Risk Assessment on Bovine Spongiform Encephalopathy in Cattle in Canada

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EXECUTIVE SUMMARY

Bovine spongiform encephalopathy (BSE) is a fatal neurological disease of cattle, with a long incubation period (average five to six years) and no existing test to detect disease in the live animal. Effective BSE prevention and/or effective control involves an evaluation of risk factors, implementation of appropriate risk management measures based on the outcome of the risk factor evaluation and an effective surveillance program.

In order to evaluate the risk for BSE in Canada, the Canadian Food Inspection Agency (CFIA) has carried out a risk assessment on BSE in cattle in Canada, which is presented in three companion reports. Part A is an evaluation of risk factors for BSE in Canada, Part B describes BSE surveillance in Canada, and Part C is a risk estimation for BSE in Canada.

PART A: EVALUATION OF RISK FACTORS

The Government of Canada is committed to safeguarding the Canadian food supply and preventing the entry and establishment of foreign diseases such as BSE, and Canada has committed significant resources to this end. It has a highly effective veterinary infrastructure, and the national Animal Health Program has implemented mandatory controls and surveillance consistent with or in excess of relevant international standards to ensure the continued exclusion of BSE.

Canadian import policies are considered to be highly effective in preventing the entry of BSE. Canada imports ruminants and ruminant products only from countries it has assessed and designated as free of BSE. A Feed Ban prohibiting the feeding of mammalian protein to ruminants (with exceptions) has been in effect since 1997. Under the feed ban, procedures must be in place to prevent cross-contamination of feeds, prohibited feed must be labelled so that it will not be fed to ruminants, and distribution records of feed and feed ingredients must be maintained.

One case of BSE was diagnosed in Canada in 1993, in a cow imported from the United Kingdom. The Canadian response was comprehensive, with the elimination from Canada of the herd, all offspring and all remaining animals imported from the U.K. Appropriate mitigating measures have been put in place in accordance with the most current scientific information.

Imports

- Import policies are consistently based on and continuously adjusted to consider the most current scientific information available and are designed to prevent the importation of contaminated materials and BSE-infected ruminants.

- The CFIA conducts risk assessments based on standards established by the Office International des Épizooties (OIE) to designate countries free of BSE. Livestock and specified livestock products may only be imported from countries designated free of BSE.

- Prior to the implementation of import policies specific for BSE, Canada's conservative import policies for animals and animal products (designed to prevent the introduction of foot-and-mouth disease and other list A diseases) reduced the probability of BSE entry.

Slaughter

- In Canada, 95% of animals are slaughtered under federal inspection, including the majority of mature cows and bulls, and are therefore subject to ante-mortem inspection by CFIA veterinarians. Some 85% of cattle are slaughtered at a young age, when they would be unlikely to have developed BSE even if the agent were present in Canada. An estimated 4% of the total slaughter consists of mature dairy cows, the population of greatest concern.

Rendering

- All rendering plants are inspected annually, and compliance with the feed ban has been found to be very high.

- The structure of the rendering industry helps to mitigate risk. There are only 32 rendering facilities. Many are corporately owned, and more than half have dedicated production of either prohibited or non-prohibited material. Of the 13 that produce both prohibited and non-prohibited material, 9 use dedicated lines. The remaining 4 plants are required to have processes in place to reduce the risk of cross-contamination.

- Given the controls in place for BSE (e.g. import policies, the Feed Ban) and the lack of evidence that BSE is present in native Canadian cattle, the CFIA does not exclude specific risk material from rendering.

Feeds

- North America produces an abundant supply of economically priced grains and protein of vegetable origin. There is significant movement of feed ingredients between the U.S. and Canada, including significant quantities of rendered animal protein. Only highly processed micro-ingredients are sourced in any quantity from countries outside North America.

- The Feed Ban is considered to be effective at feed mills, based on inspections to date. A few deficiencies related to improper record-keeping have been corrected. Procedures to reduce the likelihood of cross-contamination are in place at all feed mills handling both prohibited and non-prohibited feeds. At the feed retail and farm level, compliance with the Feed Ban is based on random inspections combined with awareness and education programs.

- There are about 600 feed mills, which produce about 50% of the complete feeds used by Canadian farms. Currently, there is a trend towards dedication of facilities to handle either prohibited or non-prohibited feeds. Thirty-five percent of feed is produced in HACCP-certified mills. Seventy percent of the total annual commercial feed production is produced by 11 large feed corporations (169 feed mills). Fifty percent of the rendered animal protein used in livestock feeds is imported from the U.S.

- Ninety percent of the feed mill companies are members of a national organization that was involved in the development of the Feed Ban regulations, and there is a high level of awareness on the part of feed mill operators.

- Husbandry and feeding practices contribute to risk mitigation on-farm. Beef cattle, which make up 75% of the Canadian cattle population, are not generally fed meat-and-bone meal (MBM). High-producing dairy cattle are more likely to receive protein supplements containing MBM.

- Fifty percent of complete feeds are mixed on farm (for all species). About 80% of beef feedlots mix their own feed. The percentage of dairy farms mixing their own complete feed is unknown.

- About 4% of commercial cattle farms raise multiple species (pork and/or poultry), the only group in which potential for cross-contamination or errors in feeding exists. The percentage of the cattle population raised on multi-species farms is small.

PART B: BSE SURVEILLANCE AND RELATED ACTIVITIES

- The BSE Surveillance Program in Canada is based on internationally recognized risk factors and pathways, in accordance with current international standards. It is developed and delivered through the collaboration of federal and provincial governments and universities. BSE surveillance programs continue to be revised and updated to ensure that they are based on the most current scientific information. In addition, education and awareness programs as well as effective compensation and cattle identification programs are in place to support the surveillance program.

- A BSE surveillance program has been in place in since 1992, with samples including mature cattle exhibiting signs of neurologic disease from abattoirs and provincial and university laboratories, rabies-negative cattle, neurologic cases submitted to veterinary diagnostic laboratories and universities (tested since January 1991), non-ambulatory cattle (downer cattle/fallen stock) and emergency slaughter cattle. As of January 2002, 7,214 brains have been examined for BSE, and no evidence of the disease has been detected in native cattle by histopathology or immunohistochemistry.

- Canada has consistently exceeded annual OIE standards for BSE surveillance since 1993, with one exception in 1995.

PART C: RISK ESTIMATION

- The estimated probability of at least one infection of BSE occurring prior to 1997 was 7.3×10^{-3} and therefore the likelihood of establishment of BSE in Canada was negligible. The risk was even further reduced by the mitigating measures in place since 1997.

- In conclusion, the measures applied prior to the 1997 Feed Ban (import policies, disease control measures, detection system on-farm and at slaughter plants) combined with Canadian feed production and feeding practices, were effective in preventing the entry of BSE and its subsequent amplification through the feed system.

Risk Assessment on Bovine Spongiform Encephalopathy in Cattle in Canada

Part A:
Evaluation of Risk Factors

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GLOSSARY OF ACRONYMS

AAFC	Agriculture and Agri-Food Canada
AAFRD	Alberta Agriculture, Food and Rural Development
ADRI	Animal Diseases Research Institute, Ottawa
AFSSB	Agri-Food Surveillance Systems Branch
AHIN	Animal Health Information Network
AHL	Animal Health Laboratory, University of Guelph
AIRS	Automated Import Reference System
AMPs	Administrative Monetary Penalties
ANAC	Animal Nutrition Association of Canada
APPI	Animal Protein Producers' Industry
BSE	Bovine spongiform encephalopathy
CAHNet	Canadian Animal Health Network
CCA	Canadian Cattlemen's Association
CCIA	Canadian Cattle Identification Agency
CDN	Canadian Dairy Network
CFIA	Canadian Food Inspection Agency
CCRA	Canada Customs and Revenue Agency
CWD	Chronic wasting disease
DEFRA	Department for Environment, Food & Rural Affairs, U.K.
EU	European Union
ERM	Edible Residual Materials
FCEP	Food Safety Enhancement Program
HACCP	Hazard Analysis Critical Control Point
IHC	Immunohistochemistry
MAFF	Ministry of Agriculture, Fisheries and Food, U.K.
MAPAQ	Le ministère de l'Agriculture, des Pechêries et de l'Alimentation
MIB	Meat Inspection Branch
NRA	National Renderers Association
NCFAD	National Centre for Foreign Animal Disease, Winnipeg
OAHSN	Ontario Animal Health Surveillance Network
OIE	Office International des Épizooties
OMAFRA	Ontario Ministry of Agriculture, Food and Rural Affairs
OVMA	Ontario Veterinary Medical Association
TSE	Transmissible spongiform encephalopathy
USDA	United States Department of Agriculture
WCVM	Western College of Veterinary Medicine, Saskatoon, Canada

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PART A: EVALUATION OF RISK FACTORS

1. INTRODUCTION

Bovine spongiform encephalopathy (BSE) is an invariably fatal neurological disease of cattle that was first diagnosed in the United Kingdom in 1986. It is one of a group of slowly progressive neurodegenerative disorders collectively known as the transmissible spongiform encephalopathies. Although the causative agent of BSE has not been fully characterized, the protein-only or prion theory has emerged to dominate the scientific literature, describing the only disease-specific macromolecule consistently isolated in BSE-affected animals. The prion theory assigns infectivity to a structurally modified form of the normal cell-membrane-associated prion protein, which then has the capacity to promote the conversion of further normal prion molecules to the same, abnormal form. The accumulation of these abnormal isoforms within the affected cells interferes with normal cell function and contributes to the characteristic spongiform changes, eventually resulting in cell death. The abnormal, disease-associated prion protein is resistant to heat, ultraviolet and ionizing radiation and an extensive range of common chemical disinfectants.

Since the disease was first described in the U.K., it has been diagnosed in 21 other countries, affecting more than 180,000 animals. There is general agreement that the most significant source of infection is the feeding of supplemental proteins containing the BSE agent to susceptible cattle. There is no evidence that BSE is transmitted via bovine embryos or semen, and if there is maternal transmission it occurs at such an extremely low rate that it would be insufficient to begin or maintain an epidemic. Within scientific circles debate continues surrounding other possible modes of transmission. BSE has a long incubation period, averaging five to six years, and there is currently no existing ante-mortem test for the disease.

Effective BSE prevention and/or control involves evaluation of risk factors, implementation of appropriate risk management measures (based on the outcome of the risk factor evaluation), and an effective surveillance program. The Canadian Food Inspection Agency (CFIA) has completed the following risk assessment on BSE in cattle in Canada to evaluate these factors. This comprehensive report details the findings and is presented in three parts. Part A evaluates the risk factors for BSE in Canada, Part B describes BSE surveillance in Canada, and Part C is a risk estimation of BSE in Canada.

At the time of the 1993 diagnosis of bovine spongiform encephalopathy in an imported cow in Canada, BSE was an obscure disease of British cattle with no apparent links to human health. Nevertheless, Canada made the disease reportable in 1990 and a surveillance program involving U.K. imports was also established. As a result, the Canadian response was rapid and comprehensive, and no other case of BSE has been diagnosed in Canada.

The chronology of measures taken by the Canadian government to address the risks associated with BSE is outlined in Appendix 1. It demonstrates that, as new scientific information has become available, Canada has taken action to prevent the entry and establishment of BSE in this country. It should be noted that in some cases Canada has met with opposition from other countries with respect to some of the measures implemented. For example, Canada's decision in 1997 to accept cattle and cattle products only from countries Canada had assessed free of BSE was contested by several countries. Given the subsequent spread of BSE within Europe and beyond, this policy has served Canada well. It should also be noted that from the very first appearance of BSE, CFIA officials have maintained close contact, both officially and unofficially, with researchers and government officials in the U.K. and Europe. Hence, the CFIA has been well informed throughout the emergence of this disease.

A 1994 risk assessment determined that the likelihood of BSE arising under Canadian conditions was extremely low, given the differences in key risk factors between Canada and the U.K. (Kellar 2002). The

occurrence of BSE in Canada would, therefore, be dependent upon the importation of infected animals and contaminated livestock products and the subsequent amplification of infectivity through the livestock feeds system.

The objective of Part A is to evaluate the risk factors for BSE in Canada. The main focus is on imports of ruminants and ruminant by-products and controls on imports, rendering and livestock feeds. Information on the structure and demographics of ruminant sectors and veterinary legislative authorities provides a contextual framework.

2. ASSUMPTIONS AND METHODS

This evaluation considers the following internationally recognized risk factors:

- importation of livestock and products from BSE-infected countries;
- rendering and livestock feed controls and practices.

2.1. Assumptions

- The only source for BSE in Canada is the importation of ruminants or ruminant products. A number of theories on the origin of BSE have been proposed, including spontaneous occurrence; however, this assessment follows the guidelines of the Office International des Épizooties (OIE) and focusses on importations.

- The main route of transmission of BSE is through feed.

- The presence of scrapie and chronic wasting disease (CWD) in Canada does not alter the risk of BSE emerging in Canada. Although one possible explanation as to the source of BSE in the United Kingdom implicates the inclusion of scrapie-contaminated MBM in cattle feed, this situation was assessed as highly unlikely to occur in Canada given the low numbers of sheep and the absence of other key risk factors (Kellar 2002). Regardless, information on all livestock prion diseases has been included for completeness in the Appendices, in response to international standards as published by the OIE.

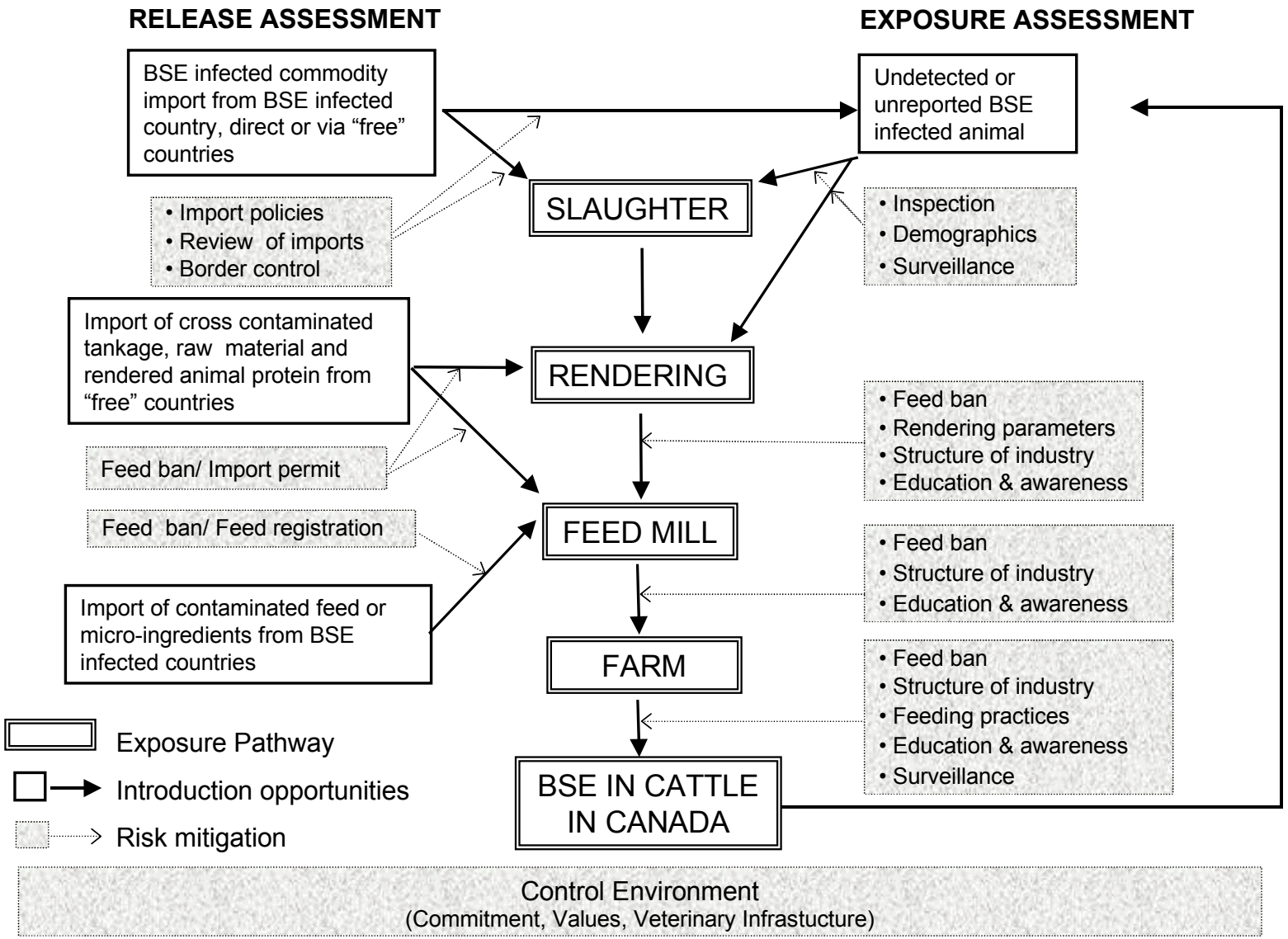
- Bovine embryos, collected and processed according to protocols established by the International Embryo Transfer Society, do not pose a BSE risk. (IETS 2001; OIE 2002).

The risk assessment also uses assumptions compiled by Health Canada in co-operation with the Canadian Food Inspection Agency (CFIA) (see Appendix 2), with the exception of the oral ID50, where 10,000 ID50s (SSC 1999) was used instead.

2.2. Methods

- Figure 1 details the risk pathways for BSE. This provides the framework for the evaluation.
- Information on other TSEs is included.
- This evaluation is much more exhaustive than Canada's evaluations of other countries for BSE because detailed information and original files were available and adequate to perform a more critical analysis. Accepting that Canada has implemented controls according to (and, in some cases, in addition to) internationally recognized standards, this critical analysis is expected to be useful in the fine-tuning of Canadian BSE control programs.
- The time period used in this risk assessment for the potential introduction of BSE is from 1979 onward for imports from the U.K. and other BSE-infected countries.

Figure 1: Risk Pathways for BSE in Canada



3. DEMOGRAPHICS AND INDUSTRY CHARACTERISTICS

Agriculture and agri-food is one of the most important sectors of Canada's economy. It is the second-largest manufacturing sector, the source of one in seven Canadian jobs, and is valued at $130 billion. Rapid growth in exports (to the current level of $23 billion) over the past several years has been largely attributed to Canada's reputation as a producer of safe, high-quality food. Canada is committed to maintaining this reputation, as demonstrated by the central role that food safety plays in the Canadian agricultural policy framework and in the food safety objectives of the CFIA (www.inspection.gc.ca), Health Canada (www.hc-sc.gc.ca), and Agriculture and Agri-Food Canada (AAFC) (www.agr.gc.ca).

3.1. Population and Distribution of Dairy and Beef Cattle

The population breakdown of cattle in Canada is found in Table 1. The cattle population has remained largely stable over the last several years at 14.6 million head in July 2001, compared with 14.7 in July 1995 and 14.9 in July 1997. The cattle population decreases by about 2 million head during the winter months, as animals are culled to reduce feeding costs. Of the total cattle population in 2001, 2.2 million were dairy cattle and 12.4 million were beef. The beef industry generally follows an 11-year cycle of growth followed by contraction in response to market supply-and-demand pressures. The dairy industry has a well-established domestic demand and limited exports. Hence, the population of dairy cattle has remained relatively stable, increasing slightly in response to small increases in the Canadian population.

Figures 2 and 3 show the geographic distribution of cattle populations across Canada. The dairy population is proportional to the human population in each province, and as such is concentrated in the central Canadian provinces of Quebec and Ontario. Beef production is concentrated in the western provinces of Alberta and Saskatchewan.

Table 1: Total Cattle Inventory, 2000–2001

	Jan 1/00	July 1/00	Jan 1/01	July 1/01
On ALL CATTLE Operations:	*'000 head*			
Bulls[1]	229.1	249.8	228.3	251.2
Milk cows[1]	1,140.6	1,127.4	1,135.9	1,131.5
Beef cows[1]	4,137.0	4,451.6	4,208.1	4,561.7
Milk heifers	464.6	479.0	466.0	473.0
Beef heifers - breeding	595.3	777.6	599.5	792.9
Beef heifers - slaughter	698.2	1,018.6	762.5	919.6
Steers	1,221.7	1,519.9	1,148.3	1,552.6
Calves	4,329.3	4,792.5	4,447.7	4,952.7
TOTAL Inventory	12,815.8	14,416.4	12,996.3	14,635.2
On DAIRY Operations:				
Bulls	16.4	16.2	14.6	15.0
Milk cows	1,140.6	1,127.4	1,135.9	1,131.5
Milk heifers	464.6	479.0	466.0	473.0
Beef heifers - slaughter	17.8	17.4	18.2	13.9
Steers	43.4	40.9	38.9	48.2
Calves	538.2	484.9	532.8	490.8
TOTAL Inventory	2,221.0	2,165.8	2,206.4	2,172.4
On BEEF Operations:				
Bulls	212.7	233.6	213.7	236.2
Beef cows	4,137.0	4,451.6	4,208.1	4,561.7
Beef heifers - breeding	595.3	777.6	599.5	792.9
Beef heifers - slaughter	680.7	1,001.4	744.5	905.6
Steers	1,178.4	1,479.0	1,109.7	1,504.7
Calves	3,791.2	4,307.8	3,914.9	4,462.4
TOTAL Inventory	10,595.3	12,251.0	10,790.4	12,463.5

Statistics Canada - Cat. no. 23-603-UPE

[1] Target population for surveillance

Figure 2: Distribution of Cattle in Canada

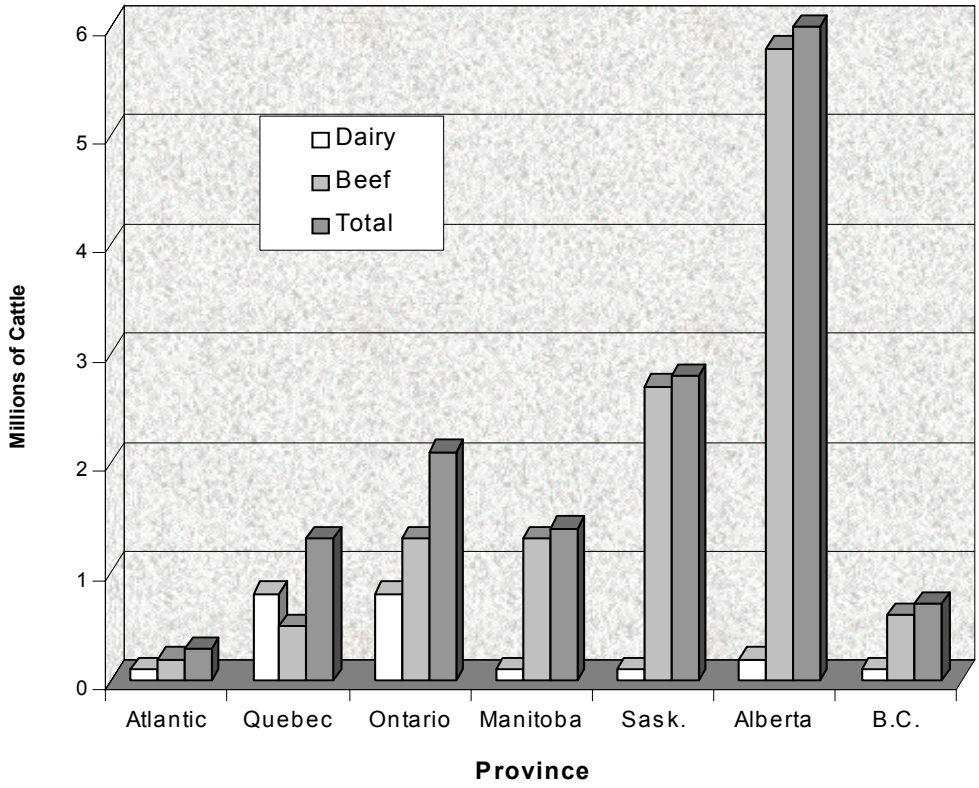
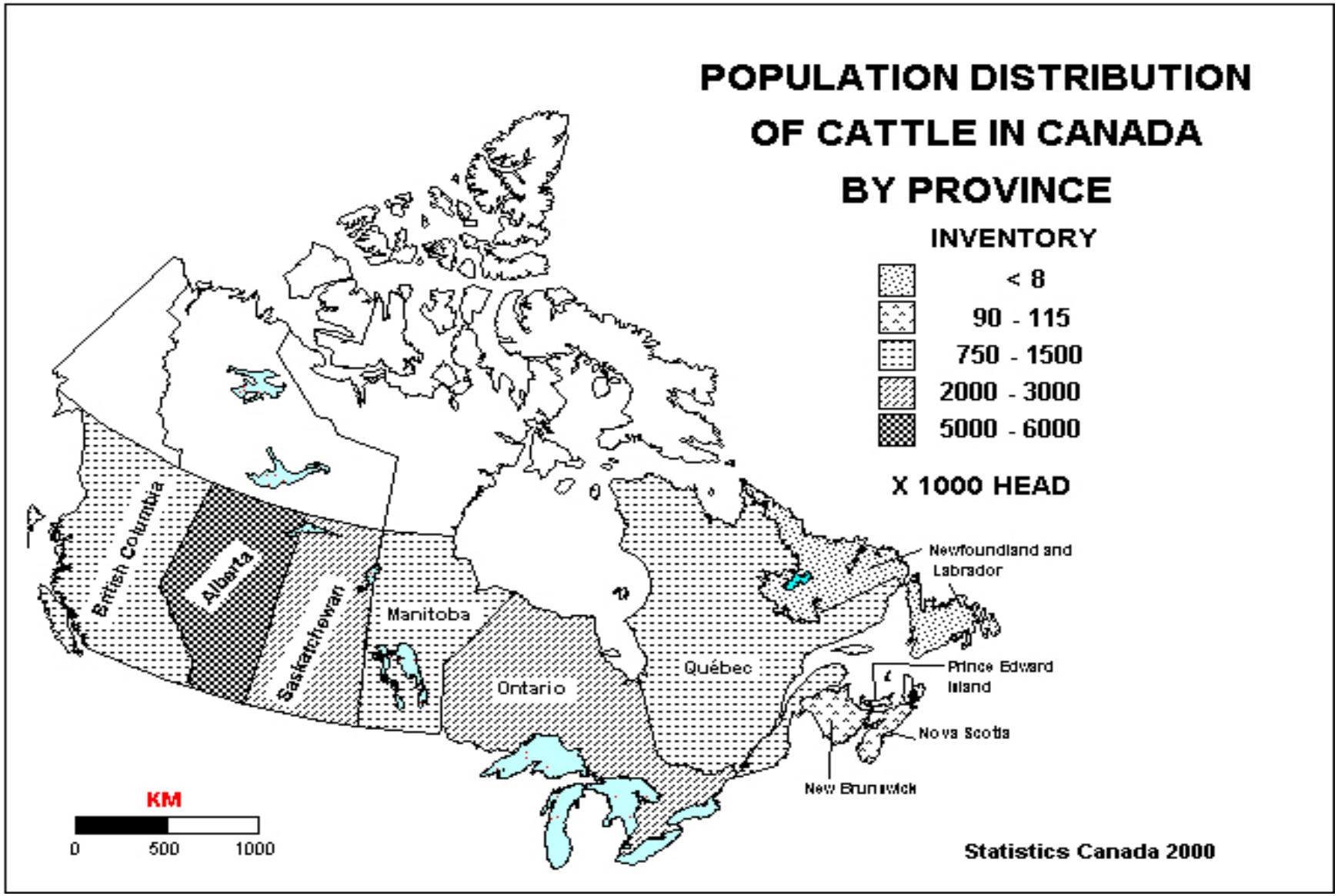


Figure 3:


POPULATION DISTRIBUTION
OF CATTLE IN CANADA
BY PROVINCE
INVENTORY
< 8
90 - 115
750 - 1500
2000 - 3000
5000 - 6000
X 1000 HEAD
British Columbia
Alberta
Saskatchewan
Manitoba
Ontario
Québec
Newfoundland and Labrador
Prince Edward Island
Nova Scotia
New Brunswick
KM
0
500
1000
Statistics Canada 2000

The distribution of slaughter and age at slaughter for Canadian cattle is found in Table 2. The bulk of the Canadian cattle slaughter (96%) occurs in federally inspected plants, which are the only establishments eligible to transport meat products across provincial and international borders. Less than 5% of the slaughter takes place in provincially inspected plants (Table 3), and of this 5%, the provinces with the largest cattle populations, Alberta, Ontario and Quebec, require that all cattle be inspected prior to slaughter (80% of the dairy population and over 60% of the total cow population are located in these three provinces). There is virtually no on-farm slaughter occurring in Canada. See Section 6.1 for details on the slaughter inspection system.

Over 70% of the beef slaughter in federally inspected plants takes place in Alberta. In federally inspected plants, 84% of the slaughter is made up of young animals (steers and heifers, mostly 18 months of age), with the balance consisting of cull cows and bulls. Provincially inspected plants are generally small in size, therefore tending to slaughter cattle from small farms and receiving a greater proportion of lower quality cull animals. Approximately 1.1 million young beef animals and 174,000 cull cows and bulls were exported to the U.S. for slaughter in 2000.

