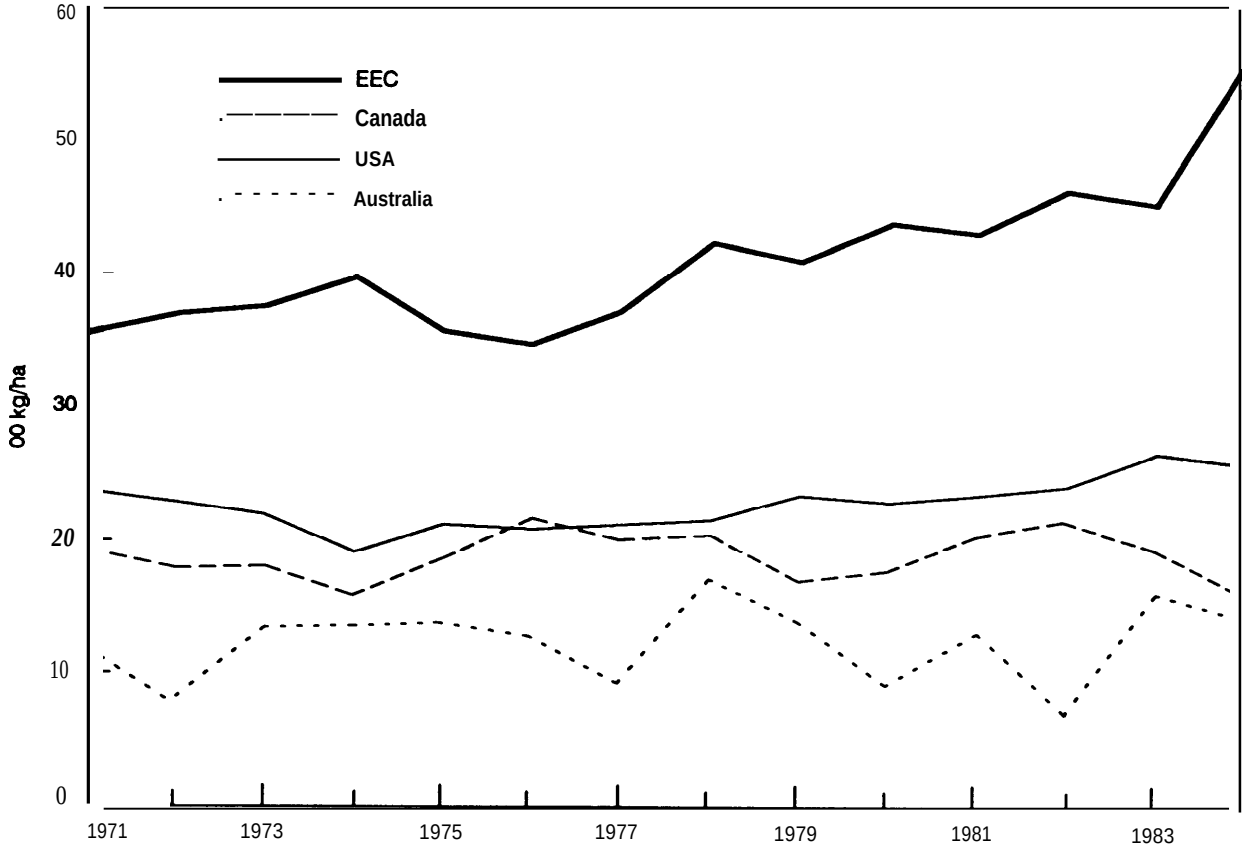


Protein content

❑ under 120/0 ❑ 12.0- 12.9% ❑ 13.0 - 13.9%,
■ 14.0-14.9% ■ over 14.9%

SOURCE: L.E. Evans, "Spring Wheat Production in the Black and Gray Soil Zones of Western Canada," *Wheat Production in Canada: A Review.* **A.E Slinkard and D.B. Fowler (eds.) (Saskatchewan: University of Saskatchewan Extension Division),**

Figure 44.-Wheat Yields of Major Exporting Countries



SOURCE: International Wheat Council, 1987.

yields have grown by 37 kg/ha per year. This converts to an annual growth rate of about half a bushel per acre in the United States.

Production Technologies

The area planted to wheat and wheat yields are less in Canada than in the United States. Over the 1972-85 period the Canadian area planted to wheat averaged 11,110 hectares annually, while the U.S. area averaged 26,467 hectares (table 4-2). During the same period Canadian wheat yields averaged 1.8 MT/ha, compared with 2.2 MT/ha in the United States. However, variability in wheat area and yield is larger in the United States than in Canada.

The higher yield in the United States is due to climatic conditions, varieties grown, and fertilizer usage. The winter varieties grown there normally receive more rainfall than the spring varieties grown in Canada. Only 20 to 25 percent of U.S. acreage is sown to the lower yielding spring varieties, compared with more than 95 percent of the acreage in Canada. In addition, the varieties grown in the United States are generally "semidwarf or short-straw types. Many of these have higher yields than the taller wheats, but Canadian regulations prevent the growing of most semidwarf varieties. It has been estimated that Canadian wheat yields would improve significantly if semidwarf varieties were permitted (5). In the past few years a selected small number of semidwarf varieties have been licensed in Canada, which should contribute to higher average yields in the future.

It is difficult to obtain data on crop-specific fertilizer application. However, it is generally true that Canadian farmers apply less fertilizer to wheat land than U.S. farmers do. During the 1984/85 season, sales in western Canada included 891,050 MT of nitrogen and 456,865 MT of phosphate fertilizers.

As the use of phosphate fertilizer is relatively constant from crop to crop, the application to wheat can be approximated by dividing total phosphate sales by total cropped acreage. This works out to about 17 kg/ha (15.5 pounds (lbs)/acre), which is only about half the rate recommended by Agriculture Canada. Nitrogen application varies substantially by crop because of the large amount of fallowing on the Canadian prairies. Agriculture Canada recommends that approximately 60 lbs of nitrogen be applied in Canada but on stubble land only 410 to 45 lbs are actually applied. Its application on summerfallow is highly variable. In the 1984/85 season, 891,050 MT of nitrogen were sold in western

Table 4-2.—U.S. and Canadian Wheat Area and Yields

	United States		Canada	
Year	Area (1,000 ha)	Yield (100 kg/ha)	Area (1,000 ha)	Yield (100 kg/ha)
1972	19,142	22.0	8,640	16.8
1973	21,913	21.3	9,430	17.1
1974	26,453	18.4	8,934	14.9
1975	28,125	20.6	9,474	18.0
1976	28,703	20.4	11,252	21.0
1977	26,986	20.6	10,114	19.6
1978	22,862	21.1	10,584	20.0
1979	25,274	21.3	10,488	16.4
1980	28,783	21.3	11,098	17.3
1981	32,634	22.5	12,427	19.9
1982	31,539	23.5	12,554	21.2
1983	24,843	24.3	13,697	19.4
1984	27,085	23.3	13,158	16.1
1985	26,196	23.0	13,688	17.4
14-year average	26,467.0	21.7	11,109.9	18.2
14-year standard deviation	9,337.2	7.3	3,995.0	6.3
Coefficient of variation	2.83	2.97	2.78	2.89

SOURCE" International Wheat Council, world *Wheat Statistics* **(various annual issues).**

Canada. The average application was therefore about 34 kg/ha (30.3 lbs/acre). The application of fertilizer in the United States is much closer to the recommended rates. Although difficult to measure, it appears that Canadian wheat farmers use about 75 percent as much fertilizer as U.S. farmers do.

A major difference in cropping practices between Canada and the United States is the practice of summer-fallowing in Canada. Fallowing is conducted to preserve soil moisture and control weeds. Although beneficial to the soil, this practice has been recognized as seriously affecting the future productive capacity of Canadian prairie lands (11). The area fallowed ranges from 20 to 25 percent of total arable land in the prairie provinces. The area in summerfallow has been gradually reduced over the past 25 years. A large increase in 1970 can be attributed to the Lower Inventories for Tomorrow (LIFT) Program, which paid farmers to set aside acres. An increase in 1987 from 20.5 to 21.3 million acres was due to the dry conditions on the prairies and the poor financial returns from crop production. Despite pressures to change, fallowed acreage is unlikely to decline much further in the foreseeable future.

Although herbicide application rates vary from region to region, the rates in Canada are similar to those in the United States. Of course, summer-fallowing in Canada reduces the need for herbicide, and therefore some Canadian farmers use very little chemical weed control. The chemical licensing laws differ between the United States and Canada, and from time to time products are available in one country but not the other, Avadex, Banvel, Brominal, Hoe-Grass, MCPA, and 24-I) are the most common chemicals used to control weeds in wheat. Ninety-five percent of the wheat acreage was treated in 1984. Since wheat production is more intensive in Manitoba than in Saskatchewan, however, this 95-percent treatment rate does not apply across the entire prairie region.

A large percentage of the Canadian wheat crop is swathed before it is harvested. This practice is more common in Canada because of the cool climatic conditions that normally prevail during the harvest there. Swathing the wheat results in a more rapid ripening and drying of the grain. According to the 1981 Census, virtually every farm in western Canada had a swather that year. The self-propelled swather is by far the most popular. The same census indicated there were about 125,000 grain combines in western Canada, and that 71 percent were self-propelled.