Table 2: Slaughter Cattle - Number Slaughtered in Federally Inspected Establishments in Canada

	British Columbia	Alberta	British Columbia/ Saskatchewan/ Manitoba	Saskatchewan/ Manitoba	Ontario	Quebec	Atlantic Provinces	Total for 2000
2000		2,306,623	172,939		550,746	185,322	39,550	3,255,180
1999	39,032	2,294,637		177,172	574,810	205,505	48,105	
1998	41,566	2,084,962		180,460	566,209	207,410	58,065	
1997	42,910	1,882,577		185,130	582,381	218,963	79,970	
1996	44,361	1,759,032		183,223	562,332	212,961	85,239	
Age and Sex of Cattle Slaughtered in Federally Inspected Establishments, 2000								
Steers		1,233,239	68,314		325,120	25,977	14,134	1,666,784
Heifers		876,190	22,845		191,387	12,367	10,961	1,113,750
Cows		191,238	79,907		30,966	140,733	13,730	456,574
Bulls		5,956	1,873		3,273	6,245	725	18,072
TOTAL		2,306,623	172,939		550,746	185,322	39,550	3,255,180

Source: Canfax and Canadian Beef Grading Agency

Table 3: Slaughter Cattle - Number Slaughtered in Provincially Inspected Establishments in Canada

	British Columbia	Alberta	Saskatchewan	Manitoba	Ontario	Quebec	Atlantic Provinces	Total
2000	9,468	27,969	3,660	10,096	98,415	10,313	8,112	168,033
1999	6,765	27,448	4,924	12,324	103,108	10,467	8,965	
1998	7,023	28,806	3,599	14,286	111,590	11,019	10,642	
1997	8,195	30,788	6,662	15,652	119,110	19,826	11,232	
1996	8,046	35,673	4,914	17,783	121,316	16,996	5,141	

Source: Canadian Food Inspection Agency and Provincial Governments

3.2. The Canadian Dairy Sector

The dairy sector is important to Canada, with total net farm cash receipts of $4.1 billion in 2000. Dairy products shipped from approximately 281 processing plants were valued at $9.8 billion, accounting for 14.3% of all processing sales in the food and beverage industry in Canada. There are nearly 26,000 people working on dairy farms, and almost 20,500 other workers are employed at the primary processing level.

About 81% of Canada's dairy farms are located in Ontario and Quebec, where the bulk of the Canadian population resides, with 14% in the western provinces and 5% in the Atlantic provinces.

For the year 2000–2001, there were 1.16 million cows in Canada on 19,411 dairy farms. The primary breeds in Canada are Holstein (comprising more than 91% of Canadian dairy herds), Ayrshire, Jersey, brown Swiss, Canadienne, Guernsey, and milking shorthorn. For each breed, a breed association has been established under the *Animal Pedigree Act*.

Based on official records for all breeds in 2000, the average production of cows enrolled on official milk recording programs was 9,152 kg of milk in 305 days of lactation. Protein and butterfat levels averaged 3.23% and 3.70% respectively. Canada has one of the highest average levels of milk production in the world. This success is due, in large part, to a well-organized national approach to dairy cattle improvement and genetic evaluations.

With an average herd size of 56 milking cows, most dairy farms in Canada are small, although the trend over the past several years is towards larger but fewer farms. Most producers raise their own replacement heifers.

Calving occurs year-round on dairy farms to ensure a constant supply of fluid milk. Calves are removed from their dams shortly after birth and fed on milk replacers. Male calves and cull heifer calves are generally sold to veal or beef operations. Replacement heifer calves are fed a grain and forage-based ration to ensure rapid growth and early onset of puberty.

Most farms produce much of their own forage and grains. Supplements are also provided to cows depending on their level and stage of production. Bypass protein is important during early lactation. Given the high productivity of Canadian dairy cattle, close management of nutrition is critical to maintaining good health.

On average, dairy cows are culled at about five years of age (Bouchard 2002). In Quebec dairy herds, about 30% of milking cows in all herds are over five years of age (purebred cows are kept longer than average). Turnover in the milking herd is estimated at 30% per year.

Generally, on farms that raise their own replacement heifers, it is more profitable to retain cows that are producing well than to cull them at an early age. Hence, one of the criteria by which bulls kept for artificial insemination are assessed is the longevity of their daughters. The longevity index is set at 3, meaning cows are expected on average to be kept for three lactations (Dagenais 2002).

Canada supplies more than 20% of dairy genetics to the world in the form of high-quality dairy cattle, embryos and semen. Canadian dairy cattle are exported to more than 50 countries. Exports of Canadian dairy genetic material were valued at more than $128 million annually prior to the BSE-related restrictions put in place by the EU in October 2001. In 2000, major export markets were the U.S., the U.K., Spain, Germany, Japan, Brazil, Australia, Iran, Italy, and Mexico.

3.3. The Canadian Beef Sector

Beef production contributed over $6.6 billion to farm cash receipts in 2000, with Canadian beef and veal packers processing over 3.4 million head of cattle. Total beef production has increased by 78% since 1970 to its current level of 1.51 million tonnes. Companies across Canada continue to invest capital for processing capacity expansion and product quality improvements.

Exports have become increasingly important, given that beef consumption in Canada has remained stable. Over 50% of Canada's production of cattle and beef is currently exported. Key markets are the U.S. (accounting for approximately 70% of total exports), Mexico, and Asia.

The major beef breeds in Canada are Hereford, Angus, Charolais, Simmental and Limousin. The industry is concentrated in regions with natural feed and land-base advantages for beef cattle production. Some 70% of beef cattle are located in the foothills and grasslands of Alberta and Saskatchewan.

Cow-calf ranching and cattle feedlot finishing are two distinct areas of specialization in Canadian beef production.

There are 4.8 million beef breeding cows and heifers in Canada (January 1, 2001). Total beef production per cow has increased from approximately 170 kg in 1972 to approximately 277 kg in 2000.

Most cow-calf ranches in Canada breed their cows in June and July, with calves born in March and April of the following year. This means that the young calves, almost all of which are raised outdoors, are not subjected to cold winter weather. The calves graze with their mothers on pastures and grasslands throughout the spring, summer, and fall seasons.

The average weight of calves at weaning in the fall (October or November) is about 250 kg, but weights can range from 160 to 320 kg depending on age at weaning, the genetic background of the calf, and grass conditions during the summer grazing season. The lighter calves (160–225 kg) are typically left on pasture for an extra 120–150 days before they enter backgrounding and high-energy feeding programs for slaughter between 18 and 24 months of age. The medium-weight calves (225–275 kg) at weaning are normally placed on a lower-energy backgrounding feeding program before being placed on a high-energy grain-feeding program for slaughter between 14 and 18 months of age. The heavier calves (275–320 kilograms) are normally placed on a high-energy grain-feeding program after weaning for up to 225 days, and are ready for slaughter between 12 and 14 months of age.

Feed rations are mostly based on barley in Western Canada's grain-feeding operations, while corn and barley is fed in Central and Eastern Canada.

Backgrounding is the process of feeding high-forage (alfalfa hay and straw) feeds to increase the weight of smaller calves up to 350 kg. At least one half of the calves produced in Canada each year are backgrounded before they start on a high-energy feedlot finishing program. After weaning, light calves are fed forages and grain through the winter to gain weight at 680 g to 1 kg per day. In the spring, the smaller of these calves remain on pasture or are put into feedlots to gain weight at a rate of about 1.2–1.4 kg per day. The larger calves move into feedlots and are fed high-energy feed rations.

Along with the trend to larger and more specialized cow-calf ranches, the Canadian cattle industry has evolved towards more specialization in the grain feeding of slaughter cattle. Feedlots range in size from a few hundred head capacity to very modern operations feeding over 40,000 animals at one time. Historically, most cattle were fed in small feedlots on diversified farms that also grew feed grains and wheat for human consumption. Since the land and water resources and climate in Canada are very suitable to cattle feeding, many feedlots have become larger and more highly mechanized over the past fifteen years to specialize in cattle feeding. It is estimated that over 70% of the cattle grain-fed in Canada are produced in feedlots with capacities over 1,000 head. This produces uniform and high-quality beef products.

In 2000, Canadian feedlots finished 2.7 million steers and heifers for slaughter in Canada. Another 780,000 were fed in Canada for slaughter in the U.S.

Feedlot owners purchase calves or feeder cattle from either cow-calf ranches or backgrounding operations. Only a small portion of the calves produced in Canada are fed to slaughter weights by the original owner of the ranch on which they were born.

In the feedlot industry, there are two basic types of feeding systems, the system used depending on the weight of the animals when they are placed on the finishing program. A multi-stage feeding system is used for those steers and heifers that enter the feedlot at lighter weights. These cattle are started on a higher forage-lower grain feed ration to initially gain weight at about 1 kg per day. They are fed at this level for a few weeks, after which the proportion of grain in the feed ration is gradually increased to 85–90%. Heavier feeder cattle begin at these high-percentage-grain feed rations. The average live weight at slaughter for steers is about 590 kg, while the average weight for heifers is about 550 kg.

In recent years, Canada has exported approximately 1 million head of live cattle to the U.S. annually. Canada has also begun importing more cattle from the U.S. for feeding and/or processing in Canada. The total number of cattle imported by Canada rose from 91,000 in 1998 to 233,000 in 1999 and to over 260,000 head in 2000.

3.4. SUMMARY - DEMOGRAPHICS AND STRUCTURE

- Food safety is a key commitment of three major federal government organizations dealing with agriculture and agri-food, food inspection, and public health.
- The dairy and beef sectors are important to Canada, contributing tens of thousands of jobs and about $11 billion in farm cash receipts to a vigorous and growing agriculture and food sector.
- The dairy and beef sectors are modern and specialized. Canadian dairy cattle are high-producing, and their genetic material is in demand in many countries of the world. Canadian beef exports are expanding, a good part of this based on Canada's reputation for delivering a safe, high-quality product.
- The dairy population is concentrated in central Canada where most of the Canadian population resides. On average, dairy cows are retained for at least three lactations before being culled at about five years of age, and would therefore be old enough to show clinical signs of BSE if the disease were present in Canada.
- Beef production is concentrated in Western Canada. Most beef animals are slaughtered at 18 months of age and would introduce little infectivity into the food or rendering system if BSE were present in Canada. Beef cows are generally forage fed over winter and put out to pasture with their new calves in the spring and are less likely than dairy cattle to be exposed to high-protein meals.

4. LEGISLATIVE AUTHORITY AND VETERINARY INFRASTRUCTURE

4.1. Legislative Authority

The Minister of Agriculture and Agri-Food is responsible for and has overall direction of the CFIA. The CFIA is responsible for the administration and enforcement of legislation related to food safety and animal health. The following acts and regulations are relevant in the prevention and control of BSE:

- *Health of Animals Act* and *Regulations* (1990, c. 21)
- *Meat Inspection Act* and *Regulations* (R.S. 1985, c. 25 (1st Supp.))
- *Feeds Act* and *Regulations* (R.S. 1985, c. F-9)
- *Agriculture and Agri-Food Administrative Monetary Penalties Act* and *Regulations* (1995, c. 40)

In general, the language used in the acts and regulations is broad, and specific actions and criteria are established in CFIA-issued policies and directives. This is an advantage in that policies and directives can be produced quickly and are relatively easy to amend in response to new scientific information, rather than legislative amendments, which can take much longer periods of time.

In cases of non-compliance, the following enforcement and compliance options are available to the CFIA:

- issuing a written warning letter;
- suspending or withdrawing a permit or registration;
- ordering imported products to be returned to the country of origin or destroyed;
- refusing to issue an import permit or export certificate;
- issuing a quarantine notice;
- imposing monetary penalties; and
- prosecuting the non-compliant individual(s).

Unofficial versions of the legislation mentioned above may be viewed at http://laws.justice.gc.ca. The legislative material on this site has been prepared for reference only and may not reflect recent amendments. For the purpose of interpreting and applying the law, users should consult:

- the acts as passed by Parliament (http://www.parl.gc.ca), which are published in the "Assented to" Acts service, Part III of the *Canada Gazette* (http://canada.gc.ca/gazette/main.html) and the annual Statutes of Canada; and

- the regulations, as registered by the Clerk of the Privy Council and published in Part II of the *Canada Gazette* (http://canada.gc.ca/gazette/main.html).

The following section gives a general overview of these acts and regulations. More details on their application are provided in individual sections of this document. A chronological overview of the Canadian legislative changes made between 1982 and 2001 in response to the threat of BSE may be found in Appendix 1.

4.1.1. *Health of Animals Act* and *Regulations*

The *Health of Animals Act* (Appendix 3) is the principal authority that the CFIA applies to regulate animal diseases and toxic substances. The purpose of the Act and its Regulations is to prevent the introduction of animal diseases into Canada, to control and eliminate diseases that either affect human health or could have a significant economic effect on the Canadian livestock industry, and to provide for the humane treatment of animals during transport. The Act and Regulations regulate international trade in live animals, animal products and by-products, animal feed, veterinary biologic and biotechnology products. They provide for the approval and registration of private quarantine premises, for the control of infected places, and for approval and registration of establishments involved in importation (animals, animal products and veterinary biologic products).

The Act authorizes the development of regulations for the purpose of protecting human and animal health through the control or elimination of diseases and toxic substances. To prevent, control and eliminate serious diseases like livestock transmissible spongiform encephalopathies, the *Health of Animals Regulations*, the *Reportable Diseases Regulations*, and the *Compensation for Destroyed Animals Regulations* were set out under this Act.

CFIA inspectors are authorized under the Act to enter premises, open receptacles or things, require presentation of animals for inspection, examine any animal or thing, require production of documents, conduct tests or analyses, seize and detain animals, and enter a dwelling place with a warrant.

Offences and punishments are outlined for contravention of any provision of the Act and Regulations. Any violation to most provisions of this Act and Regulations may also be punishable

under the *Agriculture and Agri-Food Administrative Monetary Penalties Act* and *Regulations*.

4.1.2. The *Health of Animals Regulations*

The *Health of Animals Regulations* (Appendix 4) specify requirements relating to the prevention, control and elimination of diseases and the humane treatment of animals during transport. These requirements are met by applying a broad range of rules, including, but not limited to, the control of animal movements; identification; quarantine; importation of animals, animal products and animal by-products; destruction of diseased animals; and control of veterinary biologics. The regulations are divided into ten parts and six schedules, of which the following are related to the control of BSE.

Part I (Segregation and Inspection of Animals) defines the inspector's authority to order the person having possession, care or custody of the animal to keep the animal separate for inspection and testing, to quarantine, to destroy, dispose of its carcass, and to request documentation.

Part II (Importation) regulates the import of live animals. The Minister may designate countries or parts of countries as free from the disease specified. Live animals imported from countries other than the U.S. must be accompanied by an official certificate stating that the animal meets Canadian import requirements.

Part IV (Importation of Animal By-Products, Animal Pathogens and other things sets out the rules for importing animal by-products, such as rendered animal products, garbage, blood or serum (other than veterinary biologics) and other animal products. From countries other than the U.S., these products must be accompanied by an official certificate stating that they meet Canadian import requirements.

Part VII (Quarantine of Imported Animals) stipulates that all animals imported into Canada are subject to inspection, testing and treatment at a quarantine place approved by the Minister. The Minister also has the authority to order any imported animal quarantined and to request that such an animal be destroyed or removed from Canada if it fails to prove negative to any test for a disease.

Part IX (Eradication of Diseases) regulates the establishment of an eradication area and the obligation to possess a permit to move an animal from an eradication area. The Minister may designate the animals infected or contaminated by a disease and order them to be segregated, inspected, and tested.

Part X (General Provisions) prescribes the quarantine notification to be given by an inspector and prohibits any person to do, or permit to be done, any of the listed actions on the animal, disease agent or thing quarantined, without authorization. A person who owns, has the possession, care or control of a quarantined animal has the responsibility to notify a veterinary inspector of any quarantined animal that appears sick and to comply with any notice of quarantine. Public sales, animal markets, and auctions (Sections 92 to 97) must maintain records for every animal received and sold. The use of edible residual material in feeding swine or poultry is regulated under Part X (Sections 111 to 113), as is the disposition of a diseased carcass (Section 114).

Part XI (Veterinary Biologics) requires that a permit be obtained to release and to import a veterinary biologic and that information be provided for the purpose of obtaining a permit. The manufacturer must show that a biologic is unlikely to pose a risk of harm to the environment or to human or animal health. The requirements to obtain an establishment and product licence and the conditions of operations in a licenced establishment are also set out in this part.

Part XIII (Permits and Licences) sets out the requirements to obtain a permit or licence.

Part XIV (Food for Ruminants, Livestock and Poultry) defines “prohibited material” as “anything that is, or that contains any protein that originated from a mammal, other than a porcine or an equine. It does not include milk, blood, gelatin, rendered animal fat or their products” (Section 162) and prohibits the feeding of this material to ruminants. This part prohibits the production and the importation of rendered material without a permit and identifies the obligation to keep records and to place a warning label if the feed contains prohibited materials. The importation, manufacturing, packaging, labelling, storage, distribution, sale or advertisement for sale of animal food or animal food for ruminants that contains prohibited material is regulated within this part.

Part XV (Animal Identification) regulates the approval and issuance of identification devices, the obligation to keep records, and the requirement to identify an animal under a national identification program for animals.

4.1.3. *Reportable Diseases Regulations*

Pursuant to Section 2 of the *Health of Animals Act*, the Minister may designate reportable diseases. If a disease is reportable, persons having the care of animals are obliged to notify without delay the nearest veterinary inspector of the presence of a reportable disease or the suspicion that an animal is infected with a reportable disease. In November 1990, the Minister of Agriculture named BSE a reportable disease. Scrapie and chronic wasting disease (CWD) were named reportable diseases in 1945 and 2001 respectively.

4.1.4. *Compensation for Destroyed Animals Regulations*

These regulations establish the maximum amount of compensation payable for an animal that is destroyed or required to be destroyed under the *Health of Animals Act* and *Regulations*. The *Compensation for Destroyed Animals Regulations* also set out rules to compensate for carcass disposal costs paid by the owner.

4.1.5. *Meat Inspection Act* and *Regulations*

The *Meat Inspection Act* and *Regulations* regulate:

- the international and interprovincial trade in meat and meat products;
- the registration of establishments (slaughterhouse, processing/packaging, and cold storage);
- the inspection of animals and meat products in registered establishments; and
- the standards for animals slaughtered and for meat products prepared in those establishments.

The Act and its Regulations play a role in animal health programs by regulating meat products, ante-mortem and post-mortem inspection, slaughter, animal condemnation, and disposition. Under the *Meat Inspection Act* and *Regulations,* federal inspectors are required to be present in federally registered slaughterhouses, may enter premises or vehicles, open packages, inspect and take samples, require production of documents, seize and detain meat, and enter a dwelling place with a warrant. The Act makes provision for offences and punishment for persons in contravention of the Act and Regulations.

4.1.6. *Feeds Act* and *Regulations*

The *Feeds Act* controls and regulates substances manufactured, imported, sold or represented

for use for consumption by livestock. Feeds may only be manufactured, sold or imported into Canada if they are registered (with some exclusions), conform to standards and are labelled, or are exempt from these provisions, as prescribed in the regulations.

The CFIA regulates the use of ingredients in livestock feeds. Section 2 of the Act defines feeds as: "any substance or mixture of substances containing amino acids, anti-oxidants, carbohydrates, condiments, enzymes, fats, minerals, non-protein nitrogen products, proteins or vitamins, or pelletizing, colouring, foaming or flavouring agents and any other substance manufactured, sold or represented for use:

a. for consumption by livestock;
b. for providing the nutritional requirements of livestock; or
c. for the purpose of preventing or correcting nutritional disorders of livestock, or any substance for use in any such substance or mixture of substances."

Using the authority of the *Feeds Act*, the CFIA administers a national livestock feed program to verify that all livestock feeds manufactured and sold in Canada or imported into Canada are safe, effective and are labelled appropriately. The *Feed Regulations* outline feed registration requirements, standards as to composition, freedom from contamination, and labelling requirements. Regulated feeds are divided into two categories: feed ingredients and mixed feeds.

Inspectors designated under the *CFIA Act* may enter premises, open packages, examine feed, take samples, require documentation, seize and detain articles, and enter a dwelling place with a warrant. The Act also makes provisions of offences and punishment for every person who is guilty of contravening any provisions of the Act and Regulations.

4.1.7. *Agriculture and Agri-Food Administrative Monetary Penalties Act* and *Regulations*

The *Agriculture and Agri-Food Administrative Monetary Penalties Act* establishes a fair and efficient administrative monetary penalty system for the enforcement of the *Health of Animals Act* and other acts legislated by the agri-food acts. It is used as an alternative to the existing penalty system and as a supplement to existing enforcement measures. Administrative monetary penalties (AMPs) emphasize compliance rather than punitive action and provide for more immediate enforcement and corrective action.

The CFIA is proposing to add provisions to the AMPs that would identify violations of Part XIV (Food for Ruminants, Livestock and Poultry) and Part XV (Animal Identification) of the *Health of Animals Regulations*.

4.2. Veterinary Infrastructure

In Canada there are approximately 8,720 veterinarians (Canadian Veterinary Medical Association November 2001) and approximately 3,000 registered animal health-veterinary technicians/ technologists (Canadian Association for Animal Health Technologists/Technicians January 2002). A breakdown of the geographic distribution of veterinarians and practice types in Canada may be found in Appendix 5.

Although there are no specific statistics available for the veterinarians providing services to cattle farms, it should be noted that most commercial dairy farms are enrolled in health management programs that include regular monthly visits by their veterinarian. Similarly, most large cattle

feedlots have engaged the services of their veterinarian for regular farm visits to view the animals on feed and to discuss any health and production problems. Cow-calf farms using health management normally schedule quarterly farm visits with their veterinarian for health management procedures. For those not using health management, veterinarians would be on-farm frequently during the spring calving season and in the fall for pregnancy checks and to assist in culling decisions.

In Canada, veterinary licensure is the responsibility of provincial and territorial veterinary bodies, authorized by acts of the provincial and territorial governments. In addition, there is a national organization, the Canadian Veterinary Medical Association (CVMA), which co-ordinates the National Examining Board examinations.

Licencing for veterinarians requires graduation from a recognized veterinary school, and may also require completion of all or part of the National Examining Board of the CVMA. In some cases, maintenance of a general licence requires the demonstration of continuing education.

Canada has four veterinary colleges, each accredited by the American Veterinary Medical Association. A minimum of two years of pre-veterinary studies are required before candidates can be admitted to the four-year veterinary program (five-year program in Quebec), and admission requests greatly exceed the available vacancies. Approximately 305 students are admitted annually to the Doctor of Veterinary Medicine degree in Canadian universities.

There is a diverse network of animal health laboratories across Canada, including laboratories operated by the federal and provincial governments, universities and private firms. Services provided include necropsy, histopathology, clinical immunology, microbiology, molecular biology, serology, and virology.

4.2.1. Organization and Structure of Canadian National Veterinary Services

The CFIA is the Veterinary Administration, as defined in the OIE Animal Health Code (Article 1.1.1). It is a science-based federal regulator of food, animals and plants, and is committed to enhancing the safety of federally regulated food, contributing to the health and welfare of animals, and protecting the plant resource base.

With its headquarters in Ottawa and a program and operations network throughout Canada (Figure 4), the CFIA delivers its mandate through 4 area offices (Atlantic, Quebec, Ontario and Western), 18 regional offices, 185 field offices and hundreds of offices in non-governmental and commercial establishments. In addition, the CFIA has 21 laboratory and research facilities across Canada.

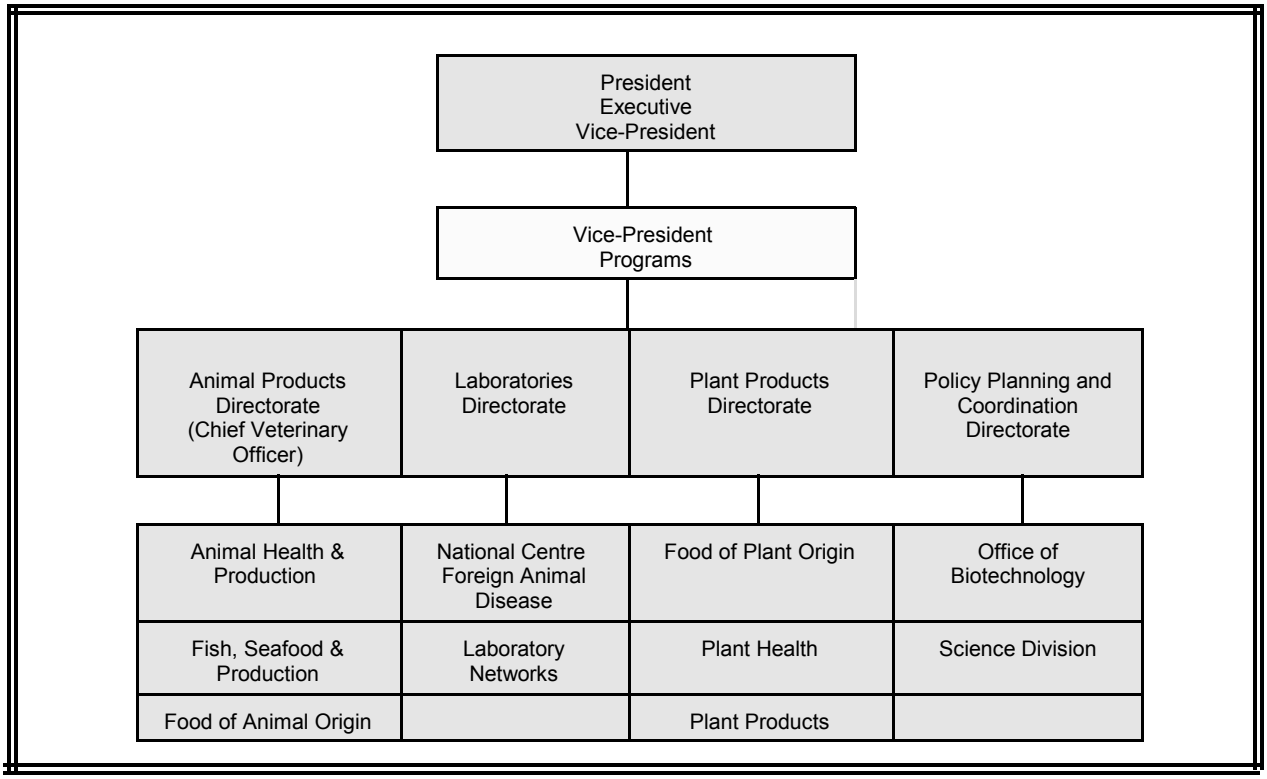
The CFIA controls specified animal diseases, regulates animal feed and veterinary biologics, performs tests on animals exported from and imported into Canada, and is also responsible for the control of zoonotic diseases. In addition, the CFIA monitors businesses engaged in the international or domestic movement of animals for compliance with regulations pertaining to the humane transportation of animals. Canada is a long-standing member of the OIE, consistently fulfilling its reporting requirements, and uses the Animal Health Code as the relevant standard for zoo-sanitary control.

The CFIA has a comprehensive veterinary infrastructure that provides for disease surveillance and control:

- Canada has about 500 official veterinarians who are qualified and well-trained;
- official services are complemented by private sector and industry veterinarians;
- the legislation is modern and establishes controls over the entire food production continuum—from farm to plate; and
- Canada has effectively controlled or eradicated many serious animal diseases and enforces international standards relevant to the use of drugs and other treatments in animals.

A highly effective veterinary infrastructure is in place to verify that controls are being properly enforced, as values and ethics are considered important by the Government of Canada (Treasury Board of Canada 2000). Canada is recognized internationally as having a very low level of corruption (Corruption Index 2000).

Figure 4: The Organizational Structure of the Canadian Food Inspection Agency



4.2.1.2. Material (including financial) Resources

Material and financial allocations provide for well-qualified and well-equipped staff to deliver national veterinary services. Of a total of CDN $442 million in expenses in 2001, the CFIA spent CDN $88 million (or about 20%) on animal health programs.

The CFIA's effort to mitigate risks will continue to require a significant resource commitment, particularly when international circumstances call for heightened vigilance and protection.

4.2.1.3. Human Resources

The CFIA employs approximately 4,800 staff. These include highly trained front-line inspectors, veterinarians, agronomists, biologists, chemists, administrative staff, computer systems specialists, financial officers, communications experts, research scientists, laboratory technicians, and managers (CFIA Annual Report 2000–2001).

Over 300 veterinarians, along with over 1,000 lay inspectors, are employed in the various regions of Canada to implement animal health and meat hygiene programs and would therefore be involved with BSE surveillance. Federal veterinarians are assisted in surveillance by a formal network of federal, provincial, academic and practising veterinarians (see Part B: BSE Surveillance and Related Activities, Section 3.3.3).

Veterinarians employed by the CFIA must have a degree in veterinary medicine from a recognized university and be eligible for membership in a Canadian Veterinary Medical Association.

4.2.1.4. Laboratory Services

The CFIA operates 21 laboratories across Canada, providing both research and diagnostic services. The distribution of CFIA laboratories across Canada is available in Appendix 6. Of these, 5 are directly involved in the provision of animal health diagnostic services supporting the Animal Health Program of the CFIA and have been accredited or are actively seeking accreditation by the Standards Council of Canada according to guidelines of the International Standards Organization (ISO 25 or 17025).

In addition to CFIA-operated laboratories, a number a laboratories are accredited by the CFIA to perform specific diagnostic tests. A description of the accreditation process as well as a list of accredited laboratories across Canada is found in Appendix 6.

4.2.1.5. Provincial Veterinary Services

The provincial governments play important supporting roles in the areas of disease diagnosis, surveillance and control for the CFIA's national Animal Health Program. These provincial functions have their origins in a longstanding rapport with the federal government developed over many decades of disease control work. Close relationships between federal and provincial animal health diagnostic laboratories ensure co-operation in disease control and consistency in diagnostic protocols.

In addition, the provincial governments take the lead role in detection and control of the several dozen OIE List B diseases that do not fall under the federal reportable disease list. Emerging diseases are also included in the domain of their investigations. Communication among the provinces and CFIA pertaining to these "non-program" diseases is ongoing, through a formal mechanism called the Canadian Animal Health Network. The CFIA plays a supporting role in this network; the provincial-federal weighting of veterinary infrastructure is reversed from that described above.

The Canadian federal and provincial veterinary infrastructures are complementary for national-level animal disease detection and control — this co-operation has created a valuable interdependence.

The role the provinces play in disease surveillance is described in Part B, Section 3.3.3.

4.3 SUMMARY - LEGISLATIVE AUTHORITY AND VETERINARY INFRASTRUCTURE

- The Minister of Agriculture and Agri-Food is responsible and has overall direction of the CFIA, which administers and enforces pertinent legislation related to food safety and animal health.
- The *Health of Animals Act* and *Regulations* is the primary authority used by the CFIA to regulate animal diseases and toxic substances. The Act prevents the introduction of animal diseases into Canada, controls and eliminates diseases that affect human health or could have a significant economic impact on the Canadian livestock industry, and provides for humane treatment of animals during transport.
- The *Meat Inspection Act* and *Regulations* regulate meat products, ante- and post-mortem inspection, slaughter, animal condemnation and disposition
- The *Feeds Act* and *Regulations* regulate substances manufactured, imported, sold or represented for use for consumption by livestock. The CFIA administers a national livestock feed program under authority of the Act to verify that all livestock feeds manufactured and sold in Canada or imported into Canada are safe, effective, and labelled properly.
- The *Agriculture and Agri-Food Administrative Monetary Penalties Act* and *Regulations* establish a fair and efficient administrative monetary penalty system for the enforcement of the *Health of Animals Act*.
- In Canada there are approximately 8,720 veterinarians. There are four veterinary colleges, as well as a network of animal health laboratories across the country.
- The CFIA employs approximately 4,800 staff, including a comprehensive veterinary infrastructure of about 500 veterinarians, providing for disease surveillance and control.

5. IMPORT

5.1. Import Policies

5.1.1. Overview of Import Policies and Legislation

In the early 1980s, before the advent of animal health risk analysis, while few efforts were made to actually quantify the risk associated with importations, Canada was protective of its animal health status. The import of products that would introduce foreign diseases was not allowed. Given that the major disease of interest was foot-and-mouth disease (FMD), many animal products that had the potential to spread BSE (such as tankage and meat meal) were not allowed to be imported except from the U.S. Cattle from Europe (which was, at that time, still experiencing FMD outbreaks in certain countries) were subject to extensive testing and lengthy quarantines, an expensive process that limited the number of imports.

In the late 1980s, in response to domestic and international trade initiatives, the regulatory process was reviewed with respect to the import of animals and animal products. The resulting 1988 General Import Policy for Inedible Meats and Animal Products specifically defined the conditions under which certain animal products could be imported. The import of commercial shipments of meat meal, blood meal, bone meal, and other inedible meat products from countries other than the U.S. was prohibited. While not directed at BSE, these measures nevertheless reduced the probability of BSE entry.

However, the 1988 General Import Policy had a greater impact than originally envisaged. The clear definition of conditions and rationale for import decisions created a situation whereby all import conditions were now subject to review and challenge based on science. This ongoing review, coupled with improved health status in many European countries, led to restrictions being eased for certain countries.

Meanwhile, BSE was emerging as a significant disease in the U.K., and there was evidence of its spread to other European countries. Canadian import policies and practices were amended accordingly. In 1990, an import ban was placed on cattle from the U.K., in 1991 the import of beef products from European countries not free of BSE was banned, and in 1994 a ban was imposed on the import of cattle from countries where BSE had been diagnosed in native cattle.

All animals and most animal products originating from Europe required (and still do require) an import permit before being imported into Canada. Throughout this period and until 1998, the issuance of import permits was the responsibility of CFIA headquarters. The import specialists were aware of the growing problems with BSE, and as a result, import permits were not issued if there was concern about BSE risk. Similarly, requests for approval of meat establishments in countries considered to be at risk for BSE were deferred.

Several commodities, including feeds, live animals, animal products and by-products, veterinary pharmaceuticals and biologics, pose a BSE risk. As new scientific information became available, the CFIA made appropriate amendments to the import conditions. And the need to standardize BSE import policies with those of other BSE-free countries was accelerated when BSE was linked to human disease in the U.K.

In 1996, the CFIA undertook a formal review of all animal, animal product and veterinary biologics import policies and produced an updated integrated import policy for BSE.

Historically, exemptions have allowed travellers to import cooked canned meat for personal consumption; however, the consolidated BSE import policies implemented in 1996 revoked this exemption. Cooked canned meat of bovine, ovine or caprine origin is only permitted entry from countries recognized free from BSE. Food of European origin for travellers, athletes and armed forces personnel temporarily entering Canada is allowed under permit, with the condition that all remnants of food with beef or beef ingredients are re-exported or incinerated.

Fundamental to the policy established in 1996 and updated in April 1998, December 1998 and March 2001, is the principle that BSE-susceptible livestock or animal products should only be imported from countries Canada has designated free of BSE. Countries wishing to export these products to Canada must provide relevant information, which is used to conduct a risk assessment according to OIE standards. The countries currently designated free of BSE by Canada are Argentina, Australia, Brazil, New Zealand, the U.S., and Uruguay. A risk assessment of Mexico is close to finalization.

Although there were objections when this principle was implemented, the CFIA considers that this prevented the importation of "risk" products from countries that subsequently reported cases of BSE.

Key developments in the evolution of Canadian import policies on BSE are presented below.

5.1.2. Current BSE Import Policies

The current policy was implemented in February 2000, for conditions related to live animal and meat imports and on December 7, 2000, for conditions related to rendered animal proteins. The consolidated version of the import policies (dated March 2, 2001) is found in Appendix 7.

Live ruminants may only be imported from countries that Canada has designated free from BSE following a comprehensive risk assessment.

Bovine embryos may be imported from countries not classified free from BSE if the country of origin certifies that:

- The donor cow was born after:

    1. BSE was made a nationally notifiable disease in the country of origin;
    2. the country has implemented an acceptable eradication policy (e.g. destruction of positive and at-risk animals);
    3. the country has implemented an acceptable surveillance and monitoring program for BSE; and
    4. the country has implemented an appropriate risk management strategy for BSE.

- The donor cow was not fed ruminant meat-and-bone meal.
- The donor is not a BSE suspect or progeny of a sire or dam affected with BSE.

Embryos have not been imported from Great Britain since 1998, when embryo import conditions were suspended for that country.

Ovine and caprine embryos may only be imported from countries designated free from BSE.

Bovine, ovine, and caprine semen are exempt from import requirements specific to BSE.

Animal product and by-product exemptions from import requirements for BSE are:

- milk, milk products and derivatives (casein and lactose);
- hides, skins, hair and products derived from these tissues (including gelatin and collagen);
- gelatin and collagen derived from other tissues, providing it is not used in livestock feed;
- products produced by subjecting bones to rigorous processes of extraction and purification, such as ossein, bone ash, bone charcoal, bone oil, and dicalcium phosphate;
- products containing bovine material sourced from tissues with no detected BSE infectivity that have been subjected to rigorous processes of extraction and purification, such as glue, oleosterin, triglycerides, glycerol, and sorbitan esters; and
- pet chews.

Edible meat and meat products of ruminant origin, including edible tallow, may only be imported from countries designated free from BSE.

Rendered animal protein (all species) including tallow containing protein, pet food, and fertilizers containing animal protein may only be imported from countries designated free from BSE.

Protein-free tallow may be imported from countries not designated free from BSE if it is certified to be protein-free (maximum level of insoluble impurities of 0.15% in weight) and that measures have been taken to prevent cross-contamination.

Animal blood: sprayed dried blood may be imported only from countries designated free from BSE. Bulk fetal bovine serum may be imported under permit but may not be used for the manufacture of veterinary biologics.

Livestock feed may be imported provided it meets the controls on animal products listed elsewhere in the Canadian BSE Import Policies and provided that it is labelled in accordance with the Canadian Feed Ban.

Ruminant specific risk materials and products containing them may only be sourced from countries designated free from BSE. Requests for exemptions may be reviewed on a case-by-case basis.

Cell lines originating from bovine tissues may be imported under the authority of an import permit. Specific conditions are put in place according to the nature of the work.

Veterinary biologics containing bovine-, ovine- or caprine-origin material for animal administration may only be imported from countries designated free from BSE. No veterinary vaccines or bacterins containing ruminant materials sourced from BSE-affected countries are allowed. Veterinary biologics containing bovine material for laboratory diagnostic purposes may be imported from countries not designated free from BSE under the authority of an import permit specifying conditions of use and disposal. As of January 2002, there are significant new documentation requirements for materials of animal origin in veterinary biologics that strengthen previous requirements (Appendix 8).

5.1.3. Country Evaluations and Designated Countries

In late 1996, Canada implemented a policy requiring that countries be evaluated as to their BSE status and designated free of BSE before being allowed to export specified products to Canada. The country evaluation process involves a risk assessment according to OIE recommendations, based on information provided by the country (see Appendix 9).

Canada, the U.S. and Mexico share information and work co-operatively on country evaluations for BSE.

During a period of transition, certain countries were considered of negligible risk and were designated free prior to an in-depth evaluation of their status for BSE. These included Australia, Denmark, Finland, Iceland, New Zealand, Norway, Sweden, and the U.S.

Denmark, Finland, Iceland, Norway and Sweden were later dropped from the list, and the U.S., Australia, New Zealand, Argentina, Brazil, and Uruguay were added as their country evaluations were completed.

5.1.4. Previous BSE Import Policies

Unless otherwise referenced, the following dates refer to specific documents, which have been appended:

- 1982: *Animal Disease and Protection Act* and *Regulations* (ADPA) (Appendix 10)
- 1988: Import Policy for Inedible Meat and Other Animal Products (Appendix 11)
- 1996: Rationale for Canadian Import Policies Pertaining to BSE (Appendix 12)
- 1997: Policy for Importation of Rendered Products into Canada (Appendix 13)
- 1998 (April): Canadian BSE Import Policies, April 6, 1998 (Appendix 14)
- 1998 (December): Canadian BSE Import Policies, December 1, 1998 (Appendix 15)

Live ruminants:

- 1982: Importation of live ruminants allowed from Europe under permit system with strict quarantine requirements (ADPA, Sections 10–11, 63–64).
- 1987: Certification required that the farm of origin is free from BSE for cattle imported from the U.K. (Koller 2001).
- 1990: Import ban imposed on live ruminants from the U.K. and Ireland (McElheran 1990).
- 1994: Import ban imposed on live cattle from all countries where BSE had been diagnosed in native cattle.
- 1996: Live bovines may be imported only from countries Canada has recognized free from BSE.
- 1998 (April): No change from 1996 policy.
- 1998 (December): Changed from live bovine animals to live bovine, ovine and caprine animals.

Ruminant Embryos:

- 1982: Ruminant embryos may be imported under the authority of an import permit (ADPA Section 32).
- 1996: Embryos permitted to be imported provided they were collected from donors not clinically affected by BSE, not suspected of being infected, and not the progeny of an infected animal, provided that the country of origin was adhering to the risk management practices for BSE specified by the OIE.
- 1998: Import conditions suspended for bovine embryos from Great Britain (in 1997 the European Union imposed export restriction from Great Britain).
- 1998 (April): Import conditions for bovine embryos in the April 1998 policy were equivalent to current requirements. No conditions were listed for ovine and caprine embryos.
- 1998 (December): Ovine and caprine embryos banned from countries not designated free from BSE.

Ruminant Semen:

- 1982: Ruminant semen permitted under the authority of an import permit (ADPA Section 35).
- 1996: Bovine semen permitted from BSE-infected countries with some conditions.
- 1998 (April): Bovine semen exempted from import requirements specific to BSE.
- 1998 (December): Ovine and caprine semen exempted from import requirements specific to BSE.

Animal Product and By-Product Exemptions (from BSE import requirements):

- 1996: a) milk, milk products, and products derived from milk (casein, lactose);
  b) hides, skins, hair, and products derived from these tissues (gelatin);
  c) products and by-products derived from bovine material of minimal risk for BSE that have been subjected to rigorous processes, such as glue, ossein, bone ash, collagen, bone oil, tallow, and oleosterin.
- 1998 (April): Blood, serum, and derivatives were added to the list of exempt products.
- 1998 (December): No changes from previous policy.

Edible Meat and Meat Products:

- 1982: Meat imports permitted from countries provided they were free of certain foreign animal diseases, subject to inspection and approval of processing facilities (ADPA Sections 40–41, 43, 48).
- 1988: Meat imports (except meat meal and blood meal) allowed from the following low-risk countries: New Zealand, Australia, Iceland, Norway, Sweden, Finland, Denmark, Ireland and Japan. Meat imports allowed without restriction from the U.S. (Policy for Edible Meat Products December 1988).
- 1996: Bovine-origin meat no longer eligible for import from countries not recognized free of BSE. (Note: with very few exceptions, bovine meat products were not being imported because of restrictions under food safety policies.)
- 1998 (April): Bovine-origin meat eligible for import from countries not recognized free of BSE provided the country of origin had implemented specified risk management practices for BSE (no beef establishments applied for approval to export beef to Canada under the amended policy). Mechanically separated meat was only permitted from countries free of BSE.
- 1998 (December): The policy was expanded to include ovine- and caprine-origin products. There were no other changes from the previous policy.

Rendered Animal Protein:

- 1982: Meat meal not allowed from countries other than the U.S. Bone meal permitted with certification that it was produced in an approved place and manner (ADPA Sections 40, 41, 44, 46).
- 1988: Meat meal, bone meal, blood meal imports banned except from the U.S.
- 1990: Rendered animal products allowed from countries other than the U.S. under the authority of an import permit, provided that Canada was satisfied the product did not pose a hazard for the introduction of serious disease (Appendix 4, Section 46).
- 1996: Animal and pet food or material imported as ingredients of animal and pet food containing material of ruminant origin not allowed from countries not recognized free of BSE. Meat meal, bone meal and blood meal for any use eligible to be imported from the following countries: U.S., Australia, Denmark, Finland, Iceland, New Zealand, Norway and Sweden (Appendix 16).
- 1997: In accordance with the feed ban, permits are required for the import of all rendered animal products, stating the classification of the product (prohibited or non-prohibited for use in ruminant feeds) and the restrictions associated with the classification. Ruminant-origin rendered products (with the exception of milk and blood) not allowed from countries not designated free of BSE.
- 1998 (April): No change.
- 1998 (December): Policy expanded to include ovine and caprine products. Designated countries required to certify that the animal had been slaughtered in that country.

- 2000 (December): The importation of all animal protein products, including blood meal and feather meal, from any species from any country that Canada does not recognize free of BSE was suspended (Appendix 17). (Of the import permits suspended because of this action, none had been issued for ruminant MBM. Rendered blood products for use in aquaculture were permitted from Belgium. Porcine MBM, again for use in aquaculture, was permitted from Denmark.)(Carriere, 2002).

Inedible Tallow:

- 1982: Inedible tallow may be imported from the U.S.
- 1988: Tallow may be imported only from the U.S.
- 1996: Tallow exempt (with certification) from import restrictions specific to BSE. Designated countries (Australia, Denmark, Finland, Iceland, New Zealand, Norway, and Sweden) were eligible to import tallow for any use (Appendix 16). This policy remained in effect until December 2000.

Rendered Animal Blood:

- Rendered animal blood imports were regulated identically to rendered animal protein imports, with the following exception: from April 6, 1998, to December 7, 2000, blood products were exempt from import restrictions specific to BSE.

Livestock Feed:

- 1982: The import of livestock feed restricted to countries free of foot-and-mouth disease (ADPA Section 53). Rendered animal protein only allowed to be imported from the U.S. (ADPA Section 46).
- 1996: Animal and pet food containing ruminant-origin material prohibited from countries not recognized free of BSE.
- 1998 (April): The import of mammalian protein or products containing mammalian protein (except protein derived from milk, blood or sourced exclusively from equines or swine) for use in feeding ruminants prohibited.
- 1998 (December): No change.
- 2000 (December): Feeds containing any rendered animal products of any species no longer eligible for import from BSE-infected countries.

Ruminant specific risk materials:

- 1982: Regulated as per rendered animal protein
- 1996: Products and by-products containing specific risk materials banned from countries not recognized free of BSE. This policy is still in effect.

Cell Lines Originating from Bovine Tissues:

- 1982: Cell lines assessed on a case-by-case basis and imported under the authority of a permit (ADPA Sections 40–41).
- 1996: Cell lines originating from high-risk bovine tissues prohibited from countries not recognized free of BSE. Cell lines originating from low-risk bovine tissues permitted, subject to the conditions that the cell line and its derivatives cannot be administered to animals or people and that the waste material be autoclaved or incinerated.
- 1998 (April): Cell lines may be imported under the authority of an import permit. Specific conditions are put in place according to the nature of the work. This policy is still in effect.

Veterinary Biologics:

- 1982: Veterinary biologics are imported under the authority of an import permit and assessed on a case-by-base basis (ADPA Section 121).
- 1990 (July): Import of veterinary vaccines and bacterins containing materials of bovine, ovine or caprine origin prohibited from the U.K. Restrictions placed on the import of diagnostic kits and reagents for *in vitro* use (Appendix 18).
- 1996: Veterinary biologics containing bovine material for animal administration banned from countries not recognized free of BSE. Veterinary biologics for laboratory diagnostic purposes allowed provided no component can be administered to animals or people, and waste material must be autoclaved or incinerated.
- 1998 (April): Veterinary biologics containing bovine material for animal administration from countries not recognized free of BSE eligible for import under the Canadian BSE Import Policies provided that the country has implemented appropriate risk management strategies for BSE. (However, no veterinary vaccines or bacterins containing ruminant materials were permitted from countries having BSE.) Veterinary biologics for laboratory diagnostic purposes permitted under authority of an import permit specifying the conditions of use and disposal.
- 1998 (December): The previous conditions remain unchanged with the exception that restrictions on veterinary biologics for animal administration are extended to products containing ovine and caprine origin material in addition to those containing bovine material.

5.2. Compliance and Enforcement

Officials of the Canada Customs and Revenue Agency (CCRA), a Canadian governmental agency, are responsible for screening all imports at Canadian ports of entry. CCRA officials have the authority to hold shipments of animals, food, feeds, animal by-products and other such products for inspection by the CFIA. The final disposition of held shipments (e.g. release, entry refused, quarantine, or further processing) is the decision of veterinary inspectors employed by the CFIA.

CCRA officers make their decisions on imports based on a manual of procedures (the “D-19"). That portion of the manual referencing animal, animal product and by-product imports is expected to be replaced with an automated system called the Automated Import Reference System (AIRS), maintained by the CFIA. Currently, the AIRS has been implemented for CCRA purposes at selected ports of entry on a pilot basis. CCRA offices receive new and amended import directives issued by the CFIA that may affect whether or not a shipment is to be held by CCRA for inspection.

Customs officers maintain detailed records of all imports, including the date, product (identified by HS codes), exporting country, amount and value, and the name and co-ordinates of the importer. These data form the basis of the trade data generated by Statistics Canada. Original transaction records are generally kept for seven years.

CFIA inspectors are notified by Customs officials when there is a shipment to inspect. Twenty-four-hour service is available, and CFIA inspectors are aware of all import policies and directives. They receive new and revised import directives by e-mail and have full access to the AIRS. They also have access to the Import Permit System, which has been in place since 1998 to issue and maintain a record of import permits. Annual national meetings are held to discuss the rationale behind and the implementation of new import directives.

The AIRS is an electronic system containing import conditions for a wide variety of animals and products regulated by the CFIA. The system is available and accessible to all CFIA and some CCRA inspectors across Canada. The system can be updated across the country in 15 minutes. An Internet version, which is updated daily, is freely available to the public. The Import Permit System is linked to AIRS so that conditions for import are automatically generated. The AIRS works well for live animal and germplasm imports; however, it is not fully updated for some animal by-products and feeds. Hence, it must be used in combination with a paper system for those products.

In the event of foreign animal disease emergencies in trading partners, all import staff are notified by e-mail. Import conditions can be quickly suspended through AIRS and warning messages posted. In addition, the CCRA issues “border lookouts” to officials to stop imports of concern at the border.

With the exception of dogs and cats, all animal imports from countries other than the U.S. are held by Customs officers for veterinary inspection by veterinarians employed by the CFIA. All livestock entering Canada must be accompanied by an import permit except for some classes of animals originating from the U.S. Veterinary inspectors check the general condition of the imported animals either at the port of entry or, in some cases, at their final destination. Details on the animals imported are recorded and maintained at the district offices. These are tallied monthly and sent to CFIA headquarters in Ottawa, where the statistics are collated and entered into a database system.

Animal by-products are held by Customs officials in accordance with instructions in the D-19. Customs notifies the CFIA Import Service Centre, where inspection staff verify that the appropriate documentation has accompanied the shipment. Some shipments of animal by-products may be pre-cleared electronically through CFIA Service Centres.

Traveller information pertaining to meat importation is covered in "What Can I Bring into Canada" and "Be Aware You Must Declare," which are available on the CFIA website and at airports. The Government of Canada Customs Declaration Card that must be filled out by every international traveller entering Canada specifically requests that travellers indicate if they are bringing meat products into the country. If importation of meat is indicated on the declaration form, the traveller is referred for secondary inspection by CFIA personnel at airports. Dogs trained to detect food and plant products are used at several of Canada's busiest international airports to screen personal luggage for the presence of food products.

The CFIA periodically conducts blitzes, involving increased inspection and screening of commercial imports to determine if there are problems with compliance of specific import policies or requirements (Greenwood 2002).

5.3. Live Ruminants from BSE-Free Countries that Subsequently Report Cases of BSE

Imports of concern are live ruminants from countries that have reported BSE in native animals or those at high risk for BSE. The following countries and years (taken from the “Update of the Opinion of the Scientific Steering Committee on the Geographical Risk of Bovine Spongiform Encephalopathy (GBR)” adopted on January 11, 2002) have been used to determine the imports of concern.

Table 4: Countries Infected with BSE

Country	Year for Potential Infectivity
Albania	unknown - 1979 used
Austria	1988
Belgium	1983
Cyprus	1980
Czech Republic	unknown - 1979 used
Denmark	1985
Estonia	1987
Finland	1980
France	1979
Germany	1980
Greece	1985
Hungary	1981

Ireland	1980
Italy	1983
Japan	1985
Liechtenstein	1979
Lithuania	unknown - used 1979
Luxembourg	1983
Netherlands	1985
Poland	1980
Portugal	1979
Romania	unknown - used 1979
Slovak Republic	unknown - used 1979
Slovenia	1981
Spain	1985
Switzerland	1979

5.3.1. Imports of Live Ruminants from Countries Reporting BSE

Import data were collected and collated from several sources in order to validate the data sources and to ensure that the data were complete. Discrepancies among the data sources were investigated by seeking original documentation of individual transactions. Corrections were made in cases in which data entry errors were confirmed.

The “gold standard” data sources were the CFIA’s Import Database and quarantine station records. The data are collected by veterinary inspectors when animals are imported and collated monthly by CFIA headquarters. In trace-back situations, this system has proven to be the most accurate of the import data tracking systems currently available.

The other major data source used for live ruminant imports was Canadian Trade Data (Statistics Canada). Supplementary sources included the European Imports table, maintained by the import section of the CFIA for trace-back purposes; data included in the Canadian submission to the EU Geographic BSE Risk (GBR) process in 1999[1]; a risk assessment completed in 1994 (CFIA 1994); a data base with detailed data on imports from the U.K. and Ireland for the years 1982 to 1989; and personal communication with current and previous import specialists at the CFIA. For data prior to 1982, quarantine station records and archived files on the Continental European

[1] The import data submitted by Canada in 1999 for the GBR process were compared with all other data sources, and where there were discrepancies, original transaction data were examined and errors corrected.

Cattle Program were used in conjunction with the Canadian Trade Data to confirm the numbers and origins of imported cattle.

Import statistics were reviewed for the period from 1979 to July 2001 for live cattle, sheep and goat imports from the U.K. and other countries that have reported BSE or that are at high risk for BSE. Imports of concern are found in Table 5. In addition to the countries of concern, ruminants were imported during this period from the United States, New Zealand, Mexico (one shipment in 1986), Iceland (one shipment of sheep in 1990) and Sweden (one shipment of sheep in 1995).

The Canadian Trade Data are collected by CCRA officials. As members of this group are responsible for entering a large variety and volume of transactions into an electronic system, there is potential for data entry error such as improper codes for species and countries. A number of discrepancies between the Trade Data and the CFIA Import Database were investigated by Statistics Canada by examining individual import transaction documents and contacting importers to confirm the information. The discrepancies were all determined to be errors in the Trade Data with one exception — in 1992, there were 57 sheep imported from Denmark (the CFIA data recorded 17 sheep).

Data on cattle of Japanese origin imported via the U.S. were provided by the Import Section of the CFIA. Because these cattle were resident in the U.S. and therefore identified as U.S. cattle, they were not immediately identified as an import of concern when Japan declared their first case of BSE; however, during the course of their trace-back of Japanese imports, the U.S. informed Canada that Japanese-origin cattle had been exported to Canada.

The import of Japanese cattle resident in the U.S. occurred because of differences in import policies between the two countries. The U.S. prohibits the import of ruminants from countries it considers either infected or at risk of being infected with BSE, while Canada’s policy does not permit the import of ruminants from any country until a comprehensive evaluation of the country has been completed. These differences are being addressed with the U.S. and Mexico through the Tri-Country BSE Working Group.

Table 5: Live Animal Imports of Concern

Year	Cattle/Bovines Number (Country)	Sheep Number (Country)	Goats Number (Country)
2001 (July 1)	0	0	0
2000	19 water buffalo (Denmark)	0	0
1999	0	0	0
1998	15 (Japan, imported 1997 and 1998)	0	0
1997	0	0	0
1996	0	0	0
1995	1 (Japan)	0	0
1994	2 (Japan)	54 (Denmark)	
1993	9 (Denmark)	0	0
1992	0	57 (Denmark)	0
1991	0	0	0
1990	14 (U.K.)	6 (U.K.)	2 (Germany)
1989	33 (U.K.) 10 (Ireland)	28 (U.K.)	0
1988	12 (U.K.)	17 (Denmark)	0
1987	40 (U.K.)	0	0
1986	12 (U.K.)	180 (U.K.) *Trade data*	0
1985	15 (U.K.) 18 (Switzerland) 12 (France) 6 (Austria) 3 (Germany)	0	0
1984	13 (U.K.) 4 (Ireland)	0	120 (Germany) 0 *trade data*
1983	16 (U.K.)	0	0
1982	27 (U.K.) 2 (Ireland)	0	0

Year	Cattle/Bovines Number (Country)	Sheep Number (Country)	Goats Number (Country)
1981	30 (U.K) 6 (Austria) 75 (France) 4 (Germany) 1 (Netherlands) 17 (Switzerland)	0	0
1980	19 (U.K.) 141 (France, Germany, Italy, the Netherlands, Switzerland)	48 (U.K.) 36 (France)	0
1979	19 (U.K.) 2 (Ireland)	0	1 (U.K.)

5.3.1.1. Disposition of Cattle Imported from the U.K. and Ireland (1982–1990)

- In 1990, the CFIA placed all cattle imported from the U.K. and Ireland since 1982 in a monitoring program. This was in response to a decision to ban any further cattle imports from these two countries amid growing concerns about the spread of BSE through exported cattle.

- Cattle imported prior to 1982 were not considered a hazard at the time and therefore were not traced back. From 1979 to 1981, 68 cattle were imported from the U.K. and 2 from Ireland These numbers were confirmed through an examination of quarantine station records.

- In December 1993, one imported cow showed clinical signs consistent with BSE. A tentative diagnosis of BSE based on histopathological examination of brain tissue was confirmed by the Weybridge Laboratory in Great Britain.

- All of the remaining imports were placed under quarantine. Detailed data gathered at the individual animal level (such as cattle identification, age, sex, breed, disposition, import date, owner, farm of origin) were collected on each of the imported animals from 1982. Disposition data are summarized in Table 6 for the U.K. imports and Table 7 for the imports from Ireland.

- In total, 68 cattle from the U.K. died (9) or were slaughtered (59) before December 1993, and 68 imported prior to 1982 were not traced. It is assumed that these cattle were sent for rendering. This number includes one animal that was reported stolen. Similarly, a total of 12 animals imported from Ireland (9 slaughtered and 3 dead) and 2 imported prior to 1982 that were not traced may have been rendered.

- No animal that died is known to have shown clinical signs of BSE. Birth year and cause of death (where recorded) are listed below.

  United Kingdom:

Birth Year	Cause of Death
1978	not recorded
1980	acute frothy bloat
1981	not recorded
1984	not recorded
1985	not recorded
1985	not recorded
1985	uterine prolapse
1986	died at calving
1988	died after caesarean section

  Ireland:

Birth Year	Cause of Death
1977	euthanised - broken leg
1987	choked in cattle chute
1989	shipping fever (pneumonia)

- Information was received from the U.K. and Ireland on the BSE status of the farms of origin for the cattle imported after 1982. This information is summarized in Table 8 for the U.K. and Table 9 for Ireland.

- Of the 68 cattle imported since 1982 from the U.K. that were potentially rendered, the majority (58) came from farms that have never recorded a case of BSE, and 10 were sourced from farms that had had at least one case of BSE diagnosed in cattle born on the farm. Of those 10, 2 originated from an infected birth cohort. The farm of origin was not identified for 1 animal and therefore its status is unknown. For the purposes of this report, it is assumed to have been infected with BSE. The status of the farms of origin for the 68 cattle imported prior to 1982 was not determined.

- The 2 cattle originating from an infected birth cohort were herdmates of the imported cow that was diagnosed with BSE in Canada. Both of these animals were slaughtered prior to the diagnosis of the case.

- Of the 12 cattle imported from Ireland that were potentially rendered, none were sourced from farms with a case of BSE diagnosed in cattle born on the farm. The status of the farms of origin for the 2 cattle imported prior to 1982 was not determined.

Table 6: Disposition of Cattle Imported from the U.K. (1982–1990)

Year of Import	Total U.K. Imports	Slaughtered	Died	Incinerated	Buried	Exported
1982	27	10	2	1	0	14
1983	16	11	1	1	0	3
1984	13	9	0	3	0	1
1985	15	4	2	8	0	1
1986	12	3	1	6	0	2
1987	40	13	0	19	0	8
1988	12	4	2	4	0	2
1989	33	5	1	20	1	6
1990	14	0	0	14	0	0
Total	182	59	9	76	1	37

Table 7: Disposition of Cattle Imported from Ireland (1982–1990)

Year of Import	Total Imports from Ireland	Slaughtered	Died	Incinerated	Buried	Exported
1982	2	2	0	0	0	0
1983	0	0	0	0	0	0
1984	4	2	1	1	0	0
1985	0	0	0	0	0	0
1986	0	0	0	0	0	0
1987	0	0	0	0	0	0
1988	0	0	0	0	0	0
1989	10	5	2	3	0	0
1990	0	0	0	0	0	0
Total	16	9	3	4	0	0

Table 8: Infection Status of Farms of Origin and Birth Cohorts of Cattle Imported from the U.K. (1982 –1990) that were Slaughtered or Died

Year of Birth	Total Number of Cattle	Number of Cattle from Farms with BSE Cases (unknown status)	Number of Cattle from Infected Birth Cohorts (unknown status)
1974	1	0	-
1978	1	0	-
1979	7	1	0
1980	5	0	-
1981	4	1	0
1982	7	0	-
1983	9	1	0
1984	6	1	0
1985	10	1 (1)	0 (1)
1986	9	3	2
1987	5	1	0

1988	2	1	0
1989	2	0	0
Total	68	10 (1)	2 (1)

Table 9: Infection Status of Farms of Origin and Birth Cohorts of Cattle Imported from Ireland (1982–1990) that were Slaughtered or Died

Year of Birth	Total Number of Cattle	Number of Cattle from Farms with BSE Cases	Number of Cattle from Infected Birth Cohorts
1977	1	0	0
1980	1	0	0
1981	1	0	0
1983	1	0	0
1984	1	0	0
1985	2	0	0
1986	2	0	0
1987	1	0	0
1989	1	0	0
Total	11	0	0

5.3.1.2. Disposition of Ruminants Imported from BSE-Infected Countries Other Than the U.K. and Ireland

Japan:

- Japanese-origin cattle were imported into Canada from the U.S. from 1994 to 1998. Canada did not import the cattle directly from Japan, given that Canada has never designated Japan as free of BSE.