As indicated later in this chapter, Canada tends to store a larger percentage of its wheat crop than the United States does. Table 4-3 provides a breakdown of where these stocks are held. On average, during 1976 to 1987,35 percent of the stocks were held on-farm. Most farms have small bins that hold from 1,500 to 5,000 bushels. These bins are generally assembled from rolled steel sheets and they have ei-

Table 4-3.-Canadian Wheat Stocks at July 31 (thousand metric ton)

Year	On-farm		Primary elevators		Interior terminals		Transfer elevators and Export terminals		Stocks
1976	1,580	(20%)	2,896	(35°/0)	6	(0.07%)	2,586	(32°/0)	8,044
1977	7,166	(54%)	2,538	(19°/0)	7	(0.05%)	2,517	(19%)	13,324
1978	5,280	(44%)	4,019	(33%)	19	(0.16°/0)	1,747	(14%)	12,105
1979	9,117	(61 %)	3542	(24%)	6	(0.04 %)	1,542	(10%)	15,015
1980	4,218	(40%)		(34%)	9	(0.08%)	1,749	(16%)	10,604
1981	1,483	(18°/0)	3,598	(43%)	4	(0.05%)	2,159	(26°/0)	8,315
1982	3,605	(38%)	3,605	(38%)	46	(0.48%)	2,139	(22%)	9,549
1983	2,125	(21 %)	4,134	(420/o)	9	(0.09%)	2,328	(240/o)	9,913
1984	1,940	(19%)	3,247	(36%)	3	(0.03%0)	2,687	(30%0)	8,962
1985	970	(14%)	1,577	(23%)	2	(0.03%)	3,609	(520/o)	6,972
1986	700	(90%)		(43%)	27	(0.34%)	2,966	(380/o)	7,884
1987	4,797	(420/o)	2,694	(24%)	5	(0.04%)	2,880	(260/o)	11,288
12-year average	3,565	(350/0)	3,236	(32%)	12	(0.12%)	2,409	(240/o)	10,164

NOTE: Parentheses report percentage of total wheat stocks.

SOURCE: Canadian Grains Council, *Statistical Annual* (various annual issues).

ther cement or wooden floors. The cold prairie winters facilitate wheat storage as there are few insect or rodent problems.

Both heated and unheated drying are used on prairie farms. The trend in recent years has been toward unheated air drying on individual bins (i.e., aeration drying). But heated drying is still very common in the northern parts of the wheat belt. The 1986 Census conducted by Statistics Canada reported a total of 15,973 grain dryers in the three western prairie provinces. Table &I reports the energy sources used to dry wheat on prairie farms in 1981. A total of 464,000 MT were was dried on the prairies that year, most commonly by propane. Fourteen percent of the drying in Alberta was done with natural gas, which is readily available in that province. Electricity is also an important energy source, especially in Saskatchewan.

Domestic Utilization

The domestic market absorbs about one-fourth of all Canadian wheat sales in any given year, with the remainder being exported. Ninety-five percent of Canadian wheat originates in western Canada, and prairie farmers depend much less on the domestic market than eastern Canadian wheat farmers do.

On average, about 10 percent of Canadian production is milled at home, 10 percent is sold domestically as feed, and 5 percent is used locally as seed. The market for domestic milling wheat has limited growth potential because the

Table 4-4.—Energy Sources for Drying Wheat on Prairie Farms, 1981

	Province		
Principal heat source	Manitoba	Saskatchewan	Alberta
Fuel oil	—	1%	—
LPG	83%	57%	77%
Natural gas	—	—	14%
Solar	3%	—	—
Electricity	14°/0	270/o	90/0
Forced air	—	15%	—
Other fuels	—	—	—
Amount dried (thousand metric tons)	176	221	67

SOURCE: Statistics Canada, *Agricultural Census* **(Ottawa: 1981).**

demand for flour and semolina has leveled off in Canada and exports of flour have fallen dramatically. Average flour exports over the lg77-81 period were 1.1 MMT, declining to an average of only 0.494 MMT over 1981-85. Canada has lost market share in the international flour market largely because of an increase in subsidized sales from the EC and the United States.

The per capita consumption of wheat (for human food) in Canada stands at about 80 kg per year compared with 75 kg in the United States and 96 kg in the EC. Per capita consumption is gradually declining, but a very slow rate of population growth offsets this to maintain total consumption at a relatively constant level.

About 9.5 percent of the wheat produced on the prairies is milled in Canada (table 4-5). In comparison, over 28 percent of Ontario's wheat is milled domestically. More important, Ontario's share of this domestic milling market is increasing. Four reasons for the change can be cited: Ontario's proximity to the large mills and the population in eastern Canada; its production of soft white wheats, which are preferred for pastry flour; its increasing production of HRS wheats, which can be blended into bread flour grists; and the millers' preference for an alternative supply source to avoid dependence on the monopolistic CWB (which can price western wheat up to $11 per bushel under the revised 1986/87 two-price system). Given that Ontario wheat is becoming more and more acceptable to millers, the production of wheat has increased at a much faster rate there than in the rest of Canada. Acreage in Ontario has almost doubled in the past 10 years, although it exhibits considerable year-to-year variability. In the future, the production of wheat outside of the CWB designated area may continue to increase, particularly if the CWB continues to discriminate by charging more for domestic than for export sales.

The production of hard spring wheat has also become a factor in eastern Canada. Data on spring versus winter acreage are not readily available, but there is every indication that spring wheat production is on the increase in Ontario. About 30,000 acres of spring wheat

Table 4-5.—Canadian Domestic Wheat Milling, 1980181 to 1984185 Averages (thousand metric tons)

Class	Annual wheat production	Annual milling			Milling as percent of production
		Total	For exportation	For domestic use	
CWRS	19,836	1,927	487	1,440	9.7
Durum	2,568	125	37	88	4.9
CWS White	560	127	—	127	22.7
CWR Winter	338	37	—	37	10.9
Total Prairie	23,302	2,216	524	1,692	9.5
Ontario Winter	669	190	17	173	28.4
Total	23,971	2,406	541	1,865	10.0

SOURCE: Statistics Canada, unpublished data.

are now grown in Ontario. This is less than half the acreage in Quebec and about the same as in the Maritime provinces (8) If the two-price system (discussed in more detail later) is left unchanged, eastern Canada may capture 50 percent or more of the domestic milling market, provided the hard wheat produced there proves to be of suitable quality. As of December 1987, the two-price system was still operating, although the Government has indicated it will most likely be eliminated in the future. This announcement was probably brought on by large production increases of milling wheat in eastern Canada, which is outside of the CWB's jurisdiction. It gave no details as to how or when the price discrimination system would be eliminated, but the Government indicated that western farmers would be compensated for losses resulting from the elimination of the two price-policy.

Unlike milling wheat, most of the feed wheat consumed on the prairies is either handled outside the licensed elevator system or used on-farm. However, the subsidized freight rate structure encourages the movement of feed grains off the prairies. Demand for wheat for animal feed in western Canada remains fairly constant, at 2 to 2.5 MMT per annum, and shows little response to price changes. The feeding of wheat in the United States is much more responsive to market conditions, with the price of wheat relative to corn acting as a major determinant of feed wheat usage. In 1983-84, for example, the use of wheat as livestock feed nearly doubled in the United States as the relative price of corn rose dramatically. It remained high in the United States in 1984-85, at approximately 11.2 MMT (35 percent of total use), but then declined to 7.7 MMT in 1985/86.

As a percentage of total use, domestic feed usage is normally higher in Canada (about 40 percent of total domestic use) than in the United States. In Canada, the share of wheat in total domestic feed grains is also relatively high, at around 12 percent per annum. For the United States this figure averages only 4 to 5 percent. The feed market offers the most potential for increased wheat demand in Canada, but given the relatively high feeding rates for wheat now and the introduction of higher yielding dwarf barley varieties, the volume of wheat used for feed is not expected to increase dramatically. Sales of feed wheat from the prairies to eastern Canada have been falling off because of increased corn production in Ontario and Quebec. A significant shift in the location of livestock production in response to changes in transportation rates on grains would alter this situation, but this is not likely to occur.

The domestic feed grain market has been analyzed in depth by the Canada Grains Council (3). The three major markets for prairie feed grains they studied are the feed market in western Canada, the feed market in eastern Canada, and the export market. From 1974 to 1983 the feed market in western Canada showed no signs of growth, the demand from the eastern Canadian market declined, and the export market grew slowly.

Although wheat stocks fluctuate considerably from year to year, they averaged close to 13 MMT from 1960 to 1986, about 80 percent of production. The stocks-to-production ratio