- There were 22 cattle imported from Japan. Four bulls stood at stud for 4 years before being re-exported to the U.S. Of the remaining 18 of concern, 14 are still alive and have been placed under quarantine pending a decision on their disposition. Four cattle had been culled due to reproductive failure.

- The 4 Japanese-origin cattle that were slaughtered and potentially rendered were born in 1993(1) and 1994(3). They were originally imported into the United States, where they remained for an undetermined period of time prior to their export to Canada as part of two lots in 1997 and 1998. The cattle were slaughtered due to reproductive failure. Given the high cost of these animals, it is likely that they remained with the purchasing company for at least several months prior to their destruction. In any case, they would have been destroyed after the Feed Ban was in place, and therefore would not have entered the ruminant feed system.

- The CFIA has ordered that the 14 quarantined animals be disposed of and the owners compensated.

Denmark:

- Of the 9 cattle imported from Denmark in 1993, 1 was ordered destroyed and 1 had been exported to the U.S. The 7 remaining cattle are assumed to have been rendered.

- Based on the outcome of a risk assessment, 18 water buffalo imported in 2000 have been ordered destroyed. The brains of these animals will be examined for evidence of BSE, and if all test negative, progeny of these animals born in Canada over 5 months of age will be released from quarantine. One imported animal died in quarantine of causes unrelated to BSE and was incinerated.

- There were 16 sheep ordered destroyed; 1 sheep remains in quarantine pending the outcome of risk assessment review.

Cattle Imports from Europe:

- Until 1985, the CFIA operated the Continental European Cattle Program, which was designed to assist Canadian producers in importing new cattle genetics. Due to the foot-and-mouth disease situation in Europe, these cattle were subjected to lengthy quarantine periods both in Europe and in Canada.

- From 1979 to 1985, a total of 405 cattle were imported from continental Europe to Canada via the Grosse Ile Quarantine Station (countries of origin, where records still exist, are found in Table 5). These numbers were validated through a search of archived files containing documentation on the imports including, in some cases, listings of the individually identified cattle imported along with their destinations in Canada.

France:

- In 1980, 36 Romanov sheep were imported from France via the Grosse Ile Quarantine Station. These animals were sent to the Lennoxville Research Station of Agriculture Canada for breeding purposes and were maintained in quarantine until their first offspring were 60 months of age.

Germany:

- A permit was issued for the importation of 2 goats from Germany; however, they were refused entry into Canada.

- According to Canadian trade data, 120 sheep were imported from Germany in 1984. No documentation validating these numbers was found in a search of CFIA archived files.

5.3.1.3. Imports and Disposition of Other Ruminants from BSE-Affected Countries

- In 1989, 377 farmed deer were imported from Great Britain to Canada. The deer were sold into one herd, which has since been dispersed, with most of the deer having been sold to the U.S. and the remainder sent to slaughter. A shipment of 105 deer to Canada from Great Britain was “in transit,” and hence the deer did not stay in Canada. The U.K. has not reported BSE in any ruminants other than cattle and zoo animals, including farmed deer (Moreau 2002).

- There were 6 sheep imported from the U.K. in 1990, 28 in 1989 and 48 in 1980. The disposition of these sheep is unknown. The Canadian Trade Data show 180 sheep imports from the U.K. in 1986. There is no trace-back information on these sheep, and no documentation validating the number was found in a search of CFIA archived files.

5.3.2. Imports of Sheep from Countries Reporting Scrapie

Imports of sheep from countries other than the U.S. require an import permit and a certificate signed by an official veterinarian of the country of origin that:

- the sheep were inspected and found to be free of scrapie;
- no case of scrapie has been diagnosed in the flock of origin for the previous 3 years; and,
- the animal is not the progeny of a dam or sire that was affected with scrapie.

These requirements have been in place since 1982 (Appendix 10, Section 12) (Appendix 4, Section 12).

The importation of sheep from the U.S. does not require a permit; however, certification for scrapie has been required since 1982 as for all other countries. As of 1990, scrapie certification is no longer required for sheep in transit for the re-entry of animals into Canada from the U.S. within 60 days and for feeder sheep destined for immediate slaughter (Appendix 10, Section 24) (Appendix 4, Section 22).

Based on a review of information provided by those countries, Canada has recognized Australia and New Zealand free of scrapie. In the absence of specific assessments, all other countries are considered to be infected with scrapie (Greenwood, 2002). Table 10 lists the imports of sheep from countries not recognized free of scrapie.

Table 10: Imports of Breeding Sheep from Countries not Recognized Free of Scrapie (1988–July 2001)

Year	Sheep Imports from Countries Positive for Scrapie or with Unknown Scrapie Status
2001 (to July/01)	97 U.S.
2000	2,526 U.S.
1999	2,783 U.S.
1998	1,116 U.S.
1997	541 U.S.
1996	361 U.S.
1995	663 U.S. 35 Sweden
1994	477 U.S. 54 Denmark

1993	189 U.S.
1992	1,551 U.S. 57 Denmark
1991	688 U.S.
1990	533 U.S. 6 Great Britain 74 Iceland
1989	361 U.S. 28 Great Britain
1988	504 U.S. 17 Denmark

5.3.3. Imports of Cervids from Countries Reporting Chronic Wasting Disease

A permit specifying the conditions for import is required to import cervids into Canada from all countries. The conditions vary according to the species of cervid and the exporting country.

Imports of cervids from the U.S. (the only other country that reports CWD) are found in Table 11.

Table 11: Imports of Cervids from the United States

Year	Deer	Elk
1989	483	446
1990	321	205
1992	28	-
1993	202	-
1999	20	3
2000	-	13
2001	-	10

5.4. Ruminant Embryos

Import data for ruminant embryos are provided in Tables 12, 13 and 14 for the years 1990 to 2000 (Barr 2001).

In response to research evidence, the 2002 OIE Animal Health Code has been revised and recognizes that bovine embryos pose a negligible risk in the transmission of BSE. Canada permits the import (with certain conditions) of bovine embryos from countries that have reported BSE.

The importation of ovine and caprine embryos is currently permitted only from countries evaluated by Canada as free of BSE.

Table 12: Imports of Bovine Embryos from European Countries

Country	'90	'91	'92	'93	'94	'95	'96	'97	'98	'99	'00	Total
Austria	40	0	0	18	96	0	16	0	0	14	0	184
Belgium	0	68	0	16	129	0	94	8	19	0	0	334
Denmark	0	0	0	0	46	44	0	9	0	25	0	124
France	0	7	51	16	7	58	91	16	285	7	0	538
Germany	0	0	0	0	1	0	2	0	0	353	0	356
Great Britain	138	200	45	25	131	82	60	0	0	0	0	681
Italy	0	0	0	429	36	0	100	0	0	0	1	566
Netherlands	0	0	0	18	132	76	95	201	71	171	128	892
Switzerland	0	0	0	0	56	14	0	53	8	0	0	131
Total	178	275	96	522	634	274	458	287	383	570	129	3,806

Table 13: Imports of Ovine Embryos from European Countries

Country	'90	'91	'92	'93	'94	'95	'96	'97	'98	'99	'00	Total
France	0	0	0	0	124	172	211	91	0	0	0	598
Great Britain	0	0	0	160	118	278	32	29	0	0	0	755
Netherlands	0	0	0	0	0	316	558	0	0	0	0	874
Northern Ireland	0	0	0	0	0	0	0	29	0	0	0	29
Total	0	0	0	160	242	766	801	149	0	0	0	2,256

Table 14: Imports of Caprine Embryos from European Countries

Country	'90	'91	'92	'93	'94	'95	'96	'97	'98	'99	'00	Total
France	0	0	0	0	502	181	0	0	0	0	0	683
Great Britain	0	0	0	0	39	370	0	0	0	0	0	409
Total	0	0	0	0	541	551	0	0	0	0	0	1,092

5.5 Meat and Bone Meal (MBM)

In review of the risk factors associated with MBM imports, the following considerations contribute to the conclusion that Canada has primarily imported MBM for livestock feed from the United States, Australia and New Zealand. The considerations are;

- quantities of animal by-products from risk countries were minimal because of other OIE List A diseases in Europe,
- economic pressures disadvantage sourcing MBM from outside of North America,
- the imprecise nature of the Harmonized Commodity Description and Coding System (HS coding) used to record international shipments, resulted in inaccuracies with respect to identifying the nature of animal by-products.

In the 1980s and early 1990s Canada had significant concerns regarding the prevalence of reportable diseases occurring in European countries, including those of the European Union. During this period OIE reports show occurrences of foot and mouth disease (FMD) in Switzerland (reported in 1980), the United Kingdom, Austria and France (reported in 1981), Denmark (reported in 1983), Portugal and the Netherlands (reported in 1984), Spain (reported in 1986) and Germany (reported 1988). At that time, Canada considered that the countries of Eastern Europe were less reliable in regard to disease reporting. Thus, while they may not have reported foot and mouth disease or other significant diseases, these countries were thought to present an even greater risk than those of Western Europe.

In view of North America's long term freedom from FMD and other serious diseases of livestock, the CFIA and its predecessors were keenly aware of the risks presented by imports of MBM and other animal products. The OIE List A swine diseases presented almost as significant a concern as FMD, as there was no domestic segregation between ruminant and hog feed in Canada at that time.

On animal health grounds, MBM could have been imported from countries of Scandinavia or the Pacific Rim, including Japan. However, for economic and commercial reasons, these countries were not highly competitive suppliers of MBM. The USA was the only country from which significant quantities of MBM for use in livestock feed were imported into Canada. Smaller amounts were imported from Australia and New Zealand.

Since 1978, the Animal Disease and Protection Regulations, and Health of Animals Regulations (1991) prohibited the importation of MBM from countries other than the United States. Low risk materials could be imported by special provision of the legislation, under conditions equivalent to the current import permit system and small quantities of low risk materials were in fact imported.

Beginning in 1997, when the CFIA prohibited the feeding of mammalian-derived proteins (with exceptions) to ruminant species, Canada has required that all rendered animal products entering the country be accompanied by an import permit. MBM may only be imported from countries that the CFIA has assessed to be BSE free, based on a CFIA risk assessment conducted according to OIE standards. Under permit conditions, the CFIA requires a description of the product, its source and its intended end use; and specifies labeling requirements. In addition, the Feed Ban requires that the importer keep records of the sale and distribution of rendered animal products. These records are subject to periodic review by CFIA inspectors.

In 2001, Canada completed a review of MBM and related commodities imported from Europe in 1990-2000 (Appendix 19). The report covers potential imports from countries of the European Union, Scandinavia and Eastern Europe.

For the period 1990-1994 the review was based on original documents (Restricted Commodity Reports) held by CFIA veterinary inspectors at ports of entry. These reports contain product description and volume, and a classification of the product as a low, medium or high risk import according to the country of origin. The review concluded that MBM, for use in ruminant feeds, had only been imported from the U.S. (Tracey, 2002).

For imports during the period 1995 to December 2000, transaction records, obtained from the Canada Customs and Revenue Agency (CCRA), were examined. Of the 4000 entries examined, 400 required further investigation. This was based on whether the company was known to trade in livestock feed ingredients; whether import permits had been issued to the company for products of concern; or, whether any imports of MBM had occurred. To address these 400 entries the CFIA requested additional documentation from the CCRA, which formed the basis of an in depth review. The report indicates that all the transactions relating to ruminant feed were either mis-classified or the end use was not correctly identified. No potentially hazardous imports were detected during the course of this examination.

In response to a request from a trading partner, the CFIA investigated Eurostat data (Table 17) which describe imports of MBM from Europe during the period 1980 - 2000.

The first reports of MBM exports to Canada appear in Eurostat figures for 1993 (30 metric tonnes reported as imported from the UK). Import trade data provided by Statistics Canada (Tables 15 and 16) indicate that MBM was not imported from the UK during the period 1988 - 2001. A detailed examination of CCRA transaction reports confirm that highly processed inedible products have been imported periodically from the UK since 1995, in the form of dog biscuits, bone ash and bone charcoal. The discrepancy between the data sources is attributed to the broad categories used to specify commodities which results in inaccuracy not evident in the absence of a detailed examination.

Canada has imported approximately 11,000 metric tonnes of materials declared as “flour, meals and pellets, of meat or meat offal, nes, unfit for human consumption; greaves” from Denmark. Canadian records confirm that MBM was imported in certain years during this period (1994 - 2000). CCRA transaction records indicate that this material was of porcine or poultry origin and that it was imported by a maker of aquaculture feed products.

Imports from Germany appear in Canadian import data for the years 1995 and 1999 but do not appear in the Eurostat data. The CFIA has determined that poultry meal was imported in 1999 for inclusion into aquaculture feed, but was not successful in obtaining specific information relative to the 1995 importation.

A total of 13 metric tonnes of MBM from France appear in the Eurostat data for the years 1999 and 2000. An examination of CCRA transaction records indicate that less than 2 metric tonnes of feather meal were imported from France, under permit, for use in animal feed. The discrepancy in data is attributed to errors in the Harmonized Commodity Description and Coding System that is used to identify commodities for the purposes of freight tariffs and statistics, but which fails to provide the detail required to track specific import commodities.

Eurostat indicates that 25 metric tonnes of MBM were imported into Canada from Belgium in 1998 - 1999. Canada has no record of these transactions; however, it has been confirmed that several shipments of spray-dried hemoglobin, imported under permit from France to Canada, were shipped via Belgian ports. Belgium was listed as the country of origin several times, despite there being clear evidence that this material came from France. In the absence of Canadian transaction records identifying a Belgian exporter, the CFIA concludes that Eurostat data incorrectly attributed to Belgium, on the basis of a declared Belgian port of exit, consignments that originated in France. Noting that no detectable infectivity has been found in blood or blood components of cattle infect with BSE (Wells *et al* 1998, Wells

et al 1999, Bradley 1999) the CFIA considers that these imports do not compromise Canada's BSE status.

The CFIA has investigated the references to MBM importations from Japan in the years 1994, 1996 and 1997 which appear in the import trade data tables provided by Statistics Canada. A detailed examination of CCRA transaction records for Japanese imports during this period indicate that there were no importations of MBM during 1994 and significantly smaller amounts than indicated by the import trade data in both 1996 and 1997. The importer, identified by the CCRA transaction records, is not associated with the livestock industry. Discrepancies are attributed to either a misclassification of goods, or a failure to adjust the import trade data when adjustments occur after the final accounting of the goods.

A second review of import documents (restricted commodity reports and CCRA transaction records) was conducted for the period January 1, 2001 to October 19, 2001, for potential imports from the EU, Russia and Japan (Appendix 20). A total of 2707 transactions were examined, based on a coded description of the commodity (Harmonized Commodity Description and Coding System of the World Customs Organization). CFIA requested additional information on 193 of the 2707 transactions in order to verify that the commodities were in fact approved for import. The majority were found to be dried hog casings, pet supplies, supplements and food, bull pizzels, pigs ears and bone charcoal, all of which are approved commodities. On the basis of this evaluation, the CFIA confirms that no MBM was imported into Canada for use in livestock feeds from these countries during the period in question.

The CFIA periodically reviews import data to determine whether MBM for use in livestock feeds has been inadvertently imported from BSE-infected countries. The Agency has also considered the possibility of MBM being substituted for fish meal, which can be imported into Canada from any country regardless of BSE status. While fish meal is not known to present a BSE risk, substitution by MBM could be of concern if the mis-described product was used in the production of ruminant feed.

Canada is a major producer of farmed salmonids, surpassed only by Norway, Chile and Scotland in the production of salmonid products for human consumption. Aquaculture production has been growing steadily in Canada for the last 20 years, with a concurrently increasing demand for protein of appropriate quality to produce fish feed. Canada produces fish meal (from herring and scrap fish), but domestic production consistently lags behind demand, creating a market for imported fish meal. Most of the imported fish meal comes from South America, particularly Peru, a low-cost source. Lesser amounts are imported from Europe (primarily countries of Scandinavia) and the United States.

For nutritional reasons, fish meal is the most important ingredient for salmonid feed; it is also one of the most costly ingredients. Fish feed manufacturers must incorporate an adequate percentage of fish meal in their product to ensure the feed meets producers' needs. Researchers have evaluated the use of MBM as a lower cost replacement for fish meal in salmonid feed, but results have been disappointing due to the inadequate nutritional profile of this product relative to fish meal (MBM contains a much higher ash content than fish meal). The production of salmonid feed is a specialized industry, with only seven major producers in Canada, and failures in feed quality can be readily traced back to the manufacturer. Thus, the inadvertent or deliberate incorporation of MBM in salmonid feed would be unlikely to occur in any systematic manner and the CFIA considers that there would be little commercial demand for the importation of MBM mislabeled as fish meal.

Because there is a demand for fish meal in the manufacture of salmonid feed and the value of the product is high compared to other protein sources, the CFIA considers that imported product described as fish meal is unlikely to be used in the production of ruminant feed.

In summary, the CFIA has made a thorough investigation of import records from available sources, augmented by periodic spot checks of current activity. On the basis of this assessment, Canada has imported MBM for livestock feed-associated uses from the United States, Australia and New Zealand but not from other countries. The CFIA further considers that importation of MBM from these sources does not compromise Canada's BSE status.

Table 15: Canadian Imports (all countries) of Flours, Meal and Pellets, of Meat or Meat Offal, Nes, Unfit for Human Consumption; Greaves (HS code 2301.100090), for the Period 1988–2001 (Source: Statistics Canada)

Imports from All Countries														
HS CODE:	QUANTITY (KG)													
2301.10009	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
TOTAL:	5,381,617	5,945,446	7,128,594	10,877,896	5,462,983	10,383,644	16,538,903	25,124,989	24,690,473	33,733,271	35,995,504	37,285,929	33,901,798	21,757,771
Australia								101,059	300,257	295,283	264,065	35,580	39,380	1,089,273
Chile							149,963	0	0	0	0	0	0	0
China, P. Rep.														12,929
Denmark							704,293	1,134,343	1,384,540	2,545,441	2,242,226	2677665	260,656	0
France													1,411	0
Germany								46,953	0	0	0	53,809	0	0
Hong Kong										2,010	4,762	8,824	0	0
Japan							7,476	0	9,081	9,036	0	0	0	0
Korea, South								1221	0	0	0	0	0	0
New Zealand							42,526	1381194	1,710,869	1,085,172	887,646	806,305	601,431	253514
Peru												1,520,863	0	0
Puerto Rico		23,596	0	0	0	0	0	0	0	0	0	0	0	0
Thailand											542	339	0	0
United States	5,381,617	5,921,850	7,128,594	10,877,896	5,462,983	10,383,644	15,634,645	22,460,219	21,285,726	29,796,329	32,596,263	32,182,544	32,998,920	20,402,055

Table 16: Canadian Imports (all countries) of Bone Meal for the Manufacture of Livestock Feeds (HS code 0506.90010), for the Period 1988–2001 (Source: Statistics Canada)

Imports from All Countries														
HS CODE:	QUANTITY (KG)													
506.9001	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
TOTAL:	1,564,402	218,371	401,426	528,363	117,580	109,380	268,881	1,913,302	1,690,829	2,166,262	1,756,304	261,764	155,376	112,056
Australia							140,280	1,847,108	1,236,910	257,247	404,774	39,720	6,827	0
Denmark										351	0	0	0	0
Germany										1	0	0	0	0
New Zealand									379,972	1,727,664	1,127,302	27,779	15,249	0
United States	1,564,402	218,371	401,426	528,363	117,580	109,380	128,601	66,194	73,947	180,999	224,228	194,265	133,300	112,056

Table 17: MBM Imports (tonnes). Shading indicates period of different risk that exports carried the agent, 1986–1990 being the period of highest risk for U.K. imports, while 1994–1999 U.K. exports are assumed to have been safer than exports from other BSE-affected countries. Sources: C = Completed country questionnaire, E = EUROSTAT

MBM Imports into Canada from BSE-Affected Countries

Period	UK		DK		FR		Belg-Luxbg		Non-UK	
Source	C	E	C	E	C	E	C	E	C	E
1980										
1981										
1982										
1983										
1984										
1985										
1986										
80-85	0	0	0	0	0	0	0	0	0	0
1986										
1987										
1988										
1989										
1990										
86-90	0	0	0	0	0	0	0	0	0	0
1991										
1992										
1993		30								
91-93	0	30	0		0		0	0	0	
1994		22		244						244
1995		31		481						481
1996		42		516						516
1997		10		883						883
1998		13		973				6		979
1999				1,158		2		19		1,179
2000				1,324		11				1,335
94-00	0	118	0	5,579	0	13	0	25	0	5,617
∑	0	148	0	5,579	0	13	0	25	0	5,617

5.6. Other Products

Livestock Feeds and Feed Supplements:

Feeds for cattle, sheep and goats must comply with the *Health of Animals Act* and *Regulations* and the *Feeds Act* and *Regulations* (see Section 8 for further details). All mixed livestock feeds and supplements must be evaluated and registered before importation, manufacture, or sale in Canada. Manufacturers must provide a complete formulation of all ingredients that may be included in the feed in order to be evaluated for registration. Except for specialty feeds, formulations are not required from the United States due to the high degree of harmonization of feed ingredients between the two countries. Many feed ingredients and additives are not subject to mandatory registration. Rendered animal products and by-products may only be imported into Canada from countries that are recognized as free of BSE by Canada, and any mixed feeds containing these products would not be registered. Registrations are granted for a three-year period.

Canada has an abundance of inexpensive, raw materials for livestock feed; it is not economical to import livestock feeds from BSE-infected countries because of the distance and the lack of low-priced livestock feed relative to Canadian sources. Historically, only small amounts of complete feeds have been imported from offshore (these feeds must be in compliance with the *Health of Animals Act* and *Regulations* and the *Feeds Acts* and *Regulations*).

Products registered by the CFIA for import from Europe consist of feed supplements, vitamins, minerals, acidifiers and flavouring agents. Europe is the major vitamin-mineral supplier to the world, and as a result there are several products of this class that are imported into Canada from BSE-infected countries. All ingredients of such products are scrutinized for compliance with both Acts — the *Health of Animals Act* and the *Feeds Act* — with respect to BSE risk. A review of feed registrations and trade data revealed few imports of complete feeds for livestock.

The CFIA is considering the risk potential associated with imported fat-soluble vitamins coated with gelatin, which may be sourced from bovines. There is some uncertainty regarding the potential infectivity of gelatin, as evidenced by the European Community Scientific Steering Committee's ongoing investigations in this area. Health Canada is conducting a risk assessment on gelatin, and any changes to current import policies would be based on the results of that risk assessment.

Veterinary Biologics:

All veterinary biologics imported into Canada must be accompanied by an import permit specifying conditions designed to minimize the risk associated with the import.

As of January 14, 2002, manufacturers are now required to sign a "Declaration of Compliance" stating that the "animal species, supplier's sources, countries of origin, and supporting documentation for all materials of animal origin used in the preparation of the product have been examined by the manufacturer...," and that the "materials originated from sources considered to be safe from animal TSE infection or contamination." This declaration is in addition to requirements for manufacturers to list all materials of animal origin used in the preparation of or which may have come in contact with any vaccine constituents during preparation and to indicate actions taken by the manufacturer to minimize the risk for contamination of their product by TSE agents. A record of purchase and use for each lot of material of animal origin must be maintained by the manufacturer and is subject to inspection by the CFIA during facility inspection.

A review of all licenced products undertaken in the mid-1990s verified that these products did not contain and had not been exposed to material potentially contaminated with BSE.

Veterinary vaccines for use in ruminants are not imported from BSE-infected countries. Vaccines from non-BSE-infected countries may be imported provided the company meets high standards of manufacturing practices and is able to demonstrate the purity, potency, safety, and efficacy of their product. Each product must be licenced in Canada and is assessed on a case-by-case basis. Materials of ruminant origin used in the production of the vaccine must be certified by the manufacturer and the government regulatory agency in the country of origin to be from a non-BSE-infected source. Risk assessments of the country and product are conducted as required.

Most **licenced veterinary diagnostic kits** are produced in Canada or imported from the U.S. Veterinary diagnostic kits may also be imported from BSE-infected countries subject to stringent requirements similar to veterinary vaccines (and this would be permitted only where the particular product could not be sourced elsewhere). The company must be able to demonstrate high standards of manufacturing practices and assure the purity, potency, safety and efficacy of its product. Manufacturers and government agencies must certify that materials of ruminant origin used in the production of the kit are from a non-BSE- infected source, and risk assessments of the country and product may be undertaken. Import permits and labels for veterinary diagnostic kits specify that these products are for *in vitro* use only. Currently, there are no licenced *in vitro* diagnostic kits in Canada originating from BSE-infected countries. The new documentation and certification requirements, as described above, will be applied to all new licencing applications for *in vitro* diagnostic kits.

Unlicenced veterinary diagnostic kits and laboratory reagents are imported from several countries for use in biomedical research and quality control testing. Upon receipt of an import permit application, a qualitative risk assessment is conducted, taking into consideration the potential hazards associated with the product and its end use. Import permit conditions are specified to minimize risks.

Veterinary Pharmaceuticals:

Veterinary pharmaceuticals are regulated by the Veterinary Drugs Directorate (VDD) of Health Canada under the *Food and Drugs Act* and *Regulations*. The VDD applies a BSE exclusion policy developed by Health Canada to its approval process for new veterinary drugs.

5.7 SUMMARY - IMPORT

Import Policies

- In the early 1980s, trade policies in Canada and elsewhere served to limit exposure to commodities potentially contaminated with BSE. While import policies were liberalized later in this decade, import permits, which provided science-based controls, coupled with a conservative approach to risk management, helped to exclude BSE from Canada.

- Since December 31, 1996, Canada has not allowed the importation of cattle and bovine products from countries that have not been evaluated by Canada and recognized free of BSE. A small number of bovine products and by products are exempted as specified in the Canadian BSE Import Policies and in accordance with international guidelines. This has effectively prevented the introduction and establishment of BSE.

- Current import policies provide a high level of protection given current scientific knowledge of BSE. Although some imports that occurred historically are now considered to have presented a risk, CFIA analysis indicates that Canada did not import significant quantities of potentially infective materials.

MBM Imports

- Restrictions on imports based on general disease concerns precluded the importation of rendered animal products into Canada during the 1980s.

- Canada has not imported any MBM from Europe for use in livestock feeds.

- The majority of imported fish meal is derived from countries in South America. Smaller amounts have been imported from Europe (primarily Scandinavia). The salmon aquaculture industry would be the major market for fish meal for the manufacture of complete fish feeds.

Livestock Feeds and Feed Supplements

- Small quantities of vegetable-origin complete feed, of which an insignificant amount is ruminant feed products, are imported from BSE-infected countries. No rendered animal-origin MBM from any species (with the exception of fish meal) may be incorporated into these products.

- Specialized animal products, mainly vitamin and mineral supplements, are imported from Europe.

5.7 SUMMARY - IMPORT (continued)

Livestock Feeds and Feed Supplements (cont'd)

- There is some scientific uncertainty regarding the risks associated with gelatin-coated products. Health Canada is conducting a risk assessment on gelatin, and any changes in Canadian policies will be based on the results of that assessment.

Veterinary Biologics and Pharmaceuticals

- Imports of veterinary biologics have always been reviewed on a case-by-case basis. Because of their potential to introduce pathogens, the materials used in their production and manufacturing processes are closely scrutinized.
- Imported veterinary biologics are strictly evaluated for BSE/TSE risk and are therefore unlikely to pose a hazard for the introduction of BSE.
- The CFIA is working in co-operation with Health Canada, which has the mandate to regulate veterinary pharmaceuticals.

6. SLAUGHTER AND DISPOSITION

6.1. Inspection Systems

Some 95% of cattle slaughter and meat processing in Canada occurs in federally registered establishments (these include provincial facilities under federal inspection). The remaining 5% occurs in plants under provincial legislation. The annual number of cattle slaughtered in federal and provincial establishments is listed in Table 18.

Federal Inspection

Federally registered slaughter plants, processing plants and storage facilities (all meeting federal standards consistent with Codex Alimentarius) are provided with CFIA inspection under the *Meat Inspection Act*. There are about 780 federally registered establishments producing meat and meat products in Canada. These include 82 red meat establishments, 70 poultry establishments, 437 processing establishments, and 191 storage establishments. Federal inspection allows establishments to trade their products internationally and interprovincially.

The federal inspection system consists of ante-mortem and post-mortem inspection of all animals slaughtered, a monitoring and control program for chemical residues, and inspection of all packing, processing and storage facilities and operations used in the production and distribution of federally inspected meat products. A veterinary presence is required during slaughter to ensure compliance with the legislation and to supervise ante-mortem and post-mortem inspections.

CFIA officials are responsible for compliance and enforcement in federally registered establishments. Veterinarians and inspectors are trained to perform ante-mortem and post-mortem inspection and related activities to verify compliance and enforce the regulations. Veterinarians and inspectors are also responsible for ensuring the humane handling of animals.

Canada is preparing legislation to mandate Hazard Analysis Critical Control Point (HACCP) programs under its Food Safety Enhancement Program (FSEP) in all federally registered meat establishments (more than half of these facilities have instituted this program voluntarily).

Federal-Provincial Inspection

About 5% of cattle are slaughtered at provincial plants under authority of provincial meat inspection legislation. All provincial meat inspection regulations specify a requirement for ante-mortem inspection as a prerequisite to slaughter. In a portion of the provincial abattoirs this service is delivered by federal meat inspectors as part of a federal-provincial agreement whereby federal meat inspectors provide both ante- mortem and post-mortem inspection services. Under these federal-provincial inspection agreements, the CFIA provides inspection services in 53 provincial meat slaughter establishments in the provinces of British Columbia, Saskatchewan and Manitoba. Ante-mortem and post-mortem inspection is conducted according to federal (CFIA) standards. These establishments are not eligible to trade internationally or interprovincially.

Provincial Inspection

In other provinces, ante-mortem inspection is delivered by provincial meat inspectors. In all cases, animals held at ante-mortem inspection are referred to a designated veterinary inspector for disposition. There remains a small percentage of cattle that may not be subject to ante-mortem inspection. These are animals slaughtered “on-farm” to meet the immediate requirements of the farm family. Provincially inspected establishments are not eligible to trade internationally or interprovincially.

Licencing and inspection is usually provided by the provincial Department of Agriculture or Health. Licencing is mandatory in many provinces or in specific geographic areas of certain provinces. To sell meat at retail, establishments must fall under a system of either municipal and/or provincial control. Some establishments, such as those only doing custom slaughter, are not required to be inspected.

Alberta, Ontario, Quebec, and Nova Scotia have long-standing and well-established provincial meat inspection systems, and inspection is mandatory in Manitoba. Meat sold at the retail level in these provinces must have received a complete ante-mortem and post-mortem inspection by a government inspector. In Saskatchewan and British Columbia, inspection is voluntary for those plants that do not fall under federal-provincial inspection. A number of municipalities have chosen to adopt bylaws or regulations requiring meat to have received a complete inspection before being sold. New Brunswick and Newfoundland have voluntary inspection programs. In Prince Edward Island, meat must have received a “cold carcass inspection” before being sold at the retail level.

Veterinarians and inspectors working in slaughterhouses under provincial legislation receive training to allow them to perform the functions and tasks required in accordance with the respective regulations and codes.

Table 18: Number of Cattle Slaughtered in Federally and Provincially Inspected Establishments in Canada

	Federal Establishments	Provincial Establishments	Total	% in Federal Establishments	Livestock population of Canada (July 1st)
2000	3,255,180	168,033	3,414,531	95.33 %	14,416,400
1999	3,339,261	165,407	3,504,668	95.28 %	14,447,400
1998	3,138,672	177,987	3,316,665	94.63 %	14,705,500
1997	2,991,931	196,159	3,188,090	93.84 %	14,910,300
1996	2,847,148	198,161	3,045,309	93.49 %	15,051,400

Sources: Canfax and Canadian Beef Grading Agency, and CFIA and Provincial Governments

6.2. Ante-Mortem and Post-Mortem Inspection

Ante-Mortem Inspection

All livestock arriving at a federally registered establishment must receive ante-mortem inspection within 24 hours before slaughter (this same requirement applies to the provincial slaughter under federal inspection). This inspection is mandatory under Section 67 of the *Meat Inspection Regulations*. Each animal or animal lots are identified by a lot card (ante-mortem inspection card), and the following information is recorded on it: the number of animals in the lot, date and time of arrival, origin, owner, tag number, time and date of inspection, condition of the animal, and the signature or initials of the inspector who performed the ante-mortem inspection.

This inspection involves two steps. The first step, an initial screening of all animals (which is the responsibility of the plant management), is conducted by a plant employee to identify and segregate any livestock suspected of being diseased or in unsatisfactory condition for slaughter. This employee must have been trained in accordance with the document entitled, "Introduction to Antemortem for Plant Employees" (Chapter 4, Annex I, Manual of Procedures, Meat Hygiene CFIA, 2002). All normal animals are examined by an inspector while they are at rest, and from 5–10% of such animals from several lots are examined on both sides, front and rear, while in motion. The second step consists of veterinary examination and determination of the disposition of all segregated animals. The veterinarian-in-charge at the facilities supervises the initial screening by a plant employee and the ante-mortem inspection by the inspector by verifying the ante-mortem inspection card. For establishments exporting to the EU, a veterinarian must perform ante-mortem inspection on all animals. In accordance with provincial regulations, provincial establishments apply similar ante-mortem inspection principles.

Crippled animals, downers (non-ambulatory), neurologic cases and sick animals are identified, recorded and segregated from healthy animals. The segregated animals receive a detailed veterinary examination and are either condemned or slaughtered and subject to detailed post-mortem inspection by a veterinarian. A more detailed description of the ante-mortem inspection procedures and requirements is provided in the Meat Hygiene Manual of Procedures (Chapter 4.3.1).

Animals condemned on ante-mortem inspection or found dead are identified, removed to the appropriate section of the establishment (for inedible product), and are candidates for BSE surveillance sampling. Targets for BSE sampling are detailed in a document distributed to all federal plants entitled “2002 BSE Surveillance Program at Abattoirs Under Inspection by the Canadian Food Inspection Agency (CFIA)” (See Part B Appendix 1).

Briefly, samples at abattoirs are collected from neurologic cases and surveillance cases. Neurologic cases include BSE suspect cases and neurological cases that do not fit the case definition of a BSE suspect but do exhibit a combination of neurological signs falling under categories defined as mental status, sensory status, and locomotor status.

The case definition for a BSE suspect is a bovine over two years of age that on clinical examination exhibits all of the following clinical signs: poor body condition, ataxia, abnormal head carriage, nervousness, apprehension, hyperaesthesia and tremors. Surveillance cases are mature animals (greater than two years) that on inspection are from one of the following categories: non-ambulatory (downers or unable to rise on farm), emergency slaughter, dead on arrival, or animals found dead. Before the amendment to the *Meat Inspection Regulations* (Section 70, revoked) in May 1997, an animal would have been condemned at the time of ante-mortem inspection by an official veterinarian in a registered establishment, if it was found to be or was suspected on reasonable grounds of being infected with a disease of the central nervous system.

From 1996 to 2000, four training workshops were given to veterinarians working in cattle packing plants. The workshops focussed on the identification of BSE-suspect animals, collection of samples, and disposition of suspects (See Part B, Section 8.2. for more details on training). Veterinarians attending the training workshops were responsible for training staff in their areas and making the training manual available. Before these workshops, in 1994, a document was sent to the veterinarians and inspectors in slaughterhouses to explain and give a case definition description. Updated versions of the documents were sent at later dates.

Post-Mortem Inspection

Only animals that have received and passed ante-mortem examination are permitted to proceed to the slaughter floor. After humane slaughter, all carcasses undergo post-mortem inspection. This includes an examination of the carcass, head and internal organs. A detailed description of the post-mortem inspection procedure and requirements are given in the Meat Hygiene Manual of Procedures (Chapter 4.6). If no abnormality is found, the carcass and its edible parts are approved for human consumption; inedible parts are sent to rendering or some parts may be used for animal food or pharmaceutical purposes.

Further controls and veterinary examination are carried out when significant abnormalities are observed during the post-mortem examination and for all animals that were held on ante-mortem inspection or identified as a surveillance case (e.g. a downer cow). Carcasses held for veterinary post-mortem examination may be partially or entirely condemned. No part of a condemned carcass is approved for human food, including blood, head or offal. Condemned material is sent either to a rendering establishment for inedible product (under CFIA control) or for animal food. If an edible carcass is sampled as part of the active surveillance program for BSE, it must be held pending laboratory results.

In accordance with provincial regulations, similar basic principles of post-mortem inspection are applied in provincial establishments.

6.3. Disposition of Condemned and Inedible Offal

When a carcass or its parts are held on ante-mortem or post-mortem inspection, they remain under the inspector's supervision until disposed of in the prescribed manner.

- An animal ordered destroyed because of its BSE status would be either incinerated or buried.
- A condemned animal sampled for the purpose of BSE surveillance is sent to the renderer as prohibited raw material. It does not enter the human or ruminant food chain.
- According to industry controls, major renderers do not accept sheep, goat, or cervid carcasses, offal and parts, so these are normally incinerated or buried in accordance with environmental controls (see Section 7).

On average, 0.5% of the animals at federal meat inspection establishments are found unfit for human consumption. Disposition of animals, dressed carcasses and their parts is regulated by the *Meat Inspection Regulations* and the *Health of Animals Act*. At provincially inspected abattoirs the condemnation rate is slightly higher. For the province of Quebec, the average condemnation rate for the last 6 years was 1.3% for all ages of bovines and 1.8% for bovines greater than 18 months (MAPAQ 2002). For Ontario, the average for the last 8 years is 0.54% for all ages and 4.8% for cows (OMAFRA 2002).

Following condemnation, carcasses and their parts are sent to the appropriate section of the establishment for rendering or for use in animal food. Section 2(1) of the *Meat Inspection Regulations* defines animal food as a product for use as food for fish or for an animal that is a pet, kept in a zoo, or raised for fur.

A list of diseases and conditions requiring specific dispositions is provided in Chapter 4, Section 4.7 of the Meat Hygiene Manual of Procedures. This list is divided into three subsections. The first deals with diseases and conditions that can be diagnosed in slaughterhouses based on the organoleptic examination of carcasses. In the second subsection, diagnoses are made by veterinarians at slaughter based on laboratory results. And in the third subsection, diagnoses of reportable diseases are made by veterinarians at slaughter based on clinical signs. In addition to reportable diseases, any suspected case of exotic disease must be reported to the CFIA's district veterinarian, who is responsible for all follow-up actions.

No bovine offal is specifically excluded from rendering.

6.4. Stunning Methods

All stunning devices require CFIA approval. More than one method may be applicable to some species, but in all instances the method must be demonstrably suitable and effective for the animal. The following methods may be used:

- stunning by mechanical means, both penetrating and non-penetrating percussion devices;
- electric stunning (most frequently used for pigs, birds and rabbits); or
- stunning by gas or a gas mixture (e.g. carbon dioxide).

In May 2000, the CFIA prohibited the use of a captive bolt with perforation that permits compressed air injection into the cranial cavity, in recognition of the potential risk posed by this method for the contamination of tissues and organs with BSE-infected material from the central nervous system. The pithing technique has never been used in federal slaughterhouses in Canada.

6.5. Compliance and Enforcement

There are six federal acts related to the inspection and marketing of meats and meat products: the *Meat Inspection Act*, the *Health of Animals Act*, the *Food and Drugs Act*, the *Consumer Packaging and Labelling Act*, the *Weights and Measures Act*, and the *Canada Agricultural Products Act*.

Canada's *Meat Inspection Act* provides veterinarians and inspectors with the legislative power to take compliance and enforcement actions. Compliance with the *Meat Inspection Act* in slaughter establishments is facilitated by the daily presence of official veterinarians and inspectors. On an ongoing basis, deficiencies are identified and discussed with the plant manager and corrective actions identified. Any deficiency observed during operations that compromises the safety of the meat, the humane treatment of animals, or any other program must be corrected immediately to the veterinarian's satisfaction. The deficiency and its correction are noted in a log book for future reference.

Directives to the veterinarian-in-charge at registered facilities update policies and regulations. This veterinarian, with the support of inspectors, is then responsible for their implementation. Verification takes place during periodic reviews by the regional reviewer (specialist), as part of the administrative exercise to verify that correspondence, directives, and regulations are current and in effect. Compliance with ante-mortem inspection requirements, including verification of the ante-mortem card, is verified by the veterinarian and by the regional reviewer.

6.6. SUMMARY - SLAUGHTER AND DISPOSITION

- 95% of cattle are slaughtered in CFIA-registered establishments (this includes cattle slaughtered in provincial facilities under federal inspection).
- All cattle slaughtered at CFIA-registered establishments and provincial facilities under federal inspection are subject to ante-mortem inspection. Compliance and enforcement is supported by the daily presence of veterinarians and inspectors, establishment inspections, and follow-up actions concerning any deficiencies, including periodic reviews by regional reviewers.
- Air injection stunning methods have been prohibited by the CFIA.
- No bovine offal is specifically excluded from rendering.

7. RENDERING

7.1. Legislative Framework and Policies

According to the *Health of Animals Act,* Section 2(1), a rendering plant means a place "where animal by-products are prepared or treated for use in, or converted into, fertilizers, animal food, fats or oils, other than fats or oils used for human consumption," or where such substances are stored, packed, marked, and shipped.

On August 4, 1997, Canada adopted a mammalian-to-ruminant Feed Ban prohibiting the feeding of proteins from mammalian species to ruminant animals. Protein derived exclusively from porcine or equine animals and milk and blood proteins from all mammals, including ruminants (*Health of Animals Regulations,* Section 162), may be fed to all species including ruminants.

Since 1997, rendering facilities in Canada have operated under an annual permit system to specifically address risks associated with the feeding of ruminant protein meals to ruminant animals. Three types of permits are issued, allowing companies to produce only non-prohibited material, only prohibited material, or both non-prohibited and prohibited material. Prohibited means anything that is, or that contains any protein that originated from a mammal, other than porcine or equine species (*Health of Animals Regulations,* Section 162). It does not include milk, blood, gelatin, rendered animal fat or their products. Edible residual materials (ERM) and "plate waste" or similar wastes generated by restaurants, cafeterias, and other food-serving establishments are considered as "prohibited material" and cannot be fed to ruminants

An annual inspection is performed by the CFIA before new permits are issued. To qualify for a permit to operate, a renderer has to meet the manufacturing controls, record-keeping and labelling requirements prescribed in the Feed Ban regulations. For rendering plants that manufacture both prohibited and non-prohibited material on the same premises, procedures to keep these materials separated and to prevent cross-contamination are critical.

On October 3, 1997, the CFIA introduced a requirement for the clear identification of all products containing prohibited materials. All renderers are required to include the statement "Do not feed to cattle, sheep, deer or other ruminants" on labels and invoices for prohibited material.

Imported rendered animal proteins are subject to a similar requirement, whereby the importer is required to obtain an import permit declaring the source of the rendered product and must comply with the documentation and labelling requirements of the feed ban and *Feeds Regulations*.

Canada does not exclude specified bovine offal from MBM, but products of ruminant origin (except as identified above) are treated as prohibited materials.

No BSE suspect animal or animal infected with scrapie or CWD may enter the human or animal feed chain, including through rendering.

Under the CFIA's scrapie and CWD eradication programs, animals ordered destroyed are incinerated or buried. They are not disposed of through abattoirs or renderers.

7.2. Industry Profile

Between 2 to 3 million tonnes of inedible by-products are processed by 32 Canadian renderers each year. Renderers are well aware of the international and national implications if BSE were introduced into Canada. Two thirds of these facilities are owned and operated by large corporations, including international vertically integrated food companies with a vested interest in ensuring BSE is not introduced to Canadian livestock. Five facilities are attached to federally registered slaughter plants so that these companies can control the rendering and disposition of raw material from their own operations.

As a result of the Feed Ban, certain critical Good Manufacturing Practices (for example, written procedures to prevent cross-contamination, production records and distribution records) are in place at all rendering plants. In addition, more than 80% of the renderers have adopted HACCP-based Quality Assurance Programs. In 2001, the Animal Protein Producers Industry (APPI), a U.S.-based organization, launched a certification program to verify compliance with the Feed Ban. To date, 12 large Canadian rendering plants, responsible for 74% of the production, have been officially audited by a third party through this program (http://www.animalprotein.org/new/whatsnew_frm.htm) and have been assessed as meeting the conditions for proper implementation of the Feed Ban.

Sources of raw material include livestock and poultry carcasses and offal, fish, fat trimmings, bones, and other tissues/products considered inedible from slaughter and processing facilities, dead stock, spent cooking fats and oils, and trim material from supermarkets and restaurants.

Tankage and raw materials for rendering are imported from the U.S. only.

More than 50% of the products processed by rendering are protein meals. The remainder are animal fats and fatty acids, which account for two thirds of the renderers' revenue. Canada produces approximately 530,000 tonnes of MBM (including pork, poultry, and fish protein meal) annually (refer to Table 19). Approximately 270,000 tonnes of animal fats and fatty acids and 75.600 tonnes of blood and feather protein meal are produced annually (Refer to Appendix 21).

A large proportion of the tallow and fat produced is exported, whereas most of the protein meals are used domestically.

The protein meals produced are almost entirely used in the manufacture of feeds for livestock and poultry (90%) and pet food (10%); less than 0.5% are used for fertilizer (Refer to Table 19 and Appendix 21).

Table 19: Production of MBM and Other Protein Meals (excluding blood and feather meal) Before and After the Feed Ban

Commodity:	Average Annual Production (tonnes)	
	Domestically Produced Prior to 1997 Feed Ban (Domestic information for 1995)	**Domestically Produced** After 1997 Feed Ban (Domestic information for 2000)
Raw product estimated at (tonnes):	1,536,070	between 2,000,000 and 3,000,000
Prohibited[1] **:** MBM	134,810	374,395
Non-prohibited: Pigs	116,500	57,500
Poultry	75,190	89,416
Fish [2]	n/a	9,060
Other [3]	47,100	
TOTAL	**373,600**	**530,371**
Used as pet foods:	*10.5%*	*10%* [4]

Source: Tolusso, 2001a, CFIA
[1] Either ruminant MBM or mixed MBM (from bovine, porcine, poultry etc. origin) that is not permitted for feeding to ruminants.
[2] Production levels of domestic fish meal are not available at this time.
[3] Mixed MBM (from porcine, poultry origin)
[4] It is estimated that about 10% of all rendered proteins are used in the manufacture of pet foods.

7.3. Voluntary Industry Bans

Beginning in the early 1990s, the Canadian members of the North American National Renderers Association (NRA) introduced a voluntary ban on the processing of raw ovine/caprine materials by rendering. Some companies only accept ovines from low-risk groups (slaughter animals under one year of age) but do not accept material from mature ovine or caprine animal.

Many rendering companies are no longer accepting any companion animals (e.g. domestic cats), mink, zoo animals (import conditions do not allow imported zoo felines to be rendered), carcasses from exotic breed animals, such as deer, wapiti, elk, and antelope, or any animals of unknown provenance (Appendix 22).

7.4. Structure of the Rendering Industry

Of the 32 rendering facilities, 13 manufacture both non-prohibited material and prohibited material, 12 have permits to manufacture only non-prohibited material, and 7 have permits to process only prohibited material. Of the 7, one contracts production of its protein meals to another renderer, and one other closed in October 2001, leaving 5 facilities manufacturing prohibited material (Refer to Table 20 and Appendix 21).

Table 20: Geographic Distribution of Rendering Facilities and Permit Types (December 2001)

Province	NF	NS	NB	PEI	QC	ON	MN	SA	AL	BC	Total
No. of Rendering Facilities	1	3	-	-	5	8	3	2	6	4	32
"Prohibited" Facilities	1	1	-	-	1	3	-	-	-	1	7 (5)
"Non-Prohibited" Facilities	-	2	-	-	2	3	1	1	2	1	12
Both "Prohibited" and "Non-Prohibited" Produced in the Same Facilities	-	-	-	-	2	2	2	1	4	2	13

Source: data from annual permits, CFIA 2001

Of the facilities producing both prohibited and non-prohibited material, 4 are located in Quebec and Ontario, where most Canadian dairy cows are raised and slaughtered. Another 9 such facilities are located in Western Canada, where most of the beef cattle are raised and slaughtered. Source material entering the plants in Quebec and Ontario would be of greater concern due to dairy cattle feeding practices (see Section 8.3.1 on cattle feeding).

In Canada, 70% of the beef cattle are slaughtered in 2 plants with integrated rendering facilities. These facilities produce approximately 80,000 tonnes/year of prohibited MBM. More than 90% of the by-products use inedible material from young beef as raw material; they do not use dead stock (see Appendix 22). Both plants have a Quality Assurance Program, and one has been audited and met the requirements of the APPI. The integration with the slaughterhouse means that these companies have good controls over the input of raw material into the rendering process.

All of the plants manufacturing both prohibited and non-prohibited material, with the exception of 4, maintain separate lines for each product. Dedicated lines in these plants are dictated by the nature of the product being rendered and serve to prevent cross-contamination. For example, rendering plants attached to beef packing plants process non-prohibited blood meal and prohibited MBM. The blood is collected in the packing plant at a separate point from waste meat and bone, into containers designed to handle liquids. It is processed using equipment specialized for handling liquid product. There is very little potential for cross-contamination, with the possible exception of contamination as a result of stunning (leakage from the stunning hole or brain emboli). The use of captive bolts with perforation that permits compressed air injection into the cranial cavity was prohibited for stunning in May 2000. Similarly, plants producing non-prohibited feather meal and prohibited meat-and-bone meal in the same facility require equipment specialized for each product. The possibilities for cross-contamination are extremely limited.

Non-dedicated processing lines are used by 4 of the facilities producing prohibited and non-prohibited material (Refer to Appendix 21 and 24). Large Canadian rendering companies own 3 of them, and one of them intends to install a dedicated line to produce non-prohibited material

(projected for 2004) (Tolusso 2002). In addition to annual CFIA inspection, a Quality Assurance Program is in place in these facilities; they have been audited and met the requirements of the APPI. The other facility has an independent owner and produces a small volume of non-prohibited material (feed fat, poultry fat, poultry, and feather meal).

The companies with non-dedicated processing lines produce approximately 60,000 tonnes of prohibited MBM and approximately 100,000 tonnes of non-prohibited material (pork and poultry MBM, feather meal, blood meal, tallow, and feed fat). Because they represent a greater risk for mixing and cross-contamination, additional measures must be in place to prevent problems. These include the following:

- one complete cycle of flushing the processing and distribution equipment with a specified quantity of non-prohibited material, which is diverted to prohibited material storage;

- diverting the initial portion of a batch of non-prohibited material to prohibited material storage. The length of time is dependent on the volume contained by the specific piece of the equipment being used and the rate at which the product passes through the equipment (more time is required for larger pieces of equipment like cookers); and

- physical clean-out of the equipment combined with diverting the initial portion of a batch of non-prohibited material to the prohibited material storage.

These standards are the minimal standard procedures accepted by the CFIA. Based on the principles and procedures employed by feed manufacturers to prevent drug residue carryover, these procedures are expected to reduce cross-contamination of non-prohibited feed with prohibited. Given that a definitive test is not currently available, it has not been possible to determine the level of reduction. However, these procedures are highly effective in reducing drug residues and it is assumed, in the absence of a test, that a similar level of effectiveness exists for reducing cross-contamination with prohibited feed.

The CFIA has taken steps to ensure that the 4 plants that use the same line to produce both non-prohibited and prohibited materials are inspected closely, prior to issuing an annual operating permit. The CFIA is concerned that proper procedures are in place to reduce any potential for cross-contamination. These plants mostly operate in areas where disposal options are limited. The one large plant operating in this manner is owned by a large food corporation. This company is well aware of the BSE issue and would be seriously affected if BSE were introduced into Canada. Headquarters staff have visited this plant to ensure effective procedures are in place, and discussions have been held with the company to discuss alternatives to the use of non-dedicated lines. It is likely that the practice of using non-dedicated lines for the production of prohibited and non-prohibited material will eventually be phased out.

7.5. Processing Techniques

Four types of rendering processing systems are used in Canada (See Appendix 21):

1. continuous cooker rendering systems;
2. continuous multi-stage evaporator rendering systems;
3. continuous preheat/press/evaporator rendering systems; and
4. batch cooker rendering systems.

The majority of rendering plants in Canada use continuous cooking systems, because they can process larger volumes. Some smaller facilities use batch cooking systems, which are also used for the production of feather meal.

Blood meal and feather meal are handled and processed differently than MBM, so it is unlikely that these products would be contaminated with prohibited material. Blood meal is produced by separating the blood solids from the blood serum water, and thereafter the blood solids are fed into a continuous drying system. Poultry feathers and hog hair consist mostly of keratin, which is relatively indigestible protein. The keratin is converted into more digestible amino acids by hydrolyzation, which is effected in a batch cooker and a drying operation.

The majority of renderers grind raw material to between of ¼ inch to ½ inch in size prior to cooking. Heat treatment of rendered products at high temperature under pressure conditions is considered to be critical to reduce BSE infectivity in countries that have this disease. Each of the four processing systems has some level of efficacy for the reduction of BSE (and scrapie) infectivity (Taylor et al. 1995; Taylor et al. 1997; Schreuder et al. 1998). Examples of different rendering systems' effectiveness in reducing the infectivity of BSE or scrapie are listed in Table 21.

Table 21: Infectivity Reduction Achieved by Different Types of Rendering Systems

Processing Systems	Infectivity Reduction Achieved (log base 10)
Batch	3.1 logs
Continuous/fat added	2.0 logs
Continuous/no fat added	1.0 log
Vacuum	0.0 log

Reference: Taylor et al. 1995; Taylor et al. 1997; Schreuder et al. 1998

Of the 13 rendering plants producing both prohibited and non-prohibited material, 2 operate batch processes and 11 operate a continuous system (refer to Appendices 21 and 25).

Of the 4 facilities that do not use dedicated lines, 3 have a continuous system, and one of them operates a batch process. Together, they produce approximately 100,000 tonnes of non-prohibited material. Approximately 18,500 tonnes of the total are exported, 2,200 tonnes are sold to the pet food industry, 4,000 tonnes go to other end users, 6,000 tonnes are sold directly to farms, and 69,300 tonnes are sold to be processed by commercial feed mills.

The facility using a batch system operates at a peak temperature of 155°C for 180 minutes. Approximately 660 tonnes of non-prohibited rendered products (poultry meal) are produced, of which 640 tonnes are sold to be processed by feed mills, 7 tonnes are sold directly to farms and 13 tonnes are sold to fertiliser companies.

Of the three facilities using continuous systems, one operates at a peak temperature of 120°C for 15 to 20 minutes. This company produces 26,800 tonnes of non-prohibited rendered products, from which 19,900 tonnes are sold to be processed by feed mills, 700 tonnes are sold directly to farms, 3,300 tonnes are exported, 2,200 tonnes are sold to pet food companies and 500 tonnes are sold to other end users.

The second of the 3 facilities using common lines with a continuous system operates at a peak temperature of 132°C for 50 to 120 minutes. This company produces 62,800 tonnes of non-prohibited rendered products, from which 46,100 tonnes are sold to be processed by feed mills, 5,000 tonnes are sold directly to farms and 11,700 tonnes are exported.

The last of the 3 facilities using common lines with continuous systems operates at a peak temperature of 120°C for 20 to 25 minutes. This company produces 11,900 tonnes of MBM, and the volume of the other protein meals and tallow produced has been estimated based on another year's production at 10,000 tonnes (a conservative estimate). From this 10,000 tonnes, approximately 2,700 tonnes are sold to be processed by feed mills, 300 are sold directly to farms and 7,000 tonnes are either exported or sold to other end users.

These 4 facilities operate under a Quality Assurance Program (HACCP or GMP). The 3 facilities that are corporately operated have been certified by the APPI.

The other 9 facilities that produce both prohibited and non-prohibited products produce product on separate lines and, in compliance with the regulations, have additional measures in place to avoid the cross-contamination of products.

7.6. Compliance and Enforcement

All rendering facilities are required to obtain an annual operating permit from the CFIA. To qualify for a permit to operate, and prior to issuance of the annual permit, the CFIA inspects the rendering facilities to verify their compliance with the *Health of Animals Regulations* (Sections 162 to 171*),* the *Feeds Regulations,* and with non-mandatory requirements such a Quality Assurance (QA) Program (HACCP or GMP). A renderer must meet the mandatory manufacturing controls, record-keeping and labelling requirements to obtain a permit. Imported rendered products are also subject to a permit requirement wherein the importer is required to stipulate the source of the rendered product and compliance with the documentation and labelling requirements of the regulations. One of three types of permits may be issued to a rendering plant:

- permit to manufacture "non-prohibited material" only;
- permit to manufacture "prohibited material" only; or
- permit to manufacture both "non-prohibited material" and "prohibited material."

The CFIA encourages plant operators to implement HACCP or another quality-management system. A program is considered satisfactory if Good Manufacturing Practices are documented and used in relation to:

- premises
- transportation and storage
- equipment
- personnel
- sanitation and pest control
- product recall

A compliance guide has been developed to ensure consistency in inspection control (see Appendix 26, Compliance Guide for Rendering Plants).

No. of Rendering Plants (as of 2001-04-01)	BSE Compliance
32	100%

Since August 1997, the CFIA has conducted at least four complete inspections at each facility to verify compliance with the regulations. As of March 31, 2002 all renderers were inspected for their new permits for 2002/03.

The results showed that all renderers are complying with the requirements of the *Health of Animals Regulations*. Renderers that manufacture both prohibited and non-prohibited materials have separate production and/or distribution equipment and/or are following documented procedures that prevent the mixing and contamination of non-prohibited materials with prohibited materials.

In February and March 2002, a CFIA compliance audit was undertaken in the four national areas to verify the effective delivery by CFIA staff of the National Rendering Plant Compliance Program.

7.7. SUMMARY - RENDERING

Legislation and Policies

- On August 4, 1997, Canada adopted a Feed Ban prohibiting the feeding of proteins from mammalian species to ruminant animals. Exceptions include pure porcine and equine protein, blood, milk, and gelatin, which may be fed to ruminants and other animals.
- Rendering is regulated by the CFIA under an annual permit system. Compliance with requirements is verified by annual inspection.

Industry Profile

- There are 32 rendering facilities in Canada.
- These facilities process between 2 and 3 million tonnes of inedible by-products each year, and produce approximately 875,000 tonnes of rendered product, of which more than half is protein meal. The protein meals produced are almost entirely used in the manufacture of feeds for livestock and poultry (90%).
- More than 80% of these facilities operate under a Quality Assurance Program (HACCP or GMP).
- Canadian renderers have adopted voluntary bans relating to “higher risk” ovine materials for about 10 years. Most do not process animal by-products from sheep, goats, cervids, pet animals, and animals of unknown provenance.

Processing Techniques and Practices

- Four types of rendering processing systems are used. These systems may reduce infectivity (0 to 3.1 log) but cannot be relied upon to inactivate the BSE agent completely.
- Of the 13 rendering facilities in Canada producing both prohibited and non-prohibited material on the same premises, 9 use separate lines. The 4 that use common lines use flushing and sequencing procedures to reduce the likelihood of cross-contamination.
- Feather meal and blood meal are unlikely to be contaminated with prohibited material even if processed in the same facility, as these products are manufactured and handled differently, using different equipment.
- Since August 1997, the CFIA has inspected all rendering facilities at least four times.