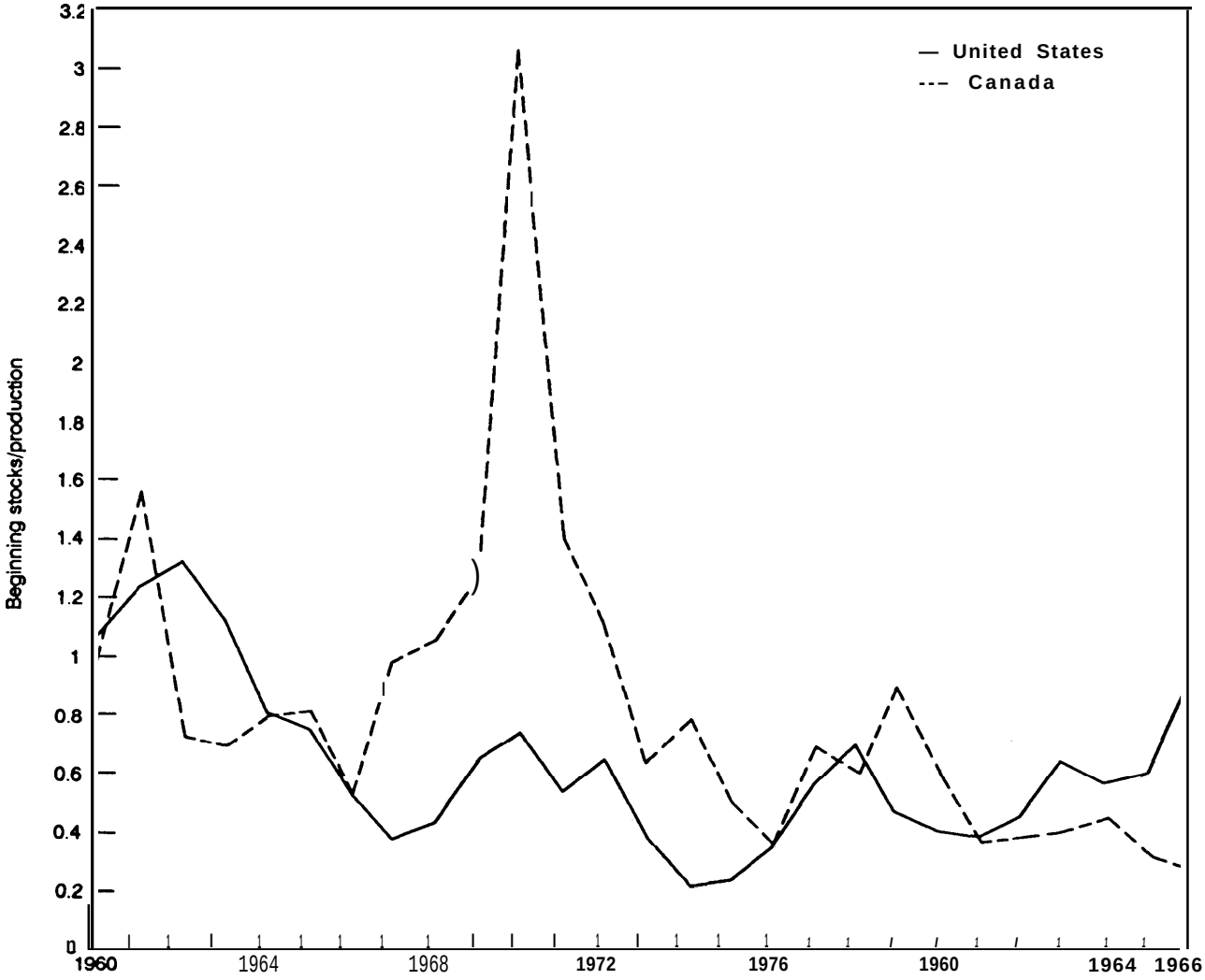
in Canada is higher than in the United States, where the ratio was 60 percent of production over this period (figure 4-5). Furthermore, Canadian stocks are largely held by farmers (or farmer-owned grain cooperatives), while in the United States the government carries a large amount of stocks.

International Trade

Canada has historically been the second largest exporter of wheat, with a market share ranging between 18 and 26 percent over the past 15 years. The other major exporters are the United States, the European Economic Community, Australia, and Argentina. The United States and Canada account for over 60 percent of the wheat trade.

Several different categories of wheat are traded internationally, but Canada specializes in high-quality and Durum wheats. Canada's ability to compete in the international market is enhanced by the fact that it offers a high-

Figure 4-5. —Wheat Stocks/Production Ratio, United States and Canada



SOURCE: Office of Technology Assessment, 1989

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quality, uniform product. High-quality wheats (No. 1 and No. 2 CWRS) represent over half of Canada exports, whereas medium-quality wheats account for almost two-thirds of U.S. exports. No. 1 CWRS is by far the dominant grade exported—accounting for 45 percent of exports on average (table 4-6). The major importers of these high-quality wheats are, in order of consumption, the U. S. S. R., China, Japan, Brazil, and the United Kingdom (UK) (table 4-7).

The high-quality wheat market is growing very slowly compared to the medium-quality market. Improvements in baking techniques worldwide permit flour of lower protein content to be used without sacrificing bread quality, which in turn reduces the need for high-quality Canadian wheat in blends.

Global trade in wheat increased from 54 MMT in 1970 to over 100 MMT in 1985. Large gains were made in the 1970s, when the grain trade grew approximately twice as fast as world production. Canada's wheat exports grew by about 30 percent. There was also an important distributional shift in the pattern of the world wheat trade. Wheat imports by industrial countries stagnated, and the centrally planned economies increased their purchases dramatically (table ***4-8).*** The CWB established a firm position in this market, and it now exports more than half its wheat to centrally planned economies.

During the l970s, Canada sold about 20 percent of its wheat to Western Europe, but this declined to 10 percent in the early 1980s as sales decreased to the UK. Sales to Japan as a percentage of total Canadian exports are also less important. The markets in Eastern Europe, the U. S. S. R., and Latin America have increased in importance. The sales strategies of the CWB

Table 4=6.-Canadian Wheat Exports by Grade, 1981182 to 1986187

Grades	Year						Average
	1981182	1982/83	1983/84	1984/85	1985/86	1986/87	1981-1986
No. 1 CWRS	54.2	46.0	45.3	63.5	38.6	22.7	45.1
No. 2 CWRS	12.5	13.1	13,0	4.8	15.7	13.2	12.0
No. 3 CWRS	12.7	15.9	17.9	11.4	21.4	27.6	17.8
Durum	12.9	12.8	12.0	10.7	8.0	9.6	11.0
Feed	1.0	3.0	0.6	1.0	8.3	19.8	5 . 6
Others	6.7	9.2	11.2	8.6	8.0	7.1	8.5

SOURCE: Canadian Grain Commission, Exports *of Canadian Grain* *and Wheat* ***Flour*** **(various issues).**

Table 4.7.–Share of Canadian Wheat Exports by Country, 1970171 to 1985186

Crop year	Brazil	China	Egypt	India	Italy	Japan	United Kingdom	U.S.S.R.	West Germany	Others
					(percent)					
1970/71	2.9	**20.3**	4.1	6.0	2.8	8.6	13.4	4.2	3.4	34.3
1971/72	2.6	**20.8**	0.6	4.5	3.7	10,1	**10.3**	19.4	1.7	26.3
1972173	2.3	**28.0**	**0.2**	2.8	2,3	8.7	**8.0**	26.7	1.6	19.4
1973/74	6.8	**11.8**		**3,0**	5.9	14.4	**10.2**	13.6	2.8	31.5
1974/75	8.8	**21.2**		**4.5**	5.2	10.6	**14.4**	2.8	0.8	31.7
1975176	4.3	**9.9**		**3.9**	5.6	13.2	**10.0**	26.0	1.0	26.1
1976177	7.6	**14,9**	1.7	**1.1**	3.9	10.2	**10.2**	9.3	2.6	38.5
1977/78	5.4	**20.9**	3.4	-	5.9	8.5	10.1	10.6	0.4	34.8
1978/79	7.8	**23.5**	1.2	····	3.0	9.1	9.8	14.0	0.1	30.7
1979/80	6.9	**17.6**	**0.2**		4.6	8.6	9.2	13.7	-	39.2
1980/81	8.3	**16.9**	**0.1**	**0.2**	5.1	8.5	7.8	25.5		27.7
1961/82	7.3	**17.3**	**1.8**	**0.5**	2.9	7.6	7.6	28.0	0.1	27.1
1982183	7.2	**21.1**	**0.1**		3.0	6.4	5.3	33.2		23.7
1983/84	6.4	**16.1**	**3.1**	**2.4**	3.5	6.2	4.5	31.8	**0.1**	25.9
1984185	6.7	**16.3**	**2.6**	···	1.3	7.7	3.7	35.3	···	26.4
1985/86	5.7	**14.8**	**2.7**	···	2.1	7.3	**4.0**	30.1	···	33.3

SOURCES: 1970/71 to 1980/81 from Canada Grains **Council,*Wheat*** **Grades** *for* ***Canada*** **(Winnipeg, MB); 1981/82 to 1984/85 from Canadian Wheat Board, *Annual Report,*** *1964/85.*

Table 4-8.—Global Wheat Imports by Region, Selected Years (million tons)

Year	Developed countries		Centrally planned countries		Developing countries		Total
1969/70	14.6	(290/o)	12.4	(24%)	23.7	(47%)	50.7
1974/75	11.8	(19%)	14.1	(22%)	37.5	(59%)	63.4
1979/80	13.8	(16°/0)	28.2	(33%)	44.0	(51 %)	86.0
1984185	12.2	(12%)	39.5	(380/o)	52.7	(50°/0)	104.4

SOURCE: International Wheat Council, World Wheat Statist/cs, 1986.

have also changed over the last 15 years. In the 1960s, most Canadian wheat sales were made to multinational grain companies that in turn sold to an importer. In the 1970s the CWB began dealing directly with importers. This of course was facilitated by growing importance of the centrally planned economies in the market and their use of state trading agencies to import grains. The multinational companies now only play a limited role in marketing Canadian wheat; the CWB deals directly with customers in most cases.

Although international trade in feed wheat is relatively small, Canada is a major exporter, as is the EC and Australia. The U.S.S.R. is the largest user of feed wheat in the world and in 1986/87 about 25 percent of its wheat imports (approximately 4 MMT) was of feed quality. This was supplied primarily by Canada and the EC.

In the early 1970s Canadian exports of flour were about 5 percent of wheat exports, and this has since fallen to less than 2.5 percent. In wheat equivalents, flour exports fell from 700,000 to 4150,000 MT over the last 15 years. Commercial markets for Canadian flour (e.g., the UK) have disappeared, and almost all of Canada's flour exports are now in the form of food aid shipments.

Prices

Wheat prices rose dramatically in the 1973/74 crop year (table 4-9). They dropped somewhat during the mid and late 1970s, rose again in 1981, but since then have continued to decline. A key factor in the downward trend is increased yields. In the 1960s yields grew by approximately 2.5 percent per annum, then slowed to an average of 2.2 percent per annum in the 1970s. Growth in the 1980s has averaged 3.6 percent thus far, largely because of achievements in China, India, and Argentina. Yields have also noticeably improved in the EC and the United States. This upward trend can be expected to continue while input prices remain relatively stable.

Table 4-9.–Average Export Prices of Wheat, 1970-84
(measured in dollars per metric ton)

Year	Argentina	Australia	Canada	France	United States
1970	54.69	54.90	61.30	75.93	58.02
1971	59.81	53.43	64.01	91.44	61.94
1972	66.78	58.14	67.09	89.80	64.25
1973	92.16	65.85	98.94	127.80	108.10
1974	176.69	148.74	205.95	149.64	176.53
1975	171.03	187.31	177.79	148.29	166.70
1976	136.78	153.73	163.99	154.38	146.21
1977	96.09	125.20	119.45	177.77	113.30
1978	108.31	104.17	116.23	203.23	127.13
1979	141.63	132.22	159.18	203.91	157.71
1980	170.04	163.01	182.21	213.41	178.31
1981	184.94	190.29	200.65	183.88	178.64
1982	177.91	174.14	180.98	165.04	164.74
1983	144.76	156.92	172.84	153.67	162.10
1984	133.22	156.13	172.97	153.65	153.33

SOURCE: 1970-S0 from Canada Grains Council, *Wheat Grades for Canada: Maintaining Excellence* (Winnipeg, MB: 19S5); 19S1-84 from U.N. Food and Agriculture Organization, *Trade Yearbook,* 1982 and 19S4 (Rome).

Table 4-10.-Wheat Import Prices by Class, Basis C and F Japan, 1970171 to 1984185 (dollars per tonne)

	Australian Standard White	No. 1 CWRS 13.50/0	U.S. No. 2 Dark North Spring 140/0	U.S. No. 2 Hard Winter 13 "/0	U.S. No. 2 Hard Winter Ordinary	U.S. No. 2 Western White
1970/71	68	76	73	73	68	69
1971/72	64	72	70	69	65	65
1972173	83	105	98	100	99	99
1973/74	180	224	213	220	223	215
1974/75	183	223	215	206	192	187
1975/76	159	204	200	185	168	162
1976/77	126	154	148	140	128	125
1977/78,	127	146	138	131	125	132
1978/79	161	179	168	166	154	159
1979/80	204	234	220	216	207	194
1980/81	216	264	243	230	220	201
1981/82	202	234	215	213	203	191
1982/83	196	225	211	215	201	202
1983184	187	227	213	212	189	182
1984/85	174	212	196	188	177	167

SOURCE: 1970171 to 1980181 from Canada Grains Council, *Wheat Grades for Canada*; 1981/82 to 1983-84 from international Wheat Council, *World Wheat Statistics*, 1985; 1984/85 from International Wheat Council, *Review of World Wheat Situation*, 1984/85.

Table 4-10 shows that import prices for premium Canadian wheat (No. ICWRS 13.5 percent) dropped approximately 20 percent, from ***$264*** to ***$212*** per metric ton between 1980/81 and 1984/85, with prices for other classes of wheat showing similar declines. The premium received for CWRS wheat has held its own, while the discount on U.S. HRW wheat has increased (table 4-11). This seems contrary to the conventional wisdom of the early 1980s that the spread between Canadian and U.S. wheat was narrowing (2). The Canadian price premium spiked up in 1974, 1976, and 1981, when there were temporary shortages of high-protein wheat. But another reason the Canadian CWRS wheat price appears to have been maintained is that the quality (with uniformity as the key factor) of U.S. wheat has declined in the eyes of some importers. This has allowed the CWB to continue to charge a premium for the reputation Canada has developed for selling wheat of uniform, predictable quality.

Table 4-11.—Annual Price Indices, Major Wheat Exporters, 1970=84 (dollars per metric ton)

Year	Argentina	Australia	Canada	United States
1970	89.5	89.8	100.3	94.9
1971	94.2	84.2	100.9	97.6
1972	99.9	87.0	100.3	96.1
1973	89.0	63,6	95.5	104.4
1974	101.3	85.3	118.1	101.2
1975	100.0	109.5	104.0	97.5
1976	89.5	100.6	107.3	95.7
1977	80.1	104,3	99.5	94.4
1978	86.9	83.6	93.3	102.0
1979	89.0	83.1	100.1	99.1
1980	94.4	90.5	101.2	99.0
1981	98.6	101.5	107.0	95.3
1982	92.7	90.8	94.3	85.9
1983	78.7	85.4	94.0	88.2
1984	75.1	88.0	97.5	86.5

SOURCES: 1970-80 from Canada Grains Council, *Wheat Grades for Canada;* updated data from U.N. Food and Agriculture Organization, Rome.

THE CANADIAN WHEAT BOARD

The Canadian Wheat Board is the sole marketing agency for wheat, oats, and barley grown in Canada and destined for export or domestic human consumption. The CWB may also market these grains in domestic feed grain markets when additional supplies are required, but producer sales to the domestic feed grain market, handled by the private trade, are usually adequate for this market.

Historical Background and Current Objectives

The CWB, established as a Crown Agency by the Canadian Wheat Board Act of 1935, was preceded by two earlier Federal Government marketing boards. Those were set up to market wheat during World War I. During World War 11, the CWB was empowered to market all

Canadian grains, but following the war it returned to marketing wheat only. Prior to 1966, the CWB's statutory authority had to be renewed every 5 years. In 1966 this requirement was dropped, however, and the Canadian Wheat Board Act became permanent legislation. In 197A the sale of western grains for use in animal feeds within Canada was removed from the CWB's jurisdiction and returned to the private trade. The CWB is the residual supplier in the domestic feed grain market.

The Canadian Wheat Board Act gives the CWB three major responsibilities:

- to market wheat grown in western Canada to the best advantage of grain producers,
- to provide price stability to producers through an annual "pooling" or price-averaging system, and
- to ensure that each producer obtains a fair share of the available grain market.

The CWB is a government agency and it is basically a sales agency as it owns no physical facilities for the handling of grain. It employs the services of both private and cooperative elevator companies to carry out the logistics of physically handling the grain. Even though it is a government agency, the CWB's responsibility is to bring the highest possible returns to producers and give them equitable access to the export market. Consumer welfare is not an overriding concern of the Board.

The CWB is the world's largest single grain marketing agency. It has three to five commissioners, who are appointed by the Government. They have a staff of about 525. The commissioners periodically seek advice from an advisory committee elected by farmers, but the advisory group has no real control over the commissioners. Unlike the Australian Wheat Board (see ch. 5), the Canadian Board is not directly responsible to producers. It answers to the Federal Government.

Most of the wheat produced in western Canada is marketed through the CWB since it has monopoly rights over all wheat exports and all domestic sales for human consumption. Approximately 95 percent of wheat production enters the primary elevator system and the remainder is used on-farm for feed or seed or sold locally. Of the wheat that does enter the elevator system, 97 percent is delivered to the CWB and 3 percent is delivered to the private trade. The private trade is only permitted to buy feed wheat, which they subsequently sell on the Winnipeg cash and futures market. The CWB, unlike the Australian Wheat Board, does not trade on the futures market.

The CWB markets grain in two basic ways. The largest proportion of sales are made under contracts negotiated annually between the CWB and buyers. This is in contrast to earlier years, when most sales were made through accredited exporters. Although this type of sale no longer dominates, most sales made by the CWB still involve a degree of participation by private trading companies operating as accredited exporters for the CWB.

Sales by the CWB maybe made under individual contracts or under provisions of a long-term agreement. Such agreements specify the minimum and usually maximum quantity of grain shipped each year during the life of the agreement. Specific grades of grain are usually not maintained, but the types of grain are identified.

The distinction between the two basic types of sales made by the CWB is not very clear cut. Most sales in fact involve private trading customers, and, when special credit is involved, the Canadian Government as well. The degree of participation by any one of these agencies depends on the buyer. For example, in sales to the U. S. S. R., negotiations on grades, quantities, prices, and other terms are carried out entirely by CWB. Once the contract terms are established, private trading companies obtain necessary documentation and supervise ship loading. For commercial sales, however, such as those to mills in Western Europe, accredited exporters conduct all negotiations, buy grain from the CWB on a cash basis, and assume responsibility for all aspects of the sale. Even in such commercial sales, however, the CWB is normally involved, whether it be in market development or assisting with negotiations in some aspect of the contract.

The CWB is very involved in market development programs. Programs for particular countries frequently involve milling and baking tests and, in the case of feed grains, feeding trials to determine if grains available in Canada are suitable for the country's needs. If Canadian grains lack particular necessary qualities, discussions with plant breeders are held to determine whether new varieties possessing the desired qualities can be developed.

Producer Pricing and Policy

The CWB achieves price stability for grain marketed by producers through a price pooling system. Receipts received by CWB from sales of a particular grain are "pooled" in a single fund.

At the beginning of each crop year (August 1st), the Government establishes initial producer prices for grain sold to the CWB. These prices are announced in advance, normally in April, to allow farmers to adjust their seeding intentions. Separate prices are established for each grade of wheat. Receipts from CWB sales into the domestic and export market are then "pooled." Producers receive the initial payment at the time of delivery. In some years they receive an interim payment during the crop year (if prices strengthen considerably), and a final payment once the crop year is over. The pool is then closed and CWB deducts its administrative expenses, interest costs, etc., from the pool. Each producer receives the price (before freight deductions) no matter what date the wheat was sold to the CWB within a particular crop year. CWB has separate "pools" for HRS wheat and Durum.

When selling to the CWB, producers' marketing costs are deducted in two stages. Freight costs and primary elevator handling costs are deducted from the initial payment at the time of delivery. Other costs, which include interest, insurance, storage, etc., and the Board's operating costs, are later charged against the "pool" before the final payment is made to the farmers.