8. FEED

8.1. Regulation of Feed

The Canadian federal government regulates the trade and commerce of feeds for livestock by controlling their manufacture, sale, and importation using the authorities provided in the federal *Feeds Act*. In addition, the federal *Health of Animals Act* may be used to make regulations prohibiting or regulating the feeding to animals of any substance that could introduce or spread disease or toxic materials to animals (*Health of Animals Act,* Section 64(t)).

Feed is defined in the *Feeds Act* as any substance or mixture of substances containing amino acids, antioxidants, carbohydrates, condiments, enzymes, fats, minerals, non-protein nitrogen products, proteins or flavouring agents, and any other substance manufactured, sold or represented for use for:

- consumption by livestock;
- provision of the nutritional requirements of livestock; or
- the purpose of preventing or correcting nutritional disorders of livestock, or any substance for use in any such substance or mixture of substances (Feeds Act, Section 2*)*.

Animal food is defined in the *Health of Animals Act* as anything that is capable of being a nutriment for animals and includes any of the constituent elements of an animal ration (*Health of Animals Act,* Section 2).

Livestock is defined in the *Feeds Act* as horses, cattle, sheep, goats, swine, foxes, fish, mink, rabbits and poultry, and includes such other creatures as may be designated by regulation as livestock for the purposes of the Act (*Feeds Act,* Section 2). The *Health of Animals Act* includes as animals embryos, fertilized eggs, and ova (*Health of Animals Act,* Section 2).

The *Feeds Act* prohibits the manufacture, sale and importation into Canada of any feed unless the feed has been registered by the federal government, conforms to prescribed standards, and is packaged and labelled as prescribed.

The federal government regulates mixed feeds and feed ingredients using the *Feeds Act*. Most domestically manufactured mixed feeds do not need to be registered (they are, however, subject to marketplace inspection under the National Feed Inspection Program). All imported mixed feeds must be registered. A complete list of feed ingredients must be provided to the CFIA in order to register certain products, e.g. feeds manufactured outside continental North America and specialty feeds such as flavouring agents. In some other cases, the complete list need only be made available on request. Registrations expire and are renewed every three years upon application by the registrant. Ingredients must be approved by the federal government for use in livestock feeds and are described and standards given under Schedule IV (roughage, energy feeds, protein feeds, vitamins, minerals and other categories) and Schedule V (flavouring agents) of the *Feeds Regulations*. Part I of each Schedule lists approved ingredients that do not require further evaluation and mandatory federal government registration, while Part II lists those ingredients for which all sources must always be evaluated and registered to confirm the safety and efficacy of each specific source.

To be eligible for free sale in Canada, livestock feeds must comply with the requirements of the *Feeds Regulations*. Feeds must also comply with the Feed Ban (described in more detail in Section 8.1.1 under the *Health of Animals Regulations*).

8.1.1. Feed Ban

The incorporation of rendered ruminant-derived protein in cattle feed in countries where the disease occurs is thought to be the main factor contributing to the spread of BSE. In August 1997, in response to a WHO recommendation, the CFIA banned the feeding of specified mammalian protein to ruminants (*Health of Animals Regulations, Part XIV,* Sections 162–171).

The Feed Ban is described in the following terms. Any feed that is, or that contains any prohibited material originating from a mammal (with exceptions) shall not be fed to a ruminant. Feeds for equines, porcines, chickens, turkeys, ducks, geese, ratites or game birds, containing prohibited materials, must be clearly labelled with the following cautionary statement, "**Do not feed to cattle, sheep, deer or other ruminants**." Labels for bulk feed are stapled to the invoice and shipping documents. Ruminants may be fed pure porcine meal, equine meat meal and non-mammalian protein meal (fish, avian), as well as milk, blood, gelatin, rendered animal fat and any products produced from these materials from all species.

Feed manufacturers must keep records regarding the composition, identity and distribution of all feeds for the species named in the regulations (i.e. ruminants, equines, porcines, chickens, turkeys, ducks, geese, ratites or game birds) (*Health of Animals Regulations,* Section 171).

Renderers, feed manufacturers and farmers must take steps to prevent cross-contamination of ruminant feeds with materials prohibited under the Feed Ban.

Users of livestock feed must keep labels or invoices from all purchased feeds containing prohibited material; these records must be kept for two years. Prohibited material may be fed to non-ruminant animals such as poultry and swine.

8.2. Feed Production

8.2.1. Feed Industry Profile

Canada is a vast country spanning several distinct geographic regions. Accordingly, livestock and crop production practices vary from coast to coast, as does the feed industry. Feed ingredients vary depending on availability and the predominant type of farming industry. The CFIA maintains information on individual commercial and farm-based manufacturers, which is derived from CFIA inspection reports. General information about the feed industry in Canada can also be obtained from the Animal Nutrition Association of Canada (ANAC) at http://www.anac-anac.ca.

In 2000, there were about 600 feed mills, 1,300 feed retailers of livestock feeds and more than 100,000 farms feeding ruminants in Canada (Tolusso 2001b). Table 22 shows the geographic distribution of mills and feed production in 1997. The ANAC website reports a similar distribution of its 520 members across Canada.

Table 22: The Geographic Distribution of Feed Mills and Feed Production in Canada (1997)

Region/ Area	# Feed Mills	Relative (%) Distribution of Feed Mills	Total Feed (Tonnes)	Relative (%) Distribution of Feed Production in Canada
Atlantic	47	8%	625,385	5%
Quebec	188	32%	3,898,740	31%
Ontario	218	36%	4,508,609	35%
Midwest	55	9%	1,092,110	9%
Alberta	70	12%	1,575,390	12%
BC	16	3%	956,450	8%
Total	**594**	**100%**	**12656684**	**100%**

Source: CFIA, 1997, Feed Mills Inspection Report

The Canadian feed industry comprises establishments that vary in size and manufacturing capacity from relatively small mills to large sophisticated and vertically integrated operations. Annual sales per operation vary from $1 million to over $150 million (ANAC). Total sales in 2000 were estimated at over CDN $3.2 billion for all livestock and poultry feed shipments (excluding pet food) (ANAC).

Approximately 13 million tonnes of complete commercial feed is manufactured every year, or about one half of the total 23–25 million tonnes of complete feed needed to feed all the livestock and poultry in Canada. Overall, about 50% of mixed complete feed is mixed on-farm (ANAC).

Two thirds of the feed mills located in Ontario and Quebec account for 66% of the total feed manufactured in Canada. Western Canada produces 29%. Given the large population of cattle in Western Canada, it is likely that many western farms are mixing their own feed. It is estimated that 80% of the feed used in beef production is mixed on-farm (Mercier 2002). In general, feed for beef cattle is formulated from forage and grains. Small amounts of commercial protein/energy supplements may be purchased from a feed mill; however, depending on price, this too may be plant in origin. Most beef feedlots are large, specialized farms. It is highly unlikely that the feed mixers used on beef feedlots would be cross-utilized to mix feeds for other species.

Commercial feed production in Canada can be broken down according to livestock sector as follows (ANAC): hogs - 37%, beef - 29%, dairy - 15%, poultry - 16%, other - 3%. Swine, dairy and poultry feeds account for approximately 85% of the complete feeds manufactured and sold by commercial manufacturers in Canada (ANAC).

Canada has abundant agricultural land suited to growing crops like corn, barley, and high-protein ingredients such as canola and soybeans. Consequently, plant-based proteins have always been an inexpensive and nutritious component of cattle feed.

The industry relies on imports from the U.S., Europe, and Asia for the majority of high-value purified micro-ingredients such as vitamins, trace minerals, amino acids, animal health

pharmaceuticals and other micro feed additives. There is virtually no vitamin production in Canada, and the pharmaceutical fine chemical industry is limited (ANAC). These products must be registered and must comply with CFIA import policies for BSE.

The feed industry is represented by ANAC, the membership of which includes 200 feed companies owning 520 feed mills across Canada, responsible for 90% of the total feed produced in Canada (ANAC). Approximately 33% of the 520 feed mills (or 169 feed mills) are owned by 11 large feed corporations and carry out 70% of the total annual commercial complete feed production. Two of these corporations have policies prescribing the use of rendered animal protein meals (Mercier 2002).

As required under the Feed Ban, Good Manufacturing Practices (such as written procedures to prevent cross-contamination, maintenance of production and distribution records) are confirmed to be in place at all feed mills. In addition, 40 mills have Quality Assurance Programs (HACCP certification) in place to verify product quality and safety (including verification of ingredients for Feed Ban compliance). These mills handle 35% of the total annual commercial complete-feed production (Mercier 2002). Another 15 to 20 mills are actively seeking HACCP certification (Mercier 2002).

8.2.2. Risk Reduction Practices for BSE in the Feed Industry

Feed manufacturers producing both ruminant and non-ruminant feeds (which may include prohibited material) in the same facility and/or with the same equipment must use specified procedures to reduce the potential for cross-contamination. These procedures are used when common equipment is used for receiving, handling, processing, transport or delivery of both the ruminant feeds and the non-ruminant feeds. Sequencing and flushing grids apply to each critical point in the manufacturing process, including ingredient receiving and storage, weighing and metering, mixing, pelleting/extrusion, packaging, finished product storage, loading, and delivery vehicles. Typical clean-out procedures include the following:

- flushing of manufacturing equipment with a specified quantity of inert material (whole grains, etc.), which is either stored for later use in non-ruminant rations or included in the previous batch containing the prohibited material;
- diverting to the previous batch of feed the initial portion of any batch of ruminant ration that has followed a feed containing prohibited material;
- sequencing of production where the manufacture of non-ruminant feeds containing prohibited material is followed by the manufacture of non-ruminant feeds not containing prohibited material, such that any residual prohibited material in the manufacturing equipment would be displaced into another non-ruminant feed manufactured later in the production sequence; and
- physical cleanout of equipment (sweeping, vacuuming), which may be combined with flushing and sequencing procedures as required.

No testing is done to detect the presence of prohibited mammalian protein in ruminant feed.

The Feed Ban imposes additional requirements on feed mills for record-keeping and prevention of cross-contamination (in addition to those required for dealing with medicated feeds), and

companies have responded in a variety of ways. Some companies with multiple manufacturing facilities within a small geographic area have designated certain facilities solely for the production of ruminant feed. Other mills designated for the production of ruminant feeds do not handle any MBM. Yet other feed manufacturers have opted to use only non-prohibited protein sources in all livestock feeds, to avoid the additional burden of complicated decontamination procedures and record-keeping specifically for the Feed Ban.

In 1996, ANAC launched a voluntary national Feed Safety Program for feed manufacturers, with the goal of facilitating the implementation of GMPs and HACPP programs in feed facilities. The Canadian industry is adopting HACPP programs in feed mills, and ANAC has requested CFIA recognition of its certification program.

8.2.3. Sources of Proteins in Livestock Feeds

The protein ingredients in ruminant feeds are selected on the basis of availability, price, nutritional value and the personal preference of livestock producers. Only animal protein derived exclusively from porcine or equine animals and milk and blood proteins from all mammals are allowed to be fed to ruminants.

On December 7, 2000, the CFIA suspended the importation of rendered animal protein products, including blood meal and feather meal of all species, from any country that the CFIA does not recognize as free of BSE. Imported rendered products are subject to a permit system, wherein the importer is required to stipulate the source of the rendered product and compliance with the documentation and labelling requirements of the regulations. Importation of rendered products from the U.S. represents a significant portion of the animal proteins used by the feed and pet food manufacturers; approximately half of the rendered products used in livestock feeds are imported from the U.S. (Thompson 2002; Carrière 2002).

Prior to the Feed Ban, soybean meal was cheaper than MBM, and other rendered animal protein was more expensive than MBM and soybean protein. Given that feed represents a significant portion of the cost of livestock production, and that soybean meals were cheaper than non-prohibited meat meal, it is likely that many feed mills (which use least-cost formulations) and cattle farmers used soybean meal or other vegetable proteins instead of rendered animal protein in their cattle rations. This price trend has continued since the Feed Ban.

Some of the meal produced, which also compares favourably in price with MBM, could be used to feed cattle. For 2001 it is estimated that approximately 74% of the porcine meal (or 43,000 tonnes) produced in Canada was manufactured in a rendering facility that uses the same line to produce prohibited and non-prohibited material. Of this 74%, approximately 10% is exported and 15% is used by the pet food industry. The quantity used in cattle rations is unknown.

Although poultry meal, blood meal and feather meal may be fed to ruminants, the higher cost of these items likely discourages this practice (Table 23). Blood meal and feather meal may be used to some extent, but because of the specialized equipment used for the processing, these products are less likely to be contaminated with prohibited materials. Poultry meal is generally reserved for the production of high-quality pet food (Desnoyer 2002).

Table 23: Price Differential Between Protein of Animal Origin and Vegetable Origin

Canadian Market[1](CDN$) (Prices based on an annual average quoted by the trade)							U.S. Market [2] (US $)			
Year (Jan. 1 to Dec.31)	**MBM ($/metric tonne (mixed meal, from ruminant, pork, poultry origin)**	**Feather Meal ($/metric tonne)**	**Porcine meal[3] ($/metric tonne)**	**Blood meal[4] ($/metric tonne)**	**Poultry meal[5] ($/metric tonne)**	**Soybean meal ($/metric tonne) (48% protein)**	**Year (Oct. 1 to Sept. 30)**	**MBM (50%) Central ($/imp ton)**	**Soyabean meal (50%) Decatur ($/imp ton)**	**Pork MBM (50%) Central ($/imp ton)**
1993 (Aug. to Dec.)	349.48	399.99	-	582.5	468.61	333.2	1992–93	195	218	-
1994	330.63	376.15	-	601.53	480.42	304.29	1993–94	193	205	-
1995	304.45	324.94	-	581.53	449.86	285.79	1994–95	163	170	-
1996	396.39	456.91	400	706.39	586.39	385.19	1995–96	230	238	-
1997	431.25	549.02	450	866.49	637.36	438.12	1996–97	270	272	-
1998	295.1	407.52	310	624.69	607.18	315.6	1997–98	178	180	-
1999	267.71	340.6	270	558.65	480.94	290.93	1998–99	140	140	150
2000	314.91	384.19	316	639.88	505.1	325.98	1999–00	162	163	183
2001	309.02	422.17	309	671.1	500.88	329.19	2000–01 (Oct. to March)	176	177	200

[1] Source for Canadian market: Economic and Industry Analysis Division, Market Research and Analysis Section, Agriculture and Agri-Food Canada
[2] USDA Agricultural Outlook and USDA Market News. (www.usda.gov/mnreports/nw_ls446.txt)
[3] Prices come from a rendering facility located in Eastern Canada, prices may be different in other areas in Canada
[4] Prices come from a rendering facility located in Western Canada, prices may be different in other areas in Canada
[5] Prices come from a rendering facility located in Western Canada, prices may be different in other areas in Canada

8.3. Feeding Practices

8.3.1. Dairy Cattle

High-producing dairy cattle need high quality protein, particularly in early lactation. In Canada, a variety of “bypass” protein sources are available that can be used for this purpose (such as treated soybean products, blood meal, fish meal, corn gluten meal, and non-prohibited MBM). Animal products were commonly used in dairy feeds before the Feed Ban in 1997 and are often used today to boost protein levels and/or balance specific nutrients (lysine and other amino acids, calcium and phosphorus, in particular). Tallow is also commonly used in small proportions, more as a facilitating agent in the manufacturing of feeds rather than as a source of energy.

Prior to the Feed Ban, some feed manufacturers used no MBM in dairy rations, while others used it in 20–30% of dairy formulations. The decision to use MBM depended largely on the nutritional philosophy of the feed manufacturer, the variety of economical bypass protein sources available in a particular region and the potential implications of *Salmonella* contamination of MBM. Before the Feed Ban was put in place, the maximum inclusion rate of MBM in dairy rations would have amounted to a consumption rate of 200–400 g/head/day.

In the Atlantic provinces, fish meal is the preferred source of animal protein used in dairy supplements beyond the vegetable proteins that make up the majority of protein in feed. Other types of protein meal are used at the customer’s request.

In Central Canada, feed companies may use porcine meal, blood meal, feather meal, and “protected” soybean meal. Animal proteins make up 1% or less of the overall diet of an animal.

In Western Canada, blood meal is commonly used in dairy feeds as a source of bypass lysine, which aids the maintenance of high milk production. Since the Feed Ban, feather and porcine meal are commonly used to boost protein levels in lieu of ruminant MBM.

Calves are removed from the cow soon after calving and fed with milk replacer (that does not contain MBM).

8.3.1.1. Use of Milk Replacers in Dairy and Veal Calves

Central Canada is the largest veal production region in Canada. The milk replacers used in white veal production typically contain bovine milk products (skim milk powder, whey protein concentrate, casein, etc.) and high quality tallow.

High-quality milk replacers provide for calf growth and performance equal to that attainable with whole milk. Milk replacers can be classified by protein source, energy content, and the presence of medication. Protein sources are generally classified as milk or alternative proteins (soy protein isolate, soy protein concentrate, modified wheat protein, plasma protein), with protein levels ranging from 18–22% and fat levels from 10–25% (Dupchak 1991; APHIS/USDA 1998). The fat content provides most of the energy in a milk replacer.

Milk replacers are regulated under the *Feeds Act* (if not containing colostrum) and all milk replacers, imported or made domestically, must be registered. In Canada, most milk replacers are formulated to contain 100% of their protein from milk sources (such as skim milk powder and whey protein concentrate), although other protein ingredients may be used. In recent years, the use of soy protein concentrate to replace some milk protein has become more common. The basic fats used are high quality animal fats (tallow) and some high quality vegetable fats.

Because of the Canadian tariff imposed on milk products and by-products, importation of milk replacers occurs at a very low level. Since December 2000, only protein-free tallow (maximum level of insoluble impurities 0.15% by weight) may be imported from countries not recognized as

free of BSE. Domestically produced tallow or tallow imported from BSE-free countries is not required to be free of protein in order to be used in milk replacer. Milk replacer manufacturers use high-quality tallow because it is palatable, odourless, and can provide the level of energy sought. According to the American Fats & Oils Association, high quality tallow is expected to have less than 0.1% insoluble impurities (McCoy 1996). In addition to the import controls, it should be noted that veal calves are slaughtered young, thus the probability of their developing BSE, even if they were exposed, would be negligible. Beef calves remain on pasture with the cow until late fall when the calves are weaned, and it is unlikely that they would receive milk replacer.

There is no evidence that milk replacers containing milk or milk products derived from ruminant animals constitute a BSE risk (WHO 2001; SEAC 1999).

8.3.2. Beef Cattle

Producers' revenues from beef production are more volatile than those of the dairy industry, so producers are generally more concerned about feed costs than the maintenance of a nutritionally consistent feeding regime. The decision to use MBM in beef feed formulations, before the Feed Ban, depended largely on the nutritional philosophy of the feed manufacturer and the most economical supplemental protein sources available, such as peas, lupins, lentils, canola, or soybean meal. As a result, beef cattle rations typically used low-cost, low-quality protein ingredients such as urea and grass forages. Feeding animal-based protein in beef cattle rations was and is not normal practice in Canada.

In Western Canada, breeding cattle are typically on range or pasture, with stocking rates as low as one cow per four hectares. Under this management system, neither the breeding animals nor their offspring receive a supplemental protein source. Accordingly, they would not have consumed MBM before or after the Feed Ban. Historically, in Western Canada, animal protein has seldom been used in beef production. At the present time in the West, urea, forages and cereal grains make up the bulk of feedlot beef cattle rations as well; however, it is becoming more common for feedlot operators to store tallow in bulk on the feedlot and use it in the final rations consumed by cattle. Consumption of tallow at 0.5 kg/head/day is normal. Calving typically occurs in March and April, and the calves are normally weaned in the fall at approximately six months of age.

In the Atlantic provinces, as in Western Canada, beef cattle, either in cow/calf or in feedlot operations, commonly receive no animal protein in their diets. An emerging "home-grown" beef production industry in Atlantic Canada (currently estimated at about 30,000 head) uses urea, locally produced cereal grains and potato by-products as the principal feed ingredients. Commercial feed manufacturers principally supply mineral feed supplements to these beef producers.

In Eastern Canada, breeding cattle are housed in barns in the winter months, with access to the outside for exercise and consumption of conserved forages. Calving typically occurs in March and April (inside or outside depending on weather conditions). Cows and calves are on pasture in the spring and remain there until late fall when the calves are weaned. Under this management system, the breeding animals would not normally receive a supplemental protein source. However, calves may have access to supplemental feeds via creep feeders, and some of these feeds could have contained MBM before the Feed Ban.

After weaning, calves are sent to feedlots where they are grouped by age, weight, and sex. Feedlot rations for younger animals may contain supplemental protein, and this was typically the stage at which MBM might have been fed before the Ban. Feeds vary in composition from company to company, but typical usage rates for MBM (occasionally porcine meal and blood meal) at this stage would have been 100–400 g/head/day. As protein quality is not an important factor for heavier feeders (e.g. >300 kg), rations for these animals typically contain urea or other low-cost protein sources of supplemental nitrogen.

8.3.3. Alternative Feed Sources

Poultry Litter

Processed poultry manure was removed from the list of approved feed ingredients in the *Feeds Regulations* in May 2000. Registration has always been mandatory in relation to the incorporation of poultry manure litter in livestock feeds; however, no commercial source has ever been registered for poultry litter in Canada. CFIA officials have worked with producer organizations, such as the Canadian Cattlemen's Association, to advise members not to use poultry manure in feeds. If cattle producers feed raw or processed poultry manure to their animals, it is a contravention of the *Feeds Act*. The CFIA investigated five reports of this practice in the province of Quebec in 1999–2000, and to date has prosecuted and fined producers in three cases. The use of poultry litter as cattle bedding has been identified as a potential risk. This practice occurs uncommonly, and the CFIA is working with industry to further discourage it.

Edible Residual Material and Plate Waste

Edible residual material (ERM) means edible material that remains after, or is not used in, the processing, manufacturing, preparing, serving, or sale of food (*Health of Animals Regulations,* Section 111). The ERM Program is regulated under the *Health of Animals Act* and *Regulations*, and controls the feeding of waste food, including meat, to swine and poultry. The feeding of ERM to cattle and other species not identified in the *Health of Animals Regulations* is prohibited unless the product is registered or approved under the *Feeds Act*. It is required that the producer hold an annual permit (Class A or B), that the ERM be cooked before feeding and that swine that have been on the premises be slaughtered at an establishment registered under the federal *Meat Inspection Act*. Since the Feed Ban in 1997, edible residual materials and "plate waste" are considered as prohibited material. Plate waste means any edible material originating from kitchens, restaurants, catering facilities or the household of the farmer or person tending the animals.

In 2001, the CFIA prohibited the feeding of ERM containing meat to pigs, and effective January 1, 2002, the feeding of ERM containing meat and meat products (formerly permit Class A) to swine and poultry is no longer permitted unless the products are registered under the *Feeds Act*. Other waste foods (bakery, vegetables, dairy, etc.) that do not contain meat may be fed under a single class of permit for waste feeding.

The change of the ERM policy does not affect current policies on BSE, in which there is an existing prohibition on feeding products derived from ruminants (which includes plate waste or waste food) to cattle.

8.4. Compliance and Enforcement

8.4.1. Inspection Program

Under the CFIA's National Feed Inspection Program, feed manufacturers (both commercial and on-farm) and feed retailers are inspected to confirm that feeds are being manufactured, distributed, handled, and used in compliance with the *Feeds Regulations* and *Health of Animals Regulations.* Canada has administered a formal feed mill inspection program since 1982 that has continued to evolve since its implementation. Factors such as process controls, record keeping, sanitation and other manufacturing practices have been evaluated as a means of assessing the compliance of feed products with the safety and compositional standards prescribed in federal regulations. Following implementation of the Feed Ban in 1997, compliance components of these regulations have been incorporated into the inspection program for these premises. A copy of the feed mill inspection form is found in Appendix 27. The form clarifies what is required to ensure that cross-contamination does not occur.

Prior to 2002, feed mills underwent a comprehensive inspection every three years. Partial inspections may occur more than once every three years, however, as these inspections, which are carried out between the comprehensive inspections, may be used, for example, to take samples (e.g. for antibiotic residues), verify labelling compliance, follow up on complaints, and trace back residues. Given the importance of compliance with the Feed Ban, as of 2002 the CFIA increased the frequency of comprehensive feed mill inspections to one per facility every year.

The inspection program requires that compliance issues identified during the course of feed mill and on-farm inspections be resolved in a timely manner. Some compliance issues, such as mislabelling of feeds, result in immediate enforcement action. The feed is placed under detention and may not be used for any purpose until it is brought into compliance. Upon completion of the follow-up inspection, an inspection report detailing the results of the follow-up inspection and any recommended actions is submitted to the feed section of the CFIA.

In light of the Feed Ban, a specific inspection component was added to the National Feed Inspection Program. The results of inspections specific to the Feed Ban are provided in Section 8.4.2.

8.4.2. Results of the Inspection Program

Feed Mills:

In the first 18 months after the Ban, nearly all feed mills in Canada were inspected to specifically assess compliance with the Ban. Of those not inspected, 2 produced feeds exclusively for the aquaculture industry and 5 others were low-volume mills in remote areas that were scheduled for comprehensive inspection shortly thereafter.

Table 24 details the feed mill inspections and Feed Ban compliance information from April 1999 to March 2001. A total of 173 mills were inspected during this period.

For each year, the initial level of compliance was in the mid-to-upper 60% range, and faults were immediately corrected. All mills were in compliance after re-inspection. Inspections did not indicate that any prohibited material was being formulated into ruminant feeds; most of the non-compliance issues related to incomplete production and distribution records. Based on immediate correction, the level of compliance reached 80%. The remaining 20% required re-inspection, at which time 100% compliance was achieved (Table 24).

In early 2000, a revised feed mill inspection form was introduced. The form combined compliance activities in respect of the *Feeds Regulations*, the Feed Ban regulations and feed industry Good Manufacturing Practices. This form currently serves as the basis for recording and compiling compliance information.

The third round of the triennial inspection program (April 2001–March 2002) has been completed. Over 360 feed mills were inspected, the results of which are in the process of being tabulated. In addition, there have been over 160 feed mill inspections from April 2002 to October 2002. All feed mills operating in Canada have now been subject to a comprehensive inspection at least twice since the implementation of the Feed Ban in 1997.

A recent revision to the feed mill inspection program has amended the requirement for triennial inspections. In accordance with this amendment, feed mills will be subject to an annual inspection beginning in the fiscal year 2002–2003.

Feed Retailers:

About 50 retailers have been inspected since 1999 for compliance with the Feed Ban. Retail outlets are required to maintain sales records for animal feeds for two years.

Farms:

About 100 farms have been inspected since 1999 for compliance with the Feed Ban. A copy of the on-farm feed mill inspection form is found in Appendix 28. The farms inspected to date are complying with the applicable requirements of the *Health of Animals Regulations* to:

- remove prohibited material from their formulae for ruminant feeds;
- maintain the applicable records and copies of invoices as required; and
- have processes in place to prevent cross-contamination.

Table 24: Feed Mill Compliance with the *Health of Animals Regulations*, Part XIV- Mammalian-to-Ruminant Feeding Ban

FEED MILL COMPLIANCE				
	1999 # of mills	cumulative % of mills in compliance	**2000** # of mills	cumulative % of mills in compliance
# mills inspected	65 [1]	--	108 [2]	--
# mills in compliance	45	69	70	65
# mills - noncompliance corrected immediately	7	80	10	74
# of mills - compliance verified upon re-inspection	13	100	28	100
REQUIREMENTS NOT IN COMPLIANCE	# of mills	% of mills inspected	# of mills	% of mills inspected
Caution statements on labels (s. 169)	1	2	7	6
No written cross-contamination procedures (s. 170)	4	6	14	13
Information on production records (s. 171(1))	9	14	18	17
Information on distribution records (s. 171(2))	9	14	13	12

Source: CFIA, Feed Mills Annual Inspection Reports

[1] Inspections by Area (% of inspections): ATL = 12 (18) QUE = 13 (20) ONT = 23 (35) WEST=17 (26)

[2] Inspections by Area (% of inspections): ATL = 12 (11) QUE = 32 (30) ONT = 37 (34) WEST = 27 (25)

8.5. Education and Awareness

Following the linkage of BSE with human disease, and upon the recommendation of the WHO, the inclusion of ruminant protein in ruminant feeds was banned. An extensive consultative process followed to develop the Feed Ban regulations with provincial governments; major national livestock, rendering and feed associations; and other stakeholders. This also served the purpose of ensuring that these groups and their members were well aware of the Feed Ban and its implications.

When the Ban came in force, the CFIA took a number of steps to ensure that feed manufacturers, renderers, feed retailers and producers were aware of the new rules, including the following:

- posting the new regulation on the CFIA Web site;
- preparing and delivering an information bulletin on the Feed Ban for national associations, feed companies, livestock producer associations, agricultural publications, farms, and CFIA regional offices (CFIA inspectors distributed these bulletins when they visited farms);
- issuing press releases (media coverage, newspapers, journals, etc.); and
- asking large animal veterinary practitioners to advise producers (through the *Canadian Veterinary Journal*).

The information bulletin developed by the CFIA was widely distributed by associations, feed companies and others. In addition, associations provided information to members in their publications. Provincial governments and veterinary associations also circulated information, such as the following, with respect to the Feed Ban (see Appendix 29):

- An article describing the implementation and rationale for the Feed Ban was published in 1997 by major newspapers across Canada.
- ANAC, a national trade association representing more than 200 livestock and poultry feed manufacturing firms, was proactive in updating its membership about the regulations. ANAC distributed information to members as early as six months before the implementation of the Feed Ban in August 1997. Before the implementation of the new regulations, it published and distributed to members a document explaining the requirements. The CFIA bulletin “Check Your Livestock Feed” was distributed to ANAC members, reaching essentially all feed mills in Canada. Since the Feed Ban, ANAC has circulated new information on BSE that could affect members’ operations, thereby reinforcing the importance of complying with the Feed Ban.
- Other national producer associations (dairy, beef, sheep, nutritionists, etc.) or stakeholders distributed information to their members. Newspapers, websites such as the official site of the *Canada Gazette*, association websites, magazines, bulletins, and other media provided information when the Feed Ban was implemented.