Domestic sales of wheat by the CWB to millers takes place at prices that are partially insulated from world levels. This is referred to as the two-price wheat policy, and it was established in 1967. During the 1970s the Canadian Government fixed the domestic price to mills at relatively low levels and thus subsidized consumers (assuming the millers and bakers passed this saving on) when world prices were above these levels.

The two-price policy has been very controversial over the years and it has gone through a number of changes. Currently the domestic price is allowed to vary with a price band of $255 to $330 per MT, and the Government is no longer involved in subsidizing either producers or consumers if the world price falls outside this range. As of December 1987 the CWB charged the minimum price of $255. Since its inception, producer gains from the 2-price program have roughly offset their losses. Consumers have received benefits of close to $500 million, which have come at the Government's expense.

In addition to pooling, the CWB regulates producer deliveries to primary elevators through quotas. The quota system is used to ensure that the kinds and quantities of grain needed to meet sales are delivered when required, and that each producer receives a fair share of available markets.

The entire quota system is currently under review. Some farmers believe the system is inequitable because each wheat farmer is assigned abase acreage whether the farmer's land is seeded or not, and quotas are announced by the CWB as a fixed number of bushels per assigned acre. No allowance is made for varying yields from farm to farm, or even for irrigated land. On the other hand, farmers in southern Saskatchewan who normally benefit from the current quota system argue that the price pooling system is inequitable from their vantage point. Some of these farmers brought a lawsuit against the CWB in 1987 because the Board allegedly subsidized the price of No. 2 and No. 3 CWRS wheat with higher prices received for No. 1 CWRS.

GRAIN HANDLING IN CANADA

Canadian farmers deliver most of their grain to country elevators. Canadian elevator numbers have declined from 5,800 in 1933 to 3,000 today. The three Wheat Pools (Alberta, Saskatchewan, and Manitoba), which are forms of producer cooperatives, own approximately 1,800 elevators; the United Grain Growers (a grain cooperative) have about 500 elevators. The remainder are owned by private companies. Thus about 80 percent of elevators are owned by farmer cooperatives and the remaining 20 percent are privately owned. Because of costs, these elevators are capable of storing only a portion of farmers' grain at harvest. As a consequence, on-farm storage is substantial, and the delivery quota system controls the flow of grain to the elevator system.

Transportation

Canada has two transcontinental railway companies, C P Rail and Canadian National, that move grain from elevators to export sites. Because of the location of production, grain has to be carried long distances over land before it can be eventually exported. Canadian grain moves essentially in only two directions from point of production—either east or west.

The wheat produced in western Canada must be moved over vast distances to reach a seaport. Most is moved by rail rather than truck or barge. The farmers deliver their grain to primary elevators located on rail lines. The rail freight rates are regulated by the Government and they have not changed much in the last 90 years. Prior to the turn of the century the Federal Government entered into an agreement with the Canadian Pacific Railway to fix rates, and in return the railway received a subsidy. Until the inflationary period of the 1960s and **1970s,** these rates were generally considered adequate to provide a return to the railways (7).

With inflation, the railways discontinued investment in the transportation system, which rapidly deteriorated. Farm stocks of wheat were high and the CWB could not transport all the grain sold. After much study and negotiation, the Federal Government increased its subsidy to the railways and farmers are now paying a larger portion of shipping costs. Variable freight rates (e.g., discount for unit trains) are now being used more and more extensively. As a result, the Canadian grain transportation bottlenecks have almost disappeared.

The CWB, which has monopoly control over wheat destined for export markets, owns no marketing or transportation facilities. Rather it contracts for these services with the national railroads and with the cooperative and private elevators. The CWB controls the grain delivered by farmers to country elevators by the quota system discussed earlier, and coordinates logistics with national railroads. Grain cars are allocated to country elevators under a block shipping system whereby western Canada is divided into 49 shipping blocks. Boxcar allocation to these blocks is determined jointly by the CWB and railways.

Cleaning

Interior terminals are relatively unimportant in the overall grain marketing system (table ***4-12).*** Farmers bypass interior terminals in order to avoid handling and elevation charges (approximately $12/MT) there and again at the export terminal. The Canadian system is not designed to move wheat by rail directly from the interior terminals to an export vessel. The inland terminals have the capability to clean grain to export standards, but, so far, this has not been taken advantage of. Interior terminals normally hold less than ***1*** percent of the car-

Table 4-12.—Handlings of Wheat at Canadian Terminal Elevators, 1986187 Crop Year (thousand metric tons)

Receipts at terminal	Wheat
Thunder Bay	9,529.9
Vancouver	6,358.8
Prince Rupert	3,183.4
Churchill	—
Interior terminals	41.9
Total	19,113.9

SOURCE: Canadian Grain Commission, *Canadian Grain Exports, 1988/87* **Crop Year.**

ryover wheat stocks and have a combined storage capacity of approximately 154,000 MT, which is largely unutilized. During the Thunder Bay worker's strike in the fall of 1986, however, the Canadian Wheat Board sent clean grain by rail directly from the inland elevators to transfer elevators on the St. Lawrence River. This demonstrated the feasibility of cleaning inland on an ongoing basis if necessary.

Most of the grain cleaning to export standards is carried out at terminal points (e.g., Thunder Bay, Vancouver, Prince Rupert) that are thousands of miles from the point of production. The two main types of cleaners used are the indent cylinder machines and screen machines. The cyclinder machine, which is not used in the United States, separates kernels on the basis of length and removes short from longer material. The screen machine separates by thickness and width.

As with drying equipment, the cleaning equipment used in various terminals is very similar from facility to facility. Most terminals carry out "single pass" cleaning, which means the grain does not have to be elevated more than once. This is especially true in Vancouver, where storage capacity is much more limited. The majority of the cleaning of prairie grain takes place at the terminals since there is limited cleaning conducted on-farm or at primary elevators.

The rationale for terminal cleaning is largely historical (9). Originally most of the export-destined grain moved through Thunder Bay, where terminal cleaning first started. In the past, grain companies typically stored grain for longer periods of time, and cleaning improved the storability of the product. There was not as much concern about throughput efficiency, and as new terminals were built cleaning facilities were routinely installed.

The export capacity of the Canadian system has been increased from 20 to 30 MMT over the past 10 years. As of 1986, there were 1,860 primary elevators, 22 terminal elevators, 28 process elevators, and 24 transfer elevators. In 1965 the storage capacity of primary elevators was 10.7 MMT, but by 1986 this declined to 7.7 MMT, a reduction of 28 percent (4). As a result, throughput rates have increased and there is added pressures for more inland cleaning to improve overall efficiency.

In the past, grain companies earned significant profits from terminal cleaning. This resulted from the sale of reclaimed grain and screenings for feed purposes (9). The farmer is assessed a cleaning charge ($1.67/MT) and is not paid for dockage. A report prepared for the Grain Transportation Agency recommends experimentation with the cleaning of grain to export standards on farms or other inland positions (Leibfried), Economic incentives over time suggest there will probably be more inland cleaning.

The cleaning assignment in Canada is very similar from terminal to terminal (9). Most plants try to clean grain as it is received at the terminal, rather than putting it into storage first and then taking it out to clean. The cleaning by-products consist of refuse screenings and whole grain. The screenings are pelleted and sold as feed, while the whole grain is either sold to the CWB or the private grain trade.

Drying

A total of 3,934 MT of wheat were dried at inland terminals in the 1986/87 crop year (table 4-13). The amount dried inland was higher than normal because of the Thunder Bay dock strike that season. The amount dried at all terminal elevators represented less than 3 percent of the total handled, which is the norm.

The dryers used in the terminal elevators are generally fed by belts and use gravity to move wheat through heated units. Natural gas and propane are common energy sources. Terminal elevators in western Canada equipped with

Table 4-13.—Wheat Dried at Terminal Elevators, 1986187 (metric tons)

Location	Artificial drying	Natural drying	Total
Inland terminals	3,443	491	3,934
Thunder Bay	494,839	362,077	856,916
Pacific Coast	381,731	322,626	704,357

SOURCE: Canadian Grain Commission: unpublished data.

machinery for artificial drying are listed in table 4-14. Drying capacity is a constraint to the operation of most terminal elevators in years when damp grain is common. In a normal year only about 5 percent of the wheat handled in these facilities requires drying, which is easily handled.

Vertical cement bins are used for storage in almost all terminal elevators in western Canada. Cargill has a flat storage bin in Thunder Bay, but its storage capacity is minimal. Some of the transfer elevators in eastern Canada use steel tanks for storage. However, it is important to note that these transfer elevators do not "process" grain. Vertical cement bins are common at the terminals because the Canadian Grain Commission does not allow blending and thus a significant number of grades must be kept separate. This is the reason that unit trains with only one grain/one grade would greatly enhance the efficiency of the terminals. For wheat alone, as many as 10 different grade separations may be required. Consequently, the Canadian terminals have a large number of "small" storage bins. For example, one Vancouver facility has over 100,000 MT storage capacity that is divided into about 120 different bins. Since the United States has no restrictions on blending and fewer grades of wheat, horizontal storage is more common there. Horizontal storage is less costly than vertical storage.

Table 4-14.—Terminal Elevators in Western Division Equipped With Drying Machinery (at Aug. 1, 1987)

Location Elevators	Capacity of heater section
Manitoba:	
Winnipeg:	
Elders Grain Co. Limited "W"	22
	22
Saskatchewan:	
Moose Jaw:	
Elders Grain Co. Limited	21
Saskatoon:	
Northern Sales Co. Limited.	70
	91
British Columbia:	
North Vancouver:	
Pioneer Grain Terminal Limited	71
Prince Rupert:	
Prince Rupert Grain Limited	75
Saskatchewan Wheat Pool	60
Vancouver:	
Alberta Wheat Pool.	56
Pacific Elevators Limited.	42
United Grain Growers Limited	22
	326
Ontario:	
Thunder Bay:	
Cargill Limited	50
Manitoba Pool Elevators No. 1	28
Manitoba Pool Elevators No. 3	40
Parrish & Heimbecker, Limited.	13
Richardson Terminals Limited	44
Saskatchewan Wheat Pool No. 4	74
Saskatchewan Wheat Pool No. 6	70
Saskatchewan Wheat Pool No. 7	53
Saskatchewan Wheat Pool No. 8	8
Saskatchewan Wheat Pool No. 15	42
United Grain Growers Limited "A"	22
United Grain Growers Limited "M"	23
	467
Total	906

NOTE: Heater capacity based on wheat.

SOURCE: Canadian Grain Commission: unpublished data

Blending

The Canadian Grain Commission regulates the blending of grains from different grades. Blending is not restricted at the primary elevators, but at terminal elevators only 2 percent of the higher grade can be a blend from a lower grade. If 1,000 MT of No. 1 CWRS are delivered to a terminal elevator, for example, no more than 20 additional MT of No. 1 CWRS can be created through blending. If blending above the allowable 2 percent occurs at the terminal, the grain can be confiscated.

In July 1987 the Canadian Grain Commission warned grain companies against blending No. 1 and No. 2 canola to create more No. 1 than was actually delivered to export positions. The cargoes were shipped to Japan and, although they were officially graded No. 1, Japanese importers were complaining. Some farmers have questioned the Canadian Grain Commission's approach since it gives the Japanese the benefit of buying lower priced No. 2 canola that otherwise would have been blended into No. 1.

The fact that blending is not restricted at primary elevators gives grain companies the potential to profit from blending. This is especially true for CWB grains. As agents of CWB, the companies buy CWB grain from the farmer at

primary elevators. But CWB does not purchase the grain from the elevator companies until it reaches the terminal location. The creation of the value through blending is therefore not captured by CWB.

Fumigation

Canada's cold winters tend to minimize insect infestation but occasionally it occurs, and fumigation is conducted under the Grain Commission's supervision. The most common treatment involves placing phosphine tablets in the infested grain as it flows from conveyor belt to storage bin. The bin is sealed, and the tablets emit a gas that kills the insects.

QUALITY CONTROL OF CANADIAN WHEAT

Quality control is achieved in the Canadian grain industry by very rigid regulations enacted by the Government. These regulations are in two major areas of importance: 1) licensing of new varieties; and 2) the establishment of the Canadian Grain Commission, which supervises the handling of grain. The Commission's quality control system involves all facets of the grain industry from breeding of new varieties to delivery of grown products to consumers. Of equal importance, however, is the system that establishes the criteria for the release of new varieties—where quality control really begins.

Variety Development and Release

The maintenance of quality standards in the Canadian system begins on the farm. The Canada Seeds Act requires that a new variety of wheat be extensively tested before it is licensed by the Minister of Agriculture for sale as seed. The Seeds Act dramatically reduces the number of varieties released and thus limits the varietal options available to farmers. From 1923 to 1986, only 34 new CWRS varieties were released in Canada (10), roughly one new variety every 2 years. In the early 1980s, in contrast, 33 new varieties were released in North Dakota over a 5-year period (10), for an average of more than 6.5 new varieties each year.

The chosen new varieties are compared in controlled experiments to Neepawa, the statutory standard, and to several existing varieties at numerous locations across the prairies. Trials are replicated four times at each location to enhance statistical reliability. Evaluation for disease resistance is most extensive at this stage. Each year's data are reviewed by three Expert Committees (on grain breeding, grain diseases, and grain quality). An entry may be rejected from the test and thus from licensing consideration by any one Committee at any stage. Varieties may remain in the Co-operative Test for 3 years. If, at that point, all three Committees recommend that a variety be licensed, the plant breeder submits an application to the Plant Products and Quarantine Directorate of Agriculture Canada. A license may then be issued under authority of the Federal Minister of Agriculture.

The three Expert Committees play an extremely important role in this process, as each one effectively has veto power over the licensing decision. Similarly, approval from each Committee essentially ensures that a variety will be licensed. The justification for vesting this level of control in the Committee structure is that the Committees are made up of the foremost experts in each field. The Expert Committee on Grain Breeding, for instance, consists largely of plant breeders and geneticists who review results on agronomic characteristics such as yield, time to maturity, resistance to lodging, height, etc. The Expert Committee on Grain Diseases consists mainly of plant pathologists who concern themselves with the degree of disease resistance shown.

The Expert Committee on Grain Quality is the most diverse of the three groups. Members are cereal chemists, marketing experts (from the Canadian Wheat Board and the Canadian

International Grains Institute), the Chief Grain Inspector of the Canadian Grain Commission, and users of the end product (milling companies). Such abroad cross-section of participants might well be expected to disagree over the merit of proposed new varieties. However, potential conflicts are limited by the strict definition of "quality" that the Committee must apply.

Generally, new varieties of wheat must make a positive contribution to existing varietal stock. This improvement must be in concert with Canada's reputation for exporting high-quality wheat. New varieties must therefore conform to a number of fixed criteria that effectively serve to define "quality" as it applies to licensing of varieties. The source of these standards is the Canada Grain Act and, specifically, the schedule of official grades set out in the Act. In order for a new variety of wheat to comply with the quality criteria it must meet two basic requirements.

First, it must be equal in quality to the standard variety for the class of wheat into which it will be licensed. For example, if a new variety of Hard Red Spring wheat fulfills the grading requirements of the Canada Western Red Spring wheat class, it must have milling and baking qualities equal to those of the Neepawa variety.

Testing for quality (relative to the standard variety) is conducted largely by Agriculture Canada, the Government's research agency, at the A and B test levels and by the Grain Research Laboratory of the Canadian Grain Commission during the Co-operative Test phase. Samples are assessed for quality at each stage in the breeding program, but the most comprehensive testing is conducted during the Co-operative Test phase. New varieties are tested against minimum standards based upon the standard variety for the class. Characteristics tested include protein content, gluten strength, flour yield, flour appearance, kernel weight, kernel hardness, and overall baking quality, which includes flour properties, theological dough properties, and baking results. If the proposed variety fails to match consistently or to surpass any of the "quality" standards, the Committee on Grain Quality must reject the variety from consideration for licensing in that class. Consequently, no variety can be licensed into a given class unless it meets all the milling and baking quality criteria regardless of agronomic merit.

Second, if a new variety is not equal in quality to the standard variety, it may be licensed into a different class, providing its kernels can be distinguished from the standard variety of the higher quality class by visual means. This visual distinguishability criterion was applied in the case of Glenlea wheat, a high-yielding but lower protein feed wheat licensed into the Canada Utility class. If the different quality variety is not visually distinguishable from the grain of an existing class, it cannot be licensed into any class. Visual distinguishability thus becomes a grading factor for wheats that do not match the milling and baking characteristics of the standard variety. In the context of this report, "quality" covers the spectrum from low (useful for feed) to high (primarily useful for pan breads and to upgrade local grists). The production of high "quality" wheat v. low "quality" wheat is dependent on variety and on geographic, climatic, and management conditions.

As a result of these stringent licensing regulations Canadian wheat is very uniform. On average, over one-third of western Canadian wheat production achieves the top grade category of No. 1 CWRS. Similarly, about 27 percent grades No. 2 and the remaining 37 percent No. 3 or lower.

Many of the semidwarf spring wheats grown in the United States are higher-yielding than Canadian varieties, but since most of them are not visually distinguishable from existing Canadian varieties they are not licensed. Some farmers "smuggled" seed into Canada in the early 1980s and started growing those wheats and selling them as "unprescribed" varieties. This meant they were sold for feed prices. Most were not visually distinguishable from CWRS varieties, and there was a fear of possible mixing into CWRS grades. But the Canadian Grain Commission found the contamination of CWRS grades with unlicensed varieties to be a problem

of minimal proportion (6). It has been estimated that the economic costs of this regulation are high, representing between 5 and 17 percent of annual net farm income in Canada (5).

By 1985 approximately 500,000 acres of wheat were seeded to unprescribed varieties (6). The Census figures for 1986 indicate that close to 600,000 acres were planted that year. In response to farmers' desire to produce semi-dwarf wheats, the Canadian Government followed the advice of the Committee on Unprescribed Varieties and licensed Oslo wheat in 1987. Oslo is visually distinguishable from Neepawa and it has become eligible for the newly established "Prairie Spring" grade.

The Canadian Grain Commission

The Government and regulatory agency responsible for the quality control of Canadian grain and for the supervision of its handling is the Canadian Grain Commission. The Commission has the legislative authority for licensing grain-handling facilities, setting grade standards, providing official inspection and weighing services, handling foreign complaints, and ensuring that quality is maintained on grain moving through the system. The Commission is totally fee-supported and assesses fees to recover its operating costs.

Licensing of Elevators

The Commission's licensing authority is used to maintain quality control throughout the Canadian handling system. An elevator cannot handle grain under the Canada Grain Act unless licensed by the Commission. The act requires plans for construction or alteration of elevators to be submitted before a license is issued. It also requires elevators to maintain handling equipment and storage facilities in sufficient condition to minimize damage of grain while handling and to prevent deterioration during storage. Licensed elevators are inspected by Commission inspectors. Failure to comply with license requirements may result in suspension or loss of license.