8.6. SUMMARY - FEED

Regulations and Policies for Feed Ban

- The manufacture, sale and importation of feed is regulated by the CFIA.
- All imported mixed feeds and certain categories of feed ingredients must be registered by the CFIA and comply with Canadian standards and regulations.
- A feed ban prohibiting the feeding of protein derived from certain mammalian sources to ruminants has been in effect since August 1997. Under the feed ban, feed manufacturers must maintain complete separation of feed containing specified ruminant-derived protein including by:
  - maintaining records,
  - labelling feed containing prohibited material, and
  - adopting measures to prevent cross-contamination.

Industry Profile and Feed Mill Practices

- Canada is a large producer of grains and has abundant supplies of vegetable protein meals that can economically and nutritionally replace MBM in feed.
- About 600 feed mills manufacture about 13 million tonnes of feed. About 35% of the total feed is produced in mills that are HACCP certified by the Animal Nutrition Association of Canada.
- Eleven feed corporations own 169 feed mills which are responsible for 70% of the total annual commercial feed production.
- Feed mills have established processes to prevent cross-contamination.
- With the exception of micro-ingredients, all feed ingredients are sourced in Canada or the U.S.

Feeding Practices

- MBM is not normally fed to beef cattle. Dairy cattle need high-quality bypass protein and may receive supplemental feed. Accordingly, this is and has been a target population for BSE surveillance.
- Little milk replacer is imported. Tallow is only imported from BSE-free countries (protein-free tallow can be imported from non-BSE free countries with additional certification).
- No registration has ever been issued for the commercial use of poultry manure.
- “Edible residual materials” and "plate waste" or similar wastes generated by restaurants, cafeterias, and other food-serving establishments are treated as “prohibited material.”

8.6 SUMMARY - FEED (continued)

Compliance and Enforcement

- Under the National Feeds Inspection Program, feed mills, retailers and farms have been inspected. Recent changes to the program will increase the intensity of inspection.
- Inspections have shown a high level of compliance. Most deficiencies found relate to minor infractions in record-keeping.

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Risk Assessment on Bovine Spongiform Encephalopathy in Cattle in Canada

Part B:
BSE Surveillance and Related Activities

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PART B: REPORT ON BSE SURVEILLANCE AND RELATED ACTIVITIES

1. INTRODUCTION

The objective of this document is to describe BSE surveillance and related activities in Canada. Effective BSE surveillance requires testing of an adequate number of samples from an appropriate target population in a laboratory system with the required diagnostic capabilities. Education and awareness programs for veterinarians and producers facilitate identification and reporting of suspect cases, and reporting is also supported by effective compensation programs. Animal identification facilitates trace-back to the herd of origin. The CFIA's regulatory framework ensures compliance with all elements of the program.

BSE surveillance in Canada has evolved since the disease was made reportable in 1990. On-going adjustments have been made to the program in response to new scientific information, including that regarding target populations, diagnostic tests and changes in international requirements.

2. REGULATORY FRAMEWORK

A description of the legislative authority relevant to BSE and of the veterinary infrastructure in Canada is found in Part A, Appendices 2 and 3.

BSE was made a reportable disease in Canada under the *Health of Animals Act* in November 1990. Any suspected case of BSE must be reported to a federal veterinarian, who has the authority to order the animal destroyed and its brain tested. Offenders may be prosecuted and subjected to monetary fines or a jail term.

3. BSE SURVEILLANCE PROGRAM

3.1. BSE Surveillance Program Overview

The BSE Surveillance Program in Canada is designed based on internationally recognized risk factors and pathways and in accordance with current international standards. It is developed and delivered through the collaboration of federal and provincial governments and universities. Testing began in January 1991, when a program to test rabies-negative mature cattle for BSE was initiated. Then in 1992 a national program was implemented based on the collection of samples from mature bovines with neurologic signs from abattoirs under federal inspection and from provincial and university laboratories.

Prior to the start of the BSE Surveillance Program, Agriculture and Agri-Food Canada (AAFC) had begun continuous monitoring of animals imported from the U.K. before a ban on imports was put in place in 1989. The monitoring program commenced in 1990 and continued until 1994, when all remaining cattle of U.K. origin imported after 1982 were ordered destroyed.

In 1997, the surveillance program was enhanced in order to increase the number of samples collected at federally inspected abattoirs. A document defining the policies and procedures for

collection of samples and including a case definition for BSE suspects was distributed to veterinarians in all federal abattoirs. A updated version of this document, entitled “2002 BSE Surveillance at Abattoirs Under Inspection by the Canadian Food Inspection Agency” is located in Appendix 1.

In 2001 a formal program was put into place in which selected federally inspected abattoirs were given minimum targets for submission of samples from non-neurologic condemnations. The targets were developed using Office International des Épizooties (OIE) surveillance targets as guidelines and applying them on a provincial basis, also ensuring that the dairy population was adequately represented (Rogers 2002). In 2002 this program was further augmented by the selection of additional abattoirs and refinement of the target population to DOAs (dead on arrivals), emergency slaughters and non-ambulatory (downer) animals. Starting in 1996, provincial ministries of agriculture were asked to develop similar programs within abattoirs that were not subject to federal inspection.

Since the beginning of the BSE Surveillance Program, the geographic distribution and targeting of risk populations of the samples submitted and tested have been reviewed annually by federal program staff and adjustments made to ensure appropriate representation (Rogers 2002).

3.2. Federal BSE Surveillance Programs

3.2.1. Federal Abattoir Program

All animals slaughtered at federally inspected abattoirs are subject to ante-mortem inspection. The inspection system at federal abattoirs in Canada is described in Part A, Section 6.

Target Population:

BSE surveillance measures currently in place at federally inspected abattoirs target “neurological” and “surveillance” cases. Neurological cases include BSE suspects as well as other cases that do not fit the case definition of a BSE suspect. A BSE suspect is defined as a mature bovine that on clinical examination exhibits all of the following signs: poor body condition, ataxia, abnormal head carriage, nervousness, apprehension, hyperaesthesia and tremors. Neurologic cases exhibit some or all of the neurological signs described as “Mental,” “Sensory,” or “Locomotor.” Surveillance cases are mature animals that are non-ambulatory (downer or unable to rise on farm)[2], emergency slaughter, dead on arrival, or found dead.

In 2001, targets for BSE surveillance were assigned to specific abattoirs under federal inspection for implementation in 2002. Sampling in 2001 was based on the geographic distribution of dairy cattle — the population considered to be a higher risk — and known consignment patterns for slaughter of this class of animals.

[2] In some countries, the terminology “fallen stock” is used for animals described herein as “non-ambulatory” or “animals found dead.”

3.2.2. Rabies Program

Rabies is a reportable disease in Canada, and a control program has been in place since the 1940s. The disease is endemic in Canada, and as a result the level of producer, veterinary and general public knowledge about rabies is considerable and stems from relatively frequent contact with wildlife species. Because of the obvious human health implications, livestock producers and veterinary practitioners are acutely aware of the often subtle early clinical signs. CFIA district office staff continue to provide literature and other information to primary producers and to the general public about rabies and about the federal disease control program. The high level of awareness about the disease in Canada increases the likelihood that any domestic animal displaying neurologic dysfunction will be brought to the attention of veterinary authorities.

Rabies-negative bovine samples have been tested for BSE since 1991. All district veterinarians as well as a significant number of lay inspectors have developed the skills necessary to take brain specimens (they have been taking brain samples for much longer than BSE has been an issue, as rabies cases are common) to ensure that appropriate samples are available for evaluation. A memo was issued to the field staff in the fall of 1992 describing the protocol for collection, fixation and submission of specimens from rabies-negative bovines, and district offices were required to insert the protocol into the rabies section of the federal Disease Control Manual. Brain samples that are collected from suspect rabies field cases are bisected, and one half of the brain is fixed in formalin, the other half sent to a federal laboratory for rabies testing. Once a negative result is confirmed for rabies, the fixed portion is submitted for BSE testing. Producers whose animals are tested are eligible for compensation (See Section 6 for details on the compensation program).

3.3. Provincial BSE Surveillance Programs

Federal and provincial governments collaborate on BSE surveillance. Historically, most samples tested by the provinces have been from animals with neurologic signs presented for diagnostic purposes to provincial and university laboratories by veterinarians or producers. More recently, the provincial laboratories have expanded testing to include non-neurologic mature bovines presented for diagnostic purposes. The CFIA provides sampling targets to provincial ministries based on the demographics of the cattle population, using targets provided by the OIE as a guideline (Greenwood 2001).

The province of Quebec has 40% of the total dairy cow population in Canada (11.5% of the total cow population). Post-mortem examinations and sample submissions are subsidized in Quebec by the provincial department of agriculture, Le ministère de l'Agriculture, des Pechêries et de l'Alimentation (MAPAQ). This subsidy has facilitated the testing of a large number of samples for BSE in Quebec.

Some provinces are further developing their BSE surveillance programs to include abattoirs subject to provincial inspection and dead stock. The provinces of Alberta and Ontario have both created provincial BSE surveillance programs. Approximately 50% of the total cow population in Canada is located in these two provinces, with Alberta accounting for 35% and Ontario 14% of the total. Ontario has 30% the total dairy cow population.

3.3.1. Alberta

A surveillance program for BSE began in Alberta in October 1996 through the Agri-Food

Surveillance Systems Branch (AFSSB), Food Safety Division (FSD) of Alberta Agriculture, Food and Rural Development (AAFRD).

1996–2001, the provincial program included:

- samples from cattle with neurologic signs and/or emaciation submitted through provincial slaughter facilities and from field veterinarians; and
- samples from cattle submitted to provincial diagnostic laboratories for post-mortem examination.

In 2001, AFSSB enhanced BSE surveillance to include the collection of samples from the following sectors:

- provincial abattoirs not under federal inspection — meat inspectors collect samples from neurological cases and cattle that are condemned for other reasons;
- rendering/dead-stock facilities — samples are collected from the three rendering facilities located in the province, in Edmonton, Calgary and Lethbridge. The plants are compensated monetarily for the collection of heads.
- private practitioners — the heads or brains from cattle with neurologic signs are purchased from practising veterinarians. The program covers container costs and courier charges for shipping specimens to the laboratory.

Alberta's BSE surveillance program is described in Appendix 2b.

3.3.2. Ontario

The Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) will significantly increase BSE surveillance in 2002. Up to 2,000 tests will be carried out this year, with 1,000 samples collected by Meat Inspection Branch (MIB) staff from downer and emergency slaughter cases over 24 months of age at four provincial abattoirs. This represents approximately 15% of the downer and emergency slaughter cases annually in the province of Ontario. Inspectors have received training in the proper method of sample collection, and will forward samples to the Animal Health Laboratory (AHL) at the University of Guelph for immunohistochemistry (IHC) testing. The AHL will also also continue to test neurologic and non-neurologic samples from mature bovine submissions. BSE suspect cases will be confirmed at the National BSE Reference Laboratory at the National Centre for Foreign Animal Disease (NCFAD/CFIA) in Winnipeg. OMAFRA has determined that 500–1,000 clinical cases collected over 24 months from the high-risk population will result in a 90–95% confidence level to detect BSE if present, assuming a prevalence of 0.00125 (based on EU prevalence data) (Appendix 2a).

3.3.3. National Surveillance Network

A surveillance network has been developed across Canada to identify diseases of interest and other targets such as BSE suspects. In 1996, the CFIA established the Canadian Animal Health Network (CAHNet), a national network for federal and provincial disease surveillance. It is administered by a support group of federal epidemiologists and policy analysts. More details can also be found on the CAHNet website (CAHNet 2001). All provinces participate in the surveillance network; key activities in specific provinces include the following:

- The Ontario Animal Health Surveillance Network (OAHSN) has a core group of surveillance partners in OMAFRA and the University of Guelph. This network collects information from diagnostic laboratories, abattoirs, sales barns, dead-stock companies, research, private practitioners and active surveillance projects.

- Manitoba has a network of provincially supported rural clinics that communicate regularly with the field service and laboratory sections of the provincial ministry of agriculture.

- Saskatchewan's provincial veterinary service and the University of Saskatchewan co-operatively support the operation of the veterinary diagnostic laboratory (Prairie Diagnostics Inc.). The Western College of Veterinary Medicine (WCVM) offers a comprehensive field disease investigation service funded in part by the Saskatchewan Cattlemen's Association.

- Provincial laboratories in Alberta have developed an Animal Health Information Network (AHIN). Data sources include provincial meat inspectors, private laboratories and veterinarians, Alberta Environmental Protection and brand inspectors. This information allows the Animal Health Laboratory Branch to assess emerging diseases, to monitor disease trends and to help provide information to the CFIA on diseases important to trade. Provincially funded laboratories provide services for investigations that cannot be offered profitably by the private sector, and disease investigation is carried out by government staff. Private veterinarians and laboratories are the primary providers of post-mortem examination and testing services. The animal health data system tracks diagnoses, tests, geography, animals at risk and tissue banks.

- In British Columbia, passive surveillance through laboratory submissions is the main source of surveillance data. Two provincial veterinarians investigate reports of new or emerging diseases.

4. SURVEILLANCE STATISTICS

The annual totals and breakdown by source are given in Table 1. A total of 1,887 animals were tested from January to September 2002. Details of surveillance numbers by province to 2001 are presented in Table 2. All samples tested were negative for BSE. All laboratory records are kept for at least seven years.

Reports listing the differential diagnosis of all neurologic samples tested in 1996 to 2001 are located in Appendix 3.

Because rabies is a serious zoonotic disease, and due to the endemic nature of rabies in Canada, any domestic animals displaying neurologic dysfunction are most likely submitted as rabies suspects. As a result, few samples are submitted directly as confirmatory negative BSE suspects.

The OIE International Animal Health Code 2001, Appendix 3.8.3., on surveillance and monitoring systems for bovine spongiform encephalopathy identifies the minimum number of annual investigations required for effective surveillance of animals showing clinical signs compatible with BSE. Canada is required to test a minimum of 336 samples annually based on its population of approximately 6 million[3] native-born cattle over 24 months of age.

[3] Total Cow Population 5,574,000 (dairy cows 1,122,400, beef cows 4,451,600)
Source: 1996 Agricultural Census.

Table 1: Summary of Annual Number of Samples Tested for BSE and Breakdown by Source

Year	Total Tested	Federal Laboratory Total	Provincial Lab Network Total	Total Neurologic samples	Provincial Neurologic Samples	Federal Neurologic Samples	Rabies Negative Samples	Rabies Positive Samples	Confirmatory Negative (BSE Suspects)	Total Survey Non-Neuro. Total (Federal)
1992	225	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1993	645	61	584	54	n/a	54	54	n/a	0	591(7)
1994	426	57	369	51	n/a	51	50	n/a	1	375(6)
1995	269	72	197	67	n/a	67	57	n/a	10	202(5)
1996	454	164	290	157	n/a	157	117	32	8	297(7)
1997	759	328	431	244	n/a	244	212	20	12	515(84)
1998	940	486	454	137	n/a	137	101	27	9	803(349)
1999	895	168	727	692	559	133	90	41	2	203(35)
2000	1,020	195	825	452	262	190	152	36	2	568(5)
2001	1,581	707	874	623	427	196	168	22	6	958(511)
Total	**7,214**	**2,238**	**4,751**	**2,477**	**1,248**	**1,229**	**1,001**	**178**	**50**	**4,512(1,009)**

Notes:

- Federal Laboratory Total = Federal Neurologic Samples + Non-Neuro. (Fed survey)
- Federal Neurologic Samples = Rabies Negative Samples + Rabies Positive Samples + Confirmatory negative
- Prior to 1999 provincial sample information was not recorded, to allow differentiation between neurological or non-neurological and therefore this appears as part of the total survey non-neuro data.
- Total neurological cases are those in which the sample submission included reference to neurological dysfunction.
- 1992–1994 - records were kept in accordance with the fiscal calender
- Total survey - non-neurological category derived from abattoir samples.

Table 2: Surveillance Numbers by Province

	ATLANTIC*			QUEBEC			ONTARIO			MANITOBA			SASK.			ALBERTA			B.C.		
	Prov.	Fed.	Total	Prov.	Fed.	Total	Prov.	Fed.	Total	Prov.	Fed.	Total	Prov.	Fed.	Total	Prov.	Fed.	Total	Prov.	Fed.	Total
1996	1	3	4	52	49	101	97	88	185	14	4	18	17	12	29	50	3	53	59	5	64
1997	24	16	40	25	87	112	62	174	236	19	14	33	12	15	27	121	11	132	168	11	179
1998	19	115	134	21	24	45	226	251	477	14	19	33	29	19	48	99	6	105	46	52	98
1999	101	3	104	16	22	38	283	76	359	7	25	32	143	29	172	164	13	177	13	0	13
2000	85	6	91	273	35	308	235	92	327	1	31	32	41	23	64	159	7	166	7	0	7
2001	72	23	95	308	227	535	181	182	363	0	24	24	93	67	160	204	123	327	16	55	71
Dairy Cows [2]	66,400			426,000			373,000			47,000			30,000			98,000			82,000		
Beef Cows [2]	65,600			216,000			399,000			554,000			1,113,000			1,835,000			269,000		
Total Cow Popu-lation [2]	132,000			642,000			772,000			601,000			1,143,000			1,933,000			351,000		

[1] Due to the small number of cattle in the maritime provinces, which include New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland, the data from the four provinces are combined.

[2] Source: 1996 Agricultural Census.

5. DIAGNOSTICS

5.1. Laboratories

5.1.1. Federal Laboratories

The CFIA has four federal laboratories involved in TSE diagnostics:

- The National Centre for Foreign Animal Disease in Winnipeg, Manitoba, is the national diagnostic reference laboratory for BSE. All samples from federal abattoirs and any suspect samples from provincial or university laboratories are sent to the NCFAD for testing and confirmation.
- The Animal Diseases Research Institute (ADRI), Ottawa, Ontario, is the national diagnostic reference laboratory for scrapie and chronic wasting disease (CWD).
- The Health of Animals and Food Laboratory, St. Hyacinthe, Quebec, carries out processing of BSE samples and scrapie testing.
- The Animal Diseases Research Institute (ADRI), Lethbridge, Alberta, carries out scrapie and CWD testing.

All CFIA laboratories are independently accredited to ISO 17025 Quality Assurance by the Standards Council of Canada (SCC).

5.1.2. Provincial and University Laboratories

Provincial diagnostic laboratories and the diagnostic laboratories of the four veterinary colleges in Canada are involved in testing samples for TSEs. Pathologists from the provincial laboratories have been trained by and have collaborated with the CFIA in the development of test protocols. (Details on training are in Section 8.2.)

5.1.3. National TSE Veterinary Diagnostic Laboratory Network

The CFIA created a National TSE Veterinary Diagnostic Laboratory Network in 2001 to ensure consistency of diagnostic testing nationally. The network includes CFIA TSE reference laboratories, CFIA and provincial network laboratories. Standard operating procedures (Appendix 4), control material and panels are provided by the federal laboratories as part of a Quality Assurance Program. Training and research are also provided. Quality assurance and biosafety guidelines were distributed early in 2002.

5.2. Diagnostic Tests

All samples are tested by histopathology (H&E) and some are tested by IHC (see Appendix 4 for test standard operating procedures). According to the OIE Manual of Standards (OIE, 2000), surveillance for BSE requires laboratory examination of brain from clinically suspect animals by histopathology and, if necessary, other methods described in the manual (i.e. western blot, scrapie-associated-fibril examination and detection of abnormal PrP by immunohistochemistry).

Prior to the opening of the NCFAD laboratory (1997), testing for BSE was performed at the ADRI, Ottawa. At this laboratory, the validation of IHC using a polyclonal antibody on central nervous tissue

began in 1994 and was completed in 1995. Validation of the IHC test for BSE using a monoclonal antibody was carried out at the National BSE Reference Laboratory at NCFAD/CFIA in Winnipeg in 2001 (Czub 2002).

As of January 2002, the provinces of Alberta, Ontario and Saskatchewan have introduced IHC testing in their laboratories. The province of Manitoba has the option to send samples to Saskatchewan for IHC, and the province of Quebec is currently acquiring laboratory capability for IHC testing (Greenwood 2002). To ensure consistency of diagnostic testing across all laboratories, the CFIA initiated a National TSE Veterinary Diagnostic Laboratory Network in 2001 (see Section 5.1.3 for details).

While less than half of Canada's BSE surveillance samples have historically been tested by IHC (see Table 2), by the end of 2002 more than 90% of all BSE samples will be tested by this method.

Confirmatory testing of a BSE suspect sample is carried out at the National BSE Reference Laboratory at NCFAD/CFIA in Winnipeg.

Rapid Tests:

Rapid tests for BSE diagnosis are not currently used in Canada; however, the CFIA is evaluating certain rapid tests used in Europe. Once the technology has been obtained and standardized in the National BSE Reference Laboratory in Winnipeg, the CFIA will consider application of these tests in the Canadian BSE Surveillance Program.

6. COMPENSATION

Since 1945, Canadian legislation has provided compensation to livestock producers whose herds or flocks are infected by contagious disease and are ordered destroyed to limit the risk to other animals and humans. Compensation maximums for animals destroyed (including confirmed cases, suspects, and at-risk animals) were legislated in 1992 under the authority of the *Health of Animals Act*. The compensation paid to an owner for each animal ordered destroyed is the assessed market value of the animal, not exceeding the compensation maximum for that species. Regulations establishing compensation maximums for each animal species came into effect in 1994. Under the *Maximum Amounts for Destroyed Animals Regulations* in 1994, the compensation maximum awarded for cattle was $2,000 for a registered animal and $1,500 for a non-registered animal. In February 1998, amendments were made to compensate for disposal costs. In accordance with the *Canadian Food Inspection Agency Act* (1997), compensation payments are paid through the Consolidated Revenue Fund. In 1998, the compensation maximum for cattle was increased to $2,500 for both registered and non-registered animals. The compensation program is an important incentive that encourages reporting of disease and aids control and eradication efforts.

7. ANIMAL IDENTIFICATION

Canada instituted a national identification program for cattle and bison on January 1, 2001 (Sanford et al. 2001), managed by the Canadian Cattle Identification Agency (CCIA), a non-profit agency. The program provides individual animal identification and herd-of-origin trace-back. All cattle are individually identified with an approved CCIA ear tag (CCIA 2002) (see Appendix 5). The CCIA and the CFIA work together to achieve effective control of animal disease risks associated with food-borne illnesses.

The program is mandated under the *Health of Animals Regulations*. As of January 1, 2001, cattle leaving the herds in which they were born must be identified with an approved eartag. As of July 1,

2001, cattle leaving all premises, whether born on them or not, must be so identified.

How the program works:

The program requires that every bovine animal be identified with an official tag before leaving the herd of origin or co-mingling with cattle of other owners. An exception is provided for cattle that are sent temporarily to a community pasture, bull test station or agricultural fair, then return home. An exception is also provided to allow unidentified cattle to be sent to facilities approved by the CCIA as an approved tagging site where the cattle may be identified with the producer's official tags. The responsibility of the producer of the herd of origin is to buy the official tag and apply it to the animal prior to departure from the herd. No time frame for tagging is established as long as the animal does not leave the herd of origin untagged. Producers are not required to maintain their own records for initial tagging, although many producers prefer to use the official ID number for their own management records. Approved official ID tags are available to producers from approved manufacturers directly or through authorized service centres and distributors. The service centres and distributors are responsible for reporting to the CCIA database the numbers of the tags purchased by producers so that producers need not assume the responsibility of recording or reporting. Official ID tags bear, as a minimum, a unique ID number, an official logo and a bar code to facilitate automated reading in places such as abattoirs.

The program also prohibits acceptance of non-tagged cattle (except where it can be shown that the official identification was lost during transportation, and the new owner must apply a new tag and record the source of the animal). In the case of an animal that loses its official identification during transportation to the abattoir, the animal need not be re-identified provided it is slaughtered immediately.

No one may remove an official tag or transfer tags from one animal to another. The manufacture and marketing of tags outside CCIA control is prohibited.

Abattoir operators are required to maintain the official identification of the live animal through to the completion of the meat inspection process, so that any disease detected upon post-mortem inspection can be traced to the herd of origin. Abattoir operators are also required to transmit the identification numbers of slaughtered cattle to the CCIA database. When no health or safety issue is associated with the animal or the carcass, the number is retired from the database. If a disease or safety issue is associated with the animal or the carcass, the CFIA is provided with information on the origin of the animal in order to start its epidemiological investigation for the containment and elimination of the problem. If an identified animal dies on the farm or ranch, the producer is required to keep a record of the number but does not have to report it in the database. Renderers, however, are required to report official tag numbers to the CCIA database.

All imported cattle not destined for immediate slaughter must be identified with an official tag of the country of origin prior to importation. These cattle must be re-identified by the importer with an official Canadian tag upon arrival in Canada and the numbers reported to the CCIA database.

Cattle imported for immediate slaughter from the U.S. may be imported without official identification as to country of origin provided the truck is sealed and is directed to a slaughter plant, where they must be segregated from Canadian cattle.

At present, all Canadian feeder cattle/calves and breeding cattle that are exported must bear an official identification and be accompanied by an export certificate. Such cattle are subject to CFIA inspection at the border. In future, the CFIA will read the tag in the animals's ear and record the

number on the export certificate rather than applying an official tag at the time of export, and the number will be recorded to account for disposition of these cattle in the database. Alternative means to reading the numbers at the time of exportation will be explored in future.

Compliance and Enforcement:

The animal identification legislation was introduced gradually, over an 18-month period, beginning with an initial information and education campaign to heighten awareness in the cattle and bison sectors regarding the program's implementation (see Appendix 5). Passive enforcement during this period ensured that the primary producers became fully aware of the program and the practical aspects of compliance. Full implementation, with active enforcement, began as of July 1, 2002. From this date, as per the enabling legislation, the CFIA has issued applied monetary penalties (AMPS) for violations of the *Health of Animals Regulations* pertaining to animal identification.

8. EDUCATION AND AWARENESS PROGRAMS AND TRAINING

8.1. Education and Awareness Programs

The CFIA provides ongoing education to government and private veterinarians, provincial, federal and university diagnosticians, farmers, and workers involved in the livestock industry through a number of activities, examples of which are listed below in relation to veterinarians and producers (see Appendix 6).

Target: Veterinarians

- An article on BSE appeared in the *Canadian Veterinary Journal* in 1989 (Little and Thorsen 1989).

- A videotape showing the clinical signs of BSE was acquired from the Ministry of Agriculture, Fisheries and Food (MAFF) in the U.K., and has been available since 1998.

- A BSE fact sheet was first published on the CFIA website in 1998 (CFIA 2002).

- Lectures about BSE are part of the curriculum for veterinary students, covered in regulatory veterinary medicine lectures given by CFIA veterinarians and/or in lectures on neurologic diseases.

- Provincial veterinary medical associations have included presentations on BSE at annual conferences and BSE information in provincial publications. For example, the Ontario Veterinary Medical Association (OVMA) had presentations on BSE at its annual conferences in 1991, 1995, 1997 and 2001. The January 2002 Alberta Veterinary Medical Association annual conference also included a lengthy presentation on BSE.

- The Agri-Food Surveillance Systems Branch (AFSSB), Food Safety Division (FSD) of Alberta Agriculture, Food and Rural Development (AAFRD) (and the former Animal Health Laboratories Branch) has focussed education and awareness activities on Alberta's veterinarians. Information has been delivered to veterinarians via periodic publications in the Alberta Veterinary Medical Association's members' magazine; articles in newsletters (Food Safety Division's Animal Health Forum and the newsletters of the Western Association of Bovine Practitioners and the Alberta Sheep and Wool Commission); Food Safety Division TSE seminars; a BSE surveillance information mail-out to Alberta veterinarians in June 2001; and instructions related to BSE

surveillance program design at the Second Food Safety Division Applied Epidemiology and Surveillance Course for Animal Health and Food Safety Professionals (Oct. 25–26, 2001). Information on BSE is also found on the AAFRD website (www.agric.gov.ab.ca/surveillance).

- OMAFRA's Veterinary Science publication, *Ceptor*, has included a number of articles on BSE surveillance. Information on BSE is also available on OMAFRA's website (www.gov.on.ca/OMAFRA).

- The Canadian Animal Health Consultative Committee (CAHCC) has been meeting annually for the past 20 years to discuss and consult on a broad range of animal health issues. BSE has been discussed at the meeting since 1993. This meeting is hosted by the Animal Health and Production Division of the Animal Products Directorate of the CFIA. The CAHCC forum provides for communication, consultation and co-ordination between the CFIA, its provincial partners, and regulated animal industries, and provides for the review, development and implementation of animal health policies and programs with the goal of promoting the long-term sustainability of Canada's animal industries. The CAHCC is made up of representatives from national industry groups, federal and provincial animal health authorities, the federal department of health (Health Canada), national animal health and welfare organizations, as well as university representatives and invited guests such as the United States Department of Agriculture and Mexico's department of agriculture, the Secretaria de Agricultura, Ganaderia y Desarrollo Rural.

Target: Producers

- A fact sheet on BSE was published by Agriculture and Agri-Food Canada (AAFC) (Animal health was the responsibility of AAFC prior to the development of the CFIA) in 1996.

- A BSE fact sheet was first published on the CFIA website in 1998 (CFIA 2002).

- Extension staff from the provincial departments of agriculture play a role in disseminating information on BSE.

- Producers and industry groups receive information at the annual CAHCC meeting (see above). Examples of the producer and industry groups that are members of the CAHCC are Canadian Cattlemen's Association, Canadian Beef Breeds Council, Canadian Dairy Breeds, Dairy Farmers of Canada, Holstein Canada, Canadian Livestock Genetics Association, Canadian Embryo Transfer Association, La Fédération des producteurs de bovins du Québec, Alberta Cattle Feeders Association, Ontario Cattlemen's Association, British Columbia Association of Cattle Feeders, The Semex Alliance, Canadian Sheep Federation, Canadian Sheep Breeders Association, Canadian Dairy Sheep Association, Canadian Goat Society, Canadian Boer Goat Society, Canadian Bison Association, Canadian Cervid Council, Alberta Whitetail and Mule Deer Association, Canadian Alpaca Breeders Association, Canadian Llama Association and the Canadian Association of Zoos and Aquaria.