Grade Standards

The Commission has responsibility for the grading system. And it has established grade standards into two categories: primary and export standards. It also provides for experimental grades. The inclusion of experimental primary grades in the Canadian system allows for testing unlicensed varieties that do not fit into the normal marketing patterns. The overall grading structure for various wheat types grown in Canada is outlined in table 4-15.

In addition to the specific numerical grade, the terms Canada, Canadian Western, and Canadian Eastern are included in the grade designation to depict the geographical location of production. Export grade specifications for Red Spring and Amber Durum wheat are outlined in tables 4-16 and 4-17.

Other tests are performed on wheat samples for the purpose of maintaining quality and statistical reporting even though they do not directly affect the numerical grade. The typi-

Table 4-15.—Canadian Wheat Varieties

Red Spring: 3 grade tables (grades 1-3 and feed)
Canadian Western (primary)
Canadian Western (export)
Canadian Eastern (primary)
Amber Durum: 2 grade tables (grades 1-5)
Canadian Western (primary)
Canadian Western (export)
Soft White Spring: 3 grade tables (grades 1-3 and food)
Canadian Western (primary)
Canadian Western (export)
Canadian Eastern (primary)
Utility: 3 grade tables (grades 1, 2, and feed)
Canadian Western (primary)
Canadian Western (export)
Canadian Eastern (primary)
Prairie Spring: 2 grade tables (grades 1, 2, and feed)
Canadian Western (primary)
Canadian Western (export)
Canadian Eastern and Western combined (primary)
Red Winter: 3 grade tables (grades 1-3 and feed)
Canadian Western (primary)
Canadian Western (export)
Canadian Eastern (primary)
White Winter: 1 grade table (grades 1-3 and feed)
Canadian Eastern (primary)

SOURCE: Office of Technology Assessment, 1989.

Table 4.16.—Export Grade Determinants of Red Spring Wheat (Canadian Western)

Grade name	Foreign material: Total removable material: 5 Buckwheat	Foreign material: Total removable material: 4.5 R.H.	Foreign material: Large seeds and wild oats	Foreign material: Other matter: Mineral matter: Stones	Foreign material: Other matter: Mineral matter: Total	Foreign material: Other matter: Ergot	Foreign material: Other matter: Sclerotinia	Foreign material: Total including other cereal grains
No. 1 C.W. Red Spring	0.3% broken grain	0.1 % including 0.05% small seeds	0.2°/0 including 0.05% wild oats	0.033%0	0.066 %	0.01 %	0.01%	0.40%
No. 2 C.W. Red Spring	0.3% broken grain	0.1 % including 0.050/0 small seeds	0.1 % including 0.05°/0 wild oats	0.033%	0.10 %	0.02%	0.02 %	0.75 %
No. 3 C.W. Red Spring	0.30/o broken grain	0.1% including 0.05% Sinai! seeds	0.2°/0 including 0.05°/0 wild oats	0.066 "/0	0.10%0	0.04 %	0.04%	1.25%
Canada Western Feed	0.5% broken grain	0.1 % including 0.050/0 small seeds	0.5°/0 including 0.1 % wild oats	0.10 "/0	0.250/o	0.10%	0.10%	5.0%

Grade name	Wheats of other classes: Contrasting classes	Wheats of other classes: Total including contrasting classes	Minimum hard vitreous kernels	Sprouted: Severe	Sprouted: Total including severe sprouted	Heated and binburnt	Shrunken and broken: Shrunken	Shrunken and broken: Broken	Shrunken and broken: Total
No. 1 C.W. Red Spring	0.3 "/0	1 .5%	65.00/o	0.1 %	0.50/0	0.05°/0 including 1 binburnt kernel per 1,000 grams	6.00/0	5.0 "/0	7.0%
No. 2 C.W. Red Spring	1.5 "/0	3.0 "/0	35.0%		1 .5%	0.40°/0 including 4 binburnt kernels per 1,000 grams	10.0 %	8.0%	11 .0%
No. 3 C.W. Red Spring	2.5%	5.0%	No minimum		5.0%	1.0% including 6 binburnt kernels per 1,000 grams	No limit	13.0%	No limit providing broken tolerances not exceeded
Canada Western Feed	No limit (10.9°/0 Amber Durum only)		No minimum	No limit	No limit	2.5°/0 including 2.5°/0 binburnt kernels	No limit	50.0%	No limit providing broken tolerances not exceeded

SOURCE: Canadian Grain Commission, *Official Grain Grading* Guide, 1987,

Table 4-17.—Export Grade Determinants of Amber Durum Wheat (Canadian Wes e n

Grade name	Total removable material		Large seeds and wild oats	Foreign material				Total including other cereal grains
				Other matter				
				Mineral matter				
	5 Buckwheat	4.5 R.H.		Stones	Total	Ergot	Sclerotinia	
No. 1 C.W. Amber Durum	0.3% broken grain	0.1% including 0.05% small seeds	0.20% including 0.1% wild oats	0.033%	0.066%	0.01%	0.01%	0.50%
No. 2 C.W. Amber Durum	0.3% broken grain	0.1% including 0.05% small seeds	0.20% including 0.1% wild oats	0.033%	0.10%	0.02%	0.02%	0.80%
No. 3 C.W. Amber Durum	0.3% broken grain	0.1% including 0.05% small seeds	0.20% including 0.1% wild oats	0.066%	0.10%	0.04%	0.04%	1.0%
No. 4 C.W. Amber Durum	0.5% broken grain	0.1% including 0.05% small seeds	0.50% including 0.1% wild oats	0.066%	0.10%	0.04%	0.04%	3.0%
No. 5 C.W. Amber Durum	0.5% broken grain	0.1% including 0.05% small seeds	1.0% including 0.1% wild oats	0.1%	0.25%	0.10%	0.10%	5.0%

Grade name	W.O.O.C. or nonregistered varieties		Minimum hard vitreous kernels	Sprouted	Heated and binburnt	Shrunken and broken			Smudge			Total smudge and blackpoint
	W.O.O.C.	Total including nonregistered varieties				Shrunken	Broken	Total	Penetrated	Red	Total	
No. 1 C.W. Amber Durum	2.0%	3.0%	80.0%	1.0%	0.05% including 1 binburnt kernel per 1,000 grams	3.0%	5.0%	7.0%	3K	30K	30K	5.0%
No. 2 C.W. Amber Durum	2.5%	5.0%	60.0%	5.0%	0.10% including 2 binburnt kernels per 1,000 grams	10.0%	8.0%	10.0%	0.25%	1.0%	1.0%	10.0%
No. 3 C.W. Amber Durum	3.5%	7.0%	40.0%	8.0%	0.4% including 4 binburnt kernels per 1,000 grams	2.0%	8.0%	13.0%	0.5%	1.0%	3.0%	20.0%
No. 4 C.W. Amber Durum	10.0%	15.0%	No minimum	12.0%	1.5% including 0.5% binburnt kernels	No limit	13.0%	No limit providing broken tolerances not exceeded	Consider overall appearance			
No. 5 C.W. Amber Durum	5.0%	No limit providing W.O.O.C. tolerance not exceeded	No minimum	No limit	5.0% including 5.0% binburnt kernels	No limit	50.0%	No limit providing broken tolerances not exceeded	No limit			

NOTE: The letter "K" refers to kernels or kernel size pieces in 500 grams.

SOURCE: Canadian Grain Commission, *Official Grain Grading Guide*, 1987.

cal tests performed by the Commission on Red Spring and Amber Durum wheat are outlined in table 4-18.

Canadian standards rely heavily on the wheat classification system. The system begins with their variety licensing program and the milling and baking qualities of the wheats produced. Commission inspectors are trained in varietal identification, and whenever they suspect that a sample contains unlicensed varieties, it is sent to Winnipeg and undergoes varietal testing. If the sample contains unlicensed varieties, the grain is segregated and handled separately.

To qualify for grades 1 and 2 Canadian Western Red Spring Wheat, the variety must be equal to or better in milling and baking quality than the variety Neepawa, as mentioned earlier. In the case of Amber Durum, the variety must be equal to or better than Hercules. According to Commission officials, even though Hercules is the standard Durum variety, the variety Wakooma is actually the working standard. Hercules has been replaced by Wakooma as the predominant variety planted and someday may replace Hercules as the official standard. This variety based grading system is outlined in table 4-19.

Table 4-18.—Quality Tests Used in Canada

Spring wheat	Durum wheat
Wheat	Wheat
Test weight, kg/hl	Test weight, kg/hi
1,000 kernel weight	1,000 kernel weight
Protein	Wheats of other classes
Alpha-amylase activity	Protein
Falling number	Ash
Flour yield	SDS sedimentation
Flour	Falling number
Protein	Milling yield
Wet gluten	Semolina yield
Ash	Semolina
Color	Protein
Starch damage	Wet gluten
Alpha-amylase activity	Ash
Maltose value	Agtron color
Baking absorption	Speck count
Bread	Spaghetti (dried at 39 and 70 'C)
Loaf volume	Color
Blend loaf volume	Cooking quality
Farinogram	Stickiness
Extensigram	Color loss
Alveogram	

SOURCE: Canadian Grain Commission, *Ouality of Canadian Grain Exports,* Grain Research Laboratory, 1986.

Standard Samples.—The Canadian inspection system develops standard samples to help with visual inspection. These samples are developed yearly for all grades of Class 1 grains. Each year at harvest, grain is collected from primary elevators and railcars unloaded at terminal and transfer elevators. The grain collected represents both old and new crop. The collection process has been designed to assure that the major grading factors for each year's crop and a cross-section of all production areas are represented.

In 1987, over 45,000 samples were collected in this process. These were used to determine the 1987 crop quality and identify the major grading factors by location. Once the quality data had been collected on these samples, large quantities of grain representing the major grade

Table 4-19.—Grade and Variety in Canada

Grade	Varieties
No, 1 C.W., 2 C.W., 3 C.W. Red Spring	Registered varieties equal to Neepawa
No. 1 C. E., 2 C. E., 3 C.E. Red Spring	Registered varieties equal to reference varieties of acceptable end-use quality
No. 1 C.W., 2 C.W., 3 C.W. Amber Durum	Registered varieties equal to Hercules
No. 4 C.W. Amber Durum	Registered varieties of Amber Durum
No. 5 C.W. Amber Durum	Any variety of Amber Durum
No. 1 C.W. & C. E., No. 2 C.W. & C. E., and No. 3 C.W. & C.E. Soft White Spring	Registered varieties equal to reference varieties of acceptable end-use quality
No. 1 C.W. & C. E., No. 2 C.W. & C. E., and No. 3 C.W. & C.E. Red Winter	Registered varieties equal to reference varieties of acceptable end-use quality
No. 1 C. E., No. 2 C. E., No. 3 C.E. White Winter	Registered varieties equal to reference varieties of acceptable end-use quality
No. 1 C.W. & C, E., No, 2 C.W. & C.E. Utility	Glenlea, Wildcat, Bluesky
No. 1 & No. 2 Canada Prairie Spring (Red)	HY 320, 0slo
C.W. & C.E. Feed	Any variety of wheat except amber durum

SOURCE: Canadian Grain Commission, *Official Grain Grad/rig Guide, 1W7.*

factors were ordered from the specific locations identified by the initial samples. After being collected the grain was blended to provide primary and export standard samples. In the case of primary standard samples, each sample represents the minimum quality for each grade. For export standard samples, they represent the average quality from the entire crop for each grade.

Primary standard samples serve as a guide for grading grain at the domestic level. The samples collected are graded, analyzed, and tested by the Commission. They are then blended to represent the minimum quality for each grade and in some instances are sent to the Grain Research Laboratory for quality testing. After being tested, the samples and all test data are submitted to the appropriate Grain Standards Committee for approval. Once approved, these samples are used by official and private inspectors as guides for grading domestic grain. They are provided to each official inspection point and, upon request, to grain companies' inspection departments, who in turn distribute them to their inspectors at primary elevators. When a conflict of interpretation exists during grading between the primary standard sample and official grade definitions, official grade definitions prevail.

Export standard samples are collected and prepared in the same manner as primary standard samples except they are only applicable to Western grain. Export standard samples are prepared for Red Spring wheat, Amber Durum wheat, and any other grain the Commission deems will be exported during the year. These samples are prepared to ensure that overseas buyers will receive shipments close to the average crop quality for each grade purchased. Minimum test weight, maximum limits of admixtures, and other grading factors are established by these samples.

Commission inspectors use the samples to govern the grading of export grain. These samples are also supplied to overseas buyers as representative samples of the quality of wheat they will receive during the coming year. Whenever there is a conflict in interpretation during grading over the official grade, the export standard sample prevails.

Protein Testing.—In addition to grade factors, protein content is determined on all Red Spring wheat shipments. When protein content is determined it does not affect the numerical grade. CWRS wheat grades 1 and 2 are segregated by protein content but other grades and classes are not. Protein content is also determined on Amber Durum and Red Winter wheat shipments upon request. Protein results are reported on a 13.5 percent moisture basis. In cases where the buyer requests a different moisture basis, the Commission will provide this service.

Infestation.—The Commission has established a zero insect tolerance for all grains. According to its regulations, when grain is found to be infested in the primary, process, or terminal elevator, the operator must immediately notify the Commission of the nature and extent of infestation. Samples of grain from the infested bins must be taken and forwarded to the Commission in Winnipeg. The grain must then be treated according to procedures issued by the Commission and no other grain maybe received or shipped while the infested or fumigated grain is being loaded out.

If the Commission finds infestation while inspecting grain at a terminal elevator, the primary elevator that shipped the grain is placed under quarantine. The elevator is required to turn each bin and draw a sample that is identified by elevator name, location, and bin number. These samples are sent to Winnipeg for analysis. The infested bins are then treated under procedures issued by the Commission. The bins that are not infested can be shipped according to instructions issued by the Commission. If a primary elevator ships infested grain to a terminal elevator more than once in a crop year, the primary elevator's license can be suspended. Officials indicated that one license was suspended in 1986.

The Commission allows infested grain to be loaded into railcars and fumigated during transit. Regulations established for these shipments include placarding, etc. Aluminum phosphide

is the main compound used for fumigation. The Commission stresses good housekeeping, use of aeration, and turning bins to control infestation.

Pesticide Residues.—The Commission has been surveying and testing wheat for pesticide residues for over 15 years. The pesticide screening program has four objectives:

1. *Ensure that pest control products do not result in residue levels that exceed tolerance in export shipments.* The Commission is not responsible for licensing these chemicals but works closely with other government agencies on issues surrounding pest control and potential health hazards.
2. *Prevent contaminated grain from entering licensed terminal elevators.* This involves surveying grain stored in primary elevators.
3. *Identify grain that is contaminated as it enters the terminal elevator.* Contaminated grain must be disposed of according to provisions of the Act and regulations.
4. *Obtain samples from each ship loaded for export for testing.* This program involves screening samples for 16 of the 58 compounds licensed for cereal grains. Five hundred grams from each cargo are tested using gas chromatography. Table 4-20 lists the compounds currently being screened.

According to the Commission, surveys over the 1978/79 and 1979/80 crop years for aluminum phosphide/phosphine, carbon disulfide, carbon tetrachloride, ethylene dichloride, and ethylene dibromide indicated that 98 percent of the crop did not contain harmful levels of these substances. As such, these substances are not routinely tested on cargo shipments. Currently, only aluminum phosphide/phosphine is sanctioned to treat infested grain.

Table 4.20.—Pesticides Screened for in Canada

carbaryl	lindane
carbathiin	linuron
carbofuran	malathion
chlorpyrifos	methoxychlor
demeton	metribuzin
dimethoate	oxydemeton-methyl
disulfoton	trial late
endrin	trifluralin

SOURCE: Canadian Grain Commission, *Quality Control for Pesticide Residues in Canadian Grain at the Grain Research Laboratory,*

FINDINGS AND CONCLUSIONS

Canada's standard class of wheat is Hard Red Spring, which is high in both protein and baking strength. Over the years Canada has established a reputation for producing not only a high-quality but also a very uniform wheat. And the premium received for Canadian Western Red Spring wheat has held its own, while the discount on U.S. Hard Red Winter wheat has increased. A major reason CWRS wheat has maintained its price is that quality (with uniformity as the key factor) of U.S. wheat has been declining in the eyes of some importers. This has allowed Canada to continue to charge a premium for the reputation it has developed for selling wheat with a uniform, predictable quality.

Three major factors affect the marketing system and the quality of wheat in Canada:

1. the Canadian Wheat Board,
2. the Canadian Grain Commission, and
3. the licensing of new varieties.

The CWB is the sole marketing agency for wheat grown in Canada and destined for export or human consumption. It is a government agency and mainly a sales agency, as it owns no physical facilities for the handling of grain. The CWB's responsibility is to bring the highest possible returns to producers and give them equitable access to the export market. Quality is a primary marketing tool used by CWB.

The Canadian Grain Commission is the regulatory body responsible for the quality control of Canadian grain and for supervision of its handling. It has the legislative authority for licensing grain handling facilities, setting grade standards, providing official inspection, and ensuring that quality is maintained on grain moving through the system. The Commission's licensing authority is used to maintain quality control throughout the handling system. Among other things, it requires elevators to maintain handling equipment and storage facilities in efficient condition to minimize damage of grain and to prevent deterioration during storage. Failure to comply with license requirements may result in suspension or loss of license.

The most fundamental aspect of the Canadian system with regard to quality is its variety development and release policy. The system requires that a new variety of wheat be extensively tested before the Minister of Agriculture can issue a license for sale as seed. This requirement has significantly reduced the number of varieties released but has assured Canada of reliable, uniform wheat. New varieties must make a positive contribution to existing varieties, and must conform to a number of fixed criteria that define quality as it applies to licensing. As a result of these stringent licensing regulations, Canadian wheat is very uniform.

CHAPTER 4 REFERENCES

1. Canada Grains Council, "Grain Grading for Efficiency and Profit, " Winnipeg, MB: 1982.
2. Canada Grains Council, ***Wheat Grades for Canada—Maintaining Excellence*** (Winnipeg, MB: 1985).
3. Canada Grains Council, ***The Structure of the Feed Grain Market in Western Canada*** (Winnipeg, MB: 1985).
4. Canada Grains Council, ***Statistical Annual,*** various issues.
5. Carter, C., Loyns, A., and Ahmedi-Esfahani, Z., "Varietal Licensing Standards and Canadian Wheat Exports," ***Canadian Journal of Agricultural Economics*** **31** (November 1986), pp. 361-377.
6. Committee on Unprescribed Varieties, "Report of the Committee on Unprescribed Varieties," Winnipeg, MB, July 1986.
7. Gilson, C., ***Western Grain Transportation Report on Consultation and Recommendations*** (Ottawa: Supply and Services Canada, June 1982).
8. Hunt, L. A., and Bulman, P., "Wheat Production in Eastern Canada, " unpublished manuscript, Department of Crop Science, University of Guelph, 1986.
9. Leibfried, J. L., "Grain Handling Efficiency Study," prepared for the Grain Transportation Agency, Winnipeg, MB, 1987.
10. Leisle, D., "The Canadian Varietal Registration System and Varietal Development," presented to 91st Technical Session, Association of Operative Millers, Toronto, ON, May 1987.
11. Senate of Canada, ***Soil at Risk*** (Ottawa: ***1984).***