- Producer groups have also published information on BSE. One of the largest producer groups is the Canadian Cattlemen's Association (CCA), which is a national association representing the interests of Canada's 100,000 beef producers in Canada. The CCA has extensive information about BSE on its website (www.cattle.ca), and the CCA also publishes a monthly magazine.

- Education was presented on BSE in 2001 and 2002 at NCFAD/CFIA Winnipeg for cattle producers and cattle associations, including the Canadian Cattlemen's Association.

8.2. Training

When:

- Since 1989 for federal staff, and in 1994, 1997, 2001, and 2002 for field staff, provincial and university staff.

Place:

- Federal TSE laboratories for field federal staff, provincial and university staff:
  - Animal Diseases Research Institute, Ottawa
  - National BSE Reference Laboratory at NCFAD/CFIA in Winnipeg
- U.K. Veterinary Diagnostic Laboratory (VLD), Weybridge (for federal staff)

Measures:

- Two lecture series and workshops on TSEs and tissue collection techniques were held at the ADRI, Ottawa, Ontario, in March and May of 1997. Participants included veterinarians from both federal and provincial departments of agriculture and were selected by each region to act as regional trainers in brain collection techniques for all TSE diseases affecting livestock. The participants of these workshops were required to submit brain samples to ADRI, Ottawa, for evaluation and assessment. The participant list and an example of sample evaluation are included in Appendix 7.

  Two similar training courses were held in 2000, one for CFIA diagnosticians and one for provincial and university diagnosticians. The course agenda and participant list for the two courses are included in Appendix 7. Similar to the 1997 course, the objective of the course was to train participants in tissue collection techniques and to have participants be able to train other personnel in the sampling technique.

- Field staff are also trained on site (e.g. at abattoirs). The workshops on TSEs and tissue collection techniques were a venue for the preparation of "trainers." These trainers are then available to train additional field staff on site.

- Sample collection training (spatula technique) and lectures on TSEs have been included in the annual Foreign Animal Disease Recognition Course provided by NCFAD/CFIA, Winnipeg, in close cooperation with the National BSE Reference Laboratory.

- A training video (CFIA 2001c) entitled *Brain Tissue Collection Techniques for BSE Surveillance Programs* is available and has been distributed to CFIA training officers and provincial participants in the training courses. OMAFRA has also requested copies and included them as part of their CWD surveillance packages. This video is an update of a video done in 1997 entitled *Brain Tissue Collection Technique Using the Spatula Technique*.

- A national work-site training program on sample collection was delivered in June 2002.

SUMMARY - SURVEILLANCE

Regulations and Policies for Surveillance

- The CFIA collaborates with provincial governments and universities to deliver a BSE surveillance program in accordance with OIE standards.
- In 1990, BSE was made a reportable disease in Canada. In 1991, the CFIA established a monitoring program for animals imported from the U.K. before the 1989 ban. In 1992, the CFIA implemented the BSE Surveillance Program.

BSE Surveillance Program

- Under the current program, the target population for BSE surveillance includes all mature animals that present with clinical signs compatible with BSE, as well as rabies-negative neurological cases. The program also targets animals greater than two years of age from risk populations, including neurological cases, downers, emergency slaughter and animals found dead.
- Cattle that have consumed ruminant meat-and-bone meal (MBM) present the greatest risk, if BSE were present in Canada. Based on husbandry practices, dairy cattle are more likely to have consumed MBM than other classes of cattle. This population is more likely to be sampled through the provincial than federal government programs, highlighting the importance of provincial participation.
- As of September 2002, 9,101 bovine samples have been tested for BSE, consistently exceeding the annual maximum level of sampling required by the OIE since 1993, with one exception — 1995.
- All samples have been tested by histopathology and a percentage by IHC. By the end of 2002, as more provincial laboratories acquire IHC capabilities, it is expected that more than 90% of the samples will be tested by this method.

Compensation, Identification and Education

- Since 1945, the federal government has provided compensation to livestock producers whose animals are ordered destroyed as a result of disease. This is an important incentive to the reporting of disease by producers.
- In January 2001, Canada instituted a National Cattle Identification Program, managed by the Canadian Cattle Identification Agency. This program provides individual identification for all cattle, and allows herd-of-origin trace-back.
- The CFIA provides extensive ongoing education on BSE to government and private veterinarians, provincial, federal and university diagnosticians, producers, and workers involved in the livestock industry.

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Risk Assessment on Bovine Spongiform Encephalopathy in Cattle in Canada

Part C: Risk Estimation

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PART C: RISK ESTIMATION

1. INTRODUCTION

The Canadian Food Inspection Agency (CFIA) has carried out a risk assessment on BSE in cattle in Canada. The following section includes an assessment of the time frame 1979–1997, 1997 corresponding to implementation of the Feed Ban on feeding of ruminant animals meat-and-bone meal (MBM) derived from entire or partial ruminant carcasses. It also includes a review of those risk mitigating measures put in place after 1997 that have further reduced the likelihood of BSE. Figure 1 of Part A, Evaluation of Risk Factors, portrays pathways for the entry and establishment of BSE in Canada and the factors that were assessed.

The risk assessment model includes four interrelated but conceptually distinct steps: (1) the release assessment,(2) the exposure assessment, (3) the consequence assessment, and (4) the risk estimation. The following scenario tree (Figure 1) illustrates the inputs included in the release and exposure assessments.

The likelihood of establishment of BSE in cattle in Canada prior to 1997 is negligible. This is based on the number of BSE-infected animals that might have been imported and were subsequently slaughtered or died, with their carcasses rendered between 1979 and 1997, as well as the probability of exposure of Canadian cattle to any BSE infectivity.

2. HAZARD IDENTIFICATION

Bovine spongiform encephalopathy (BSE) is a chronic, degenerative disease affecting the central nervous system of cattle, belonging to the family of diseases known as transmissible spongiform encephalopathies (TSEs) (OIE 2002; Schreuder 1994). The causative agent of BSE has not been fully characterized, but currently the most accepted theory is that the agent is associated with a modified form of a normal cell protein known as a prion (Brown 2002; Collinge 2001; Glatzel and Aguzzi 2001).

In cattle infected with BSE, the normal prion becomes abnormally configured. The accumulation of this abnormal protein within nerve cells results in the characteristic spongiform changes seen histologically and eventually causes cell death. The conformational changes associated with the abnormal protein convey protease resistance to this protein isoform.

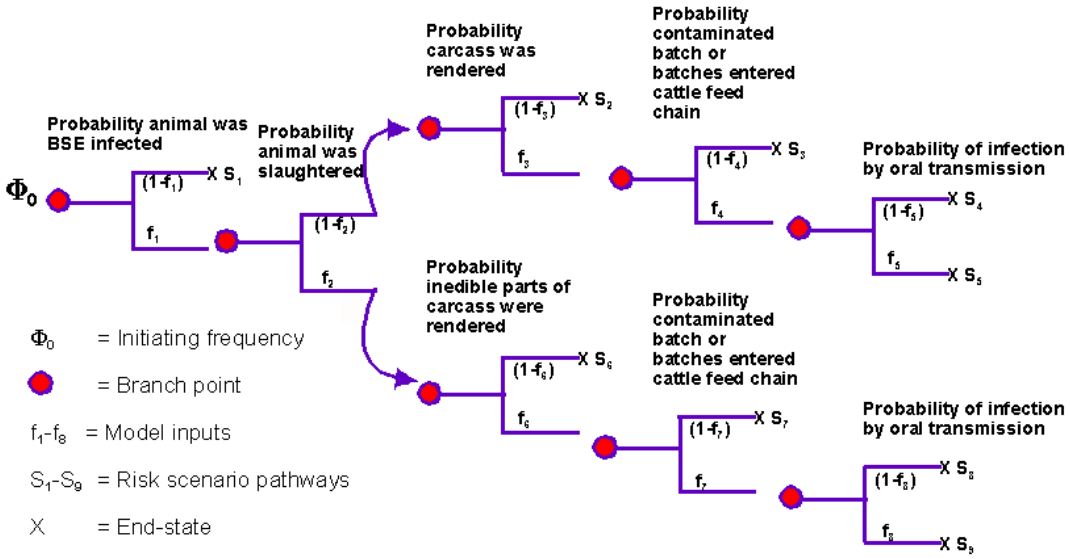
It is accepted that the BSE agent: (a) is smaller than most viral particles and is highly resistant to heat, ultraviolet light, ionizing radiation, and common disinfectants that normally inactivate viruses or bacteria; (b) causes no detectable immune or inflammatory response in the host; and (c) has not been observed microscopically (Dormont 2002; Glatzel and Aguzzi 2001; USDA 2002). BSE has a long incubation period — generally four to six years. Clinical signs of the disease include disorientation, clumsiness, and occasionally aggressive behaviour towards other animals and humans (Schreuder 1994). There is no treatment or prophylaxis.

BSE was first diagnosed in Britain in 1986. Only the U.K. has experienced a significant epidemic, peaking at the end of 1992. The disease has been diagnosed in native-born cattle in Austria, Belgium, the Czech Republic, Denmark, Finland, France, Germany, Greece, Ireland, Israel, Italy, Japan, Liechtenstein, Luxembourg, the Netherlands, Poland, Portugal, Slovenia, Spain, Switzerland, and the United Kingdom. Worldwide there have been more than 180,000 cases since the disease was first diagnosed. From 1986 through 2001, more than 98% of cases of BSE worldwide were reported from the United Kingdom (CDC 2002).

Most experts agree that BSE is spread to cattle through the feeding of contaminated meat-and-bone meal (MBM) contaminated with the BSE agent. Offal tissues of particular risk include the brain, spinal cord, eyes, spleen, and certain other nervous tissues (Weissmann et al. 2002). Semen and embryos/ova are not seen as effective transmission vectors (SSC 2001; Wrathall et al. 2002). BSE does not appear to be spread horizontally, but some studies suggest that blood and maternal transmission may occur at an extremely low level (Gore et al. 1997; SSC 2002; Wilesmith et al. 1997). BSE has not occurred in small ruminants (sheep, goats) under natural conditions; however, it has been transmitted experimentally to these species.

BSE is now considered a zoonotic disease (Taylor 2002), causing the new variant form of Creutzfeldt-Jakob disease (vCJD) in humans. vCJD was first diagnosed in humans in the United Kingdom in 1996, and as of January 2002, 113 cases had been diagnosed worldwide. The invariably fatal disease in humans is characterized by progressive degeneration of the central nervous system, and has been experimentally proven to be caused by the same agent that causes BSE in cattle.

Figure 1: Release and exposure assessment scenario tree emanating from an initiating failure event of importing cattle between 1979–1997 from the United Kingdom, Austria, Denmark, France, Germany, the Republic of Ireland, Switzerland, and the Netherlands, that were potentially infected with bovine spongiform encephalopathy.



3. RELEASE ASSESSMENT

The release assessment consists of a description of the potential of risk sources that could release or otherwise introduce the BSE risk agent into an environment accessible to animal populations. This assessment typically includes (a) a description of the types, amounts, timing, and probabilities of the release of risk agents; and (b) a description of how these attributes might change as a result of various actions or events.

The following release assessment describes the potential for a risk source to introduce the BSE agent into Canada. In this case, the only risk source requiring assessment was the past importation of cattle from BSE-infected countries (OIE 2002). Maternal transmission and genetic predisposition were not factored in this risk assessment, despite evidence indicating the risk of development of BSE in those offspring born closer to the onset of the disease in the dam (Curnow et al. 1997; Donnelly et al. 1997a, 1997b, 1997c; Ferguson et al. 1997; Gore et al. 1997). In a study of the offspring of BSE-affected pedigree beef suckler cows, none of 219 calves that had been suckled for at least one month developed the disease (Donnelly 1998). The importation of bovine embryos from BSE-infected countries was also not considered a source of infectivity, based on the work by Wrathall et al. (2002) and the conclusions of the International Embryo Transfer Society. And finally, the importation into Canada of MBM from BSE-infected countries was not factored into this assessment, as it did not occur (APFRAN 2002).

3.1. Probability that the Imported Bovine Animal is BSE-Infected (f_1)

A total of 250 cattle were imported from the U.K. between 1979 and 1990, of which 77 were ordered destroyed, 37 were exported, 9 were known to have died, 59 were known to have been slaughtered and 68 are believed to have died or been slaughtered. A total of 18 cattle were imported from the Republic of Ireland over the period 1979–1989, of which 4 were ordered destroyed, 9 were slaughtered, 3 died and 2 are believed to have died or been slaughtered. A total of 9 cattle were imported from Denmark in 1993, of which 1 was ordered destroyed, 1 was exported and 7 are believed to have been slaughtered or died.

A total of 388 cattle were imported from 1980–1985 from Austria, France, Germany, Italy, the Netherlands and Switzerland, all of which are presumed to either have died or been sent to slaughter.
Therefore, a grand total of 665 cattle were imported from BSE-infected countries between 1979 and 1993, and of these, 120 were ordered destroyed or exported.

The 545 cattle that died or were slaughtered, whose carcass or inedible carcass parts may have been rendered to produce MBM from 1979–1997, were tallied as follows: 136 cattle from the U.K. during 1979–1990 (19 in 1979, 19 in 1980, 30 in 1981, 12 in 1982, 12 in 1983, 9 in 1984, 6 in 1985, 4 in 1986, 13 in 1987, 6 in 1988 and 6 in 1989); 14 cattle from Ireland during 1979–1989 (2 in 1979, 2 in 1982, 3 in 1984 and 7 in 1989), 7 cattle from Denmark in 1993; 141 from France, Germany, Italy, the Netherlands and Switzerland in 1980; 75 from France in 1981; 126 from France in 1985; 6 from Austria in 1981; 4 from Germany in 1981; 1 from the Netherlands in 1981; 17 from Switzerland in 1981 and 18 from Switzerland in 1985 (APFRAN 2002).

The 136 cattle imported from the U.K. were primarily beef breeds; however, there were 5 Ayrshire cattle of 19 animals imported in 1979, 2 Ayrshire cattle of 19 imported in 1980, 10 Jersey cattle of 30 imported in 1981 and 14 Jersey cattle of 68 cattle imported between 1982 to 1990. Of those imported from other European countries, 2 imported in 1979 (from the Republic of Ireland) were beef cattle; 141 imported in

1980 included 105 beef cattle and an unknown number of brown Swiss and Dutch Friesian; 103 imported in 1981 included 102 beef cattle and 1 Dutch Friesian; and of 144 imported in 1985, 127 were beef cattle and 17 were brown Swiss. Overall, breed information was readily available for 490 of 545 imported cattle, indicating that 90% were beef cattle.

The incidence of BSE was dramatically different between dairy and female beef cattle in the U.K. The number of clinical BSE cases in beef cattle (suckler cases) in the U.K. as of July 31, 2002, was 21,315 (12% of the total 179,361 BSE cases) (DEFRA 2002a). Although 5.9% of the cases were designated as mixed cases and 1.3% were not recorded as either dairy or suckler, for the purposes of this risk assessment 88% was considered as the percentage of dairy cases.

In 1989 the cattle population in the United Kingdom was comprised of 2,865,900 dairy cows (65% of the total number of cows) and 1,525,400 beef cows (DEFRA 2002b).

In order to quantify the lifetime cumulative incidence rates of clinical disease for dairy and beef cattle individually, Cohen et al. (2001) developed the expressions below. The first expression is employed to estimate the proportion of BSE cases in dairy cattle (BSE_D), where BSE_D = 88%, BSE_B = 12%, the proportion of cattle that are dairy animals is F_D = 65%, and the proportion of cattle that are beef is F_B = 35%. In expression 2, the term I_BF_B is solved for. Since $I_BF_B + I_DF_D = I$, the cumulative incidence for the entire cattle population, then expression 3 follows. Both the I_D and I_B terms can be solved as shown in expressions 4 and 5.

$$BSE_D = \frac{I_D F_D}{I_D F_D + I_B F_B}$$ Expression 1

$$I_B F_B = \frac{BSE_B}{BSE_D} I_D F_D$$ Expression 2

$$I_D F_D + \frac{BSE_B}{BSE_D} I_D F_D = I$$ Expression 3

$$I_D = \frac{I}{F_D\left(1 + \frac{BSE_B}{BSE_D}\right)}$$ Expression 4

$$I_B = \frac{I - I_D F_D}{F_B}$$ Expression 5

where *I* = the cumulative lifetime incidence of infection for the entire cattle population

The lifetime cumulative incidence of clinical BSE in Great Britain was elaborated by Schreuder et al. (1997) according to a 12-month birth cohort, July to June inclusive, from July 1974 to June 1995, for both dairy

and beef cattle combined. Cohen et al. (2001) computed the calender year cumulative year incidence of clinical disease by averaging the two contributing years, which is presented below in Table 1.

The lifetime cumulative incidence of infection is a product of the lifetime cumulative incidence of clinical disease and 6.10, the latter factor based on the ratio of the number of infected cattle in Great Britain as estimated by Donnelly et al. (1997) and Donnelly and Ferguson (2000) (954,000 infected animals in the years 1974–1995) and the number of confirmed clinical BSE cases (156,360 BSE cases in the years 1974–1995) (DEFRA 2002). The model presented by Donnelly et al. (1997) was the best-fitting age-dependent susceptibility function and incubation period distribution examined. Although Cohen et al. (2001) employed the Schreuder et al. (1997) cumulative incidence to represent that for female cattle and went on to estimate the cumulative incidence of clinical disease and infection for male cattle as 6% of the female cattle incidence by year of birth, Table 1 does not differentiate incidence by gender.

Table 1: Lifetime cumulative incidence of BSE clinical disease and infection in birth cohorts in the Great Britain for the years 1974–89, and the number of cattle imported into Canada according to the year of birth (cattle that died or were slaughtered and may have been rendered).

Year of Birth	Lifetime Cumulative Incidence of Clinical Disease	Lifetime Cumulative Incidence of Infection	Lifetime Cumulative Incidence of Infection in Dairy Cattle (I_D)	Lifetime Cumulative Incidence of Infection in Beef Cattle (I_B)	No. of Dairy Cattle Imported from the United Kingdom According to Year of Birth	No. of Beef Cattle Imported from the United Kingdom According to Year of Birth
1974	0	0	0	0	0	1
1975	0	0	0	0	0	1
1976	0.00003	0.00020	0.00027	0.00007	1	2
1977	0.00012	0.00073	0.00099	0.00025	1	2
1978	0.00020	0.00122	0.00165	0.00042	5	10
1979	0.00047	0.00287	0.00388	0.00098	11	22
1980	0.00081	0.00494	0.00669	0.00169	3	14
1981	0.00170	0.01037	0.01404	0.00356	5	8
1982	0.00500	0.03050	0.04129	0.01046	1	6
1983	0.01100	0.06710	0.09084	0.02301	3	6
1984	0.01600	0.09760	0.13214	0.03346	0	6
1985	0.02300	0.14030	0.18994	0.04810	0	10
1986	0.03800	0.23180	0.31382	0.07947	1	8
1987	0.05100	0.31110	0.42118	0.10666	0	5
1988	0.03900	0.23790	0.32208	0.08157	0	2
1989	0.01800	0.10980	0.14865	0.03765	0	2
Total					31	105

The dairy and beef lifetime cumulative incidence of infection according to year of birth from Table 1 were all elaborated as beta distributions.

Denmark first reported the occurrence of indigenous clinical BSE in 2000, with an annual incidence of 1.14 per million cattle over two years of age (OIE 2002; SSC 2000a). The 7 cattle imported from Denmark in 1993 were attributed a prevalence of infection in the 1992 birth cohort as a beta distribution with parameter

values (2, 1,000,000). Without information as to when BSE infectivity was introduced into Denmark, it was considered appropriate to assign a prevalence of infection to the 1992 birth cohort based on an annual incidence of infection of 1 per million in the cohort. This reasoning was also applied to cattle imports from the other countries, at least for some of the birth cohorts from which cattle were imported.

France reported clinical cases of BSE in indigenous cattle in 1991 at an annual incidence of 0.45 cases per million cattle over two years of age (OIE 2002; SSC 2000b). The age-specific incidence modelled by birth cohort and assuming under-reporting estimated that 7,300 domestic cattle in France (95% confidence interval of 4,700 and 9,800) were infected with the BSE agent from mid-1987 to mid-1996. Over 2,500 cattle were infected in the 1988 birth cohort (Donnelly 2000). The 141 cattle imported from France in 1980, the 75 cattle imported in 1981, and the 126 cattle imported in 1985 were attributed a prevalence of BSE infection in the 1979, 1980, and 1984 birth cohorts as a beta distribution with parameter values (2, 1,000,000).

The Republic of Ireland reported indigenous BSE clinical cases in 1989 with an annual incidence of 4.41 cases per million cattle over two years of age. One or more clinical cases of BSE have originated from the 1981 birth cohort (OIE 2002; SSC 2000c). The age-specific incidence, modelled by birth cohort and assuming under-reporting of clinical cases, estimated a total of approximately 22,000 cattle infected with BSE in the Republic of Ireland from 1985–1996. About 4,400 cattle were infected in both the 1985 and 1986 birth cohorts, 2,100 in 1987 and 1,700 in 1988 (Donnelly 2002). The cattle imported from the Republic of Ireland from the 1978, 1981, 1983 and 1988 cohorts were attributed a prevalence of BSE infection as a beta distribution with parameter values (2, 1,000,000), except for the 1988 birth cohort, which was attributed a prevalence based on the modelling by Donnelly (2002) and an estimate of the birth cohort population (about 1,630,708 in 1985) (SSC 2000c) as beta (1701, 1,629,009).

Switzerland first reported indigenous clinical cases of BSE in 1990 with an annual incidence of 1 per million cattle over two years of age (OIE 2002; SSC 2000d). The expected number of infected cattle in 1984, based on modelling the BSE epidemic in Switzerland until December 31, 1997, and assuming 50% under-reporting of clinical cases, was 6 cattle under two years of age. The denominator for a prevalence estimate for cattle imported from Switzerland in 1985 was 273,300 calves under one year of age (Swiss cattle population in 1996) (Doherr et al. 1999). The prevalence estimate for the 1984 birth cohort was represented as a beta distribution with parameter values (7, 273,295). The prevalence estimate of the 1980 birth cohort was represented as a beta distribution with parameter values (2, 1,000,000).

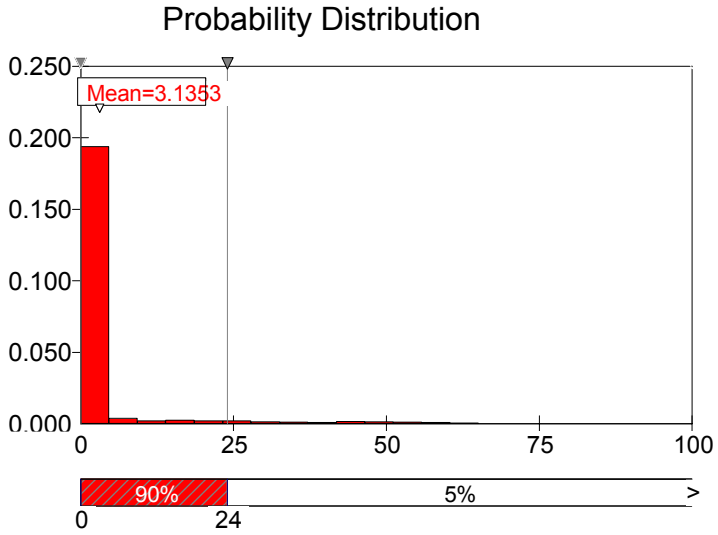
For Austria, the first report of indigenous clinical cases of BSE occurred in 2001, with an incidence of 0.96 per million cattle over two years of age (OIE 2002; SSC 2000e). For Germany, the year was 2000, with an annual incidence of 1.7 per million cattle over two years of age (OIE 2002; SSC 2000f); for the Netherlands the year was 1997, with an annual incidence of 1 (OIE 2002; SSC 2000g); and for Italy the year was 2001, with an annual incidence of 14.1 (OIE 2002; SSC 2000h). Prevalence estimates of infection for the birth cohorts of imports from these countries were all assigned beta (2, 1,000,000). The 1980 importation of 141 cattle from France, Germany, Italy, Switzerland and the Netherlands were attributed to have originated from France for the purposes of this risk assessment, since the number of cattle imported from each country was unknown.

Computer simulation with the risk analysis software @RISK (Palisade Corporation, Newfield, New York) and its binomial distribution function (RiskBinomial(n, p)) was used to estimate the number of BSE- infected animals that may have been imported from BSE-infected countries between 1979 and 1997. The n value for the binomial distribution was represented by 545, which is the number of cattle that were imported and subsequently were slaughtered or died. The lifetime cumulative incidence of infection for beef and dairy cattle by year of birth in Table 1 was converted to beta distributions for use as the p values in the binomial

distribution for the U.K.-origin beef and dairy cattle, while beta distributions represented the prevalence of BSE infection in the birth cohorts of cattle from the other countries.

The mean expected number of cases of BSE that may have been imported as part of the 545 cattle from the BSE-infected countries and the carcasses of which may have been rendered upon death or slaughter is 3 cattle, while the 95th percentile is 24 cattle (Figure 2).

Figure 2: Distribution of the estimated number of BSE-infected cattle imported from the United Kingdom, France, Switzerland, Denmark, the Republic of Ireland, Austria, Germany, and the Netherlands that were slaughtered or died and may have been rendered (binomial distribution output with 10,000 iterations of Latin hypercube sampling using the risk analysis computer software @RISK (Palisade Corporation, New York)).



4. EXPOSURE ASSESSMENT

The exposure assessment consists of a description of the relevant conditions and characteristics of animal exposures to the BSE risk agent produced or released by a given risk source. The exposure assessment includes (a) a description of the intensity, timing, frequency, and duration of exposure; (b) the routes of exposure (e.g. ingestion); and (c) the number, species and characteristics of populations that might be exposed. The exposure assessment in this case describes the likelihood that BSE infectivity was introduced into the cattle feed chain before the 1997 feed ban.

4.1. Probability that the Animal was Slaughtered (f_2)

The ratio of the mortality rate and slaughter rate of beef and dairy breeding cattle was employed to estimate what proportion of the 465 cattle died and what proportion were culled for slaughter. Fifty-nine cattle from the U.K. and 9 from the Republic of Ireland were slaughtered (a total of 68), while 9 and 3, respectively, died. Annual mortality and slaughter rates in beef cattle of 1.5% and 10.8% (NAHMS 1997a, 1998; Radostits 2001) and 3.8% and 32% (95% of Ontario Holstein dairy cow culling rate in 1995) in dairy cattle (NAHMS 1996; Ontario DHI 2002; Radostits 2001) were used to calculate the mortality/slaughter ratio for the two husbandry types. It was necessary to use the proportion of dairy and beef cattle imported, that is, approximately 12% of 656 imported cattle were dairy breeds (based on the available information on breeds of cattle imported). The proportion of 465 cattle that were slaughtered was therefore 0.88 (0.88 beef slaughter × 0.90 beef breeds + 0.89 dairy slaughter × 0.10 dairy breeds), giving a total of 409 + 68 = 477 or 88% of the 545 imported cattle. A beta distribution with parameter values (477+1, 545-477+1) was employed for this probability (f_2). The proportion of cattle that died was estimated as (1-f_2).

4.2. Probability that the Carcass was Rendered (f_3) and the Probability Inedible Parts of the Carcass were Rendered (f_6)

The probability (f_3) that the carcass of an animal that died was rendered was represented as a beta pert distribution with parameter values (0.50, 0.75, 0.80). The latter is an assumption that only 50–80% of the cattle that died on farms were sent for rendering. The probability (f_6) was represented as a beta pert distribution with parameter values (0.99, 0.999, 1).

4.3. Probability of Contaminated Batch(es) Entering the Cattle Feed Chain (f_4, f_7)

Of the 25 million tonnes of complete feed produced in Canada annually, 15% (3.75 million tonnes) was fed to dairy cattle (APFRAN 2002). If it is considered that all dairy feeds incorporated a 1% level of MBM, then approximately 37,500 tonnes of MBM were fed to dairy cattle annually. Before the Feed Ban, this amount represented about 10% of the 373,600 tonnes of MBM produced in Canada in 1995 (APFRAN 2002), indicating that about 90% of the MBM manufactured in Canada was incorporated in feeds for poultry, swine and beef cattle. The levels of MBM incorporated in swine and poultry feeds (37 and 16% of the complete feeds produced, respectively) at inclusion rates of 3–5% indicated an annual consumption of 397,500–662,500 tonnes of MBM. This consumption of MBM, representing more than the quantity produced in Canada, was met by the importation of MBM from the U.S.A., accounting for 50% of the rendered products used in livestock feeds (APFRAN 2002). The level of MBM fed to beef cattle was considered quite low because of the availability of such cheaper protein sources as non-protein nitrogen, canola and soybean meal.

A beta pert distribution was employed to estimate the proportion of MBM that was fed to swine and poultry and therefore would be eliminated from the cattle feed chain. For this input, the consumption of 90% represented the maximum value and the most likely value was 85%, while the minimum value was represented as 80%.

4.4. Probability of at Least One Oral Transmission Infection (f_5, and f_8)

Wahlstrom et al. (2002) approached the estimation of this probability by setting an average number of secondary infections produced when one infected individual is introduced into a host population, R_o. The parameter was estimated subjectively. Cohen et al. (2001) examined the actual consumption by susceptible animals of the BSE-causing agent in MBM. In this risk assessment, the sub-model for this

probability is estimated from the end consumption of each ID_{50} remaining in the final MBM. More specifically, due to the accumulative infectivity scenario that within a three-day "feeding period" (SSC 2000) the infectious dose accumulates for the same individual, the term *x* was used to denote the total number of susceptible animal feeding periods sharing a single ID_{50} of infectious agent. Given that there is no natural upper limit on *x*, a Poisson probability model for *y* = *x*-1, where the parameter lambda = - ln P(*y*=0) = - lnP(*x*=1) was used.

An assumption here is that the number of ID_{50}s per kilogram of MBM follows an exponential distribution with lambda (λ) = 1/0.068 ≈ 15 (the expected number of ID_{50}s remains 1/λ = 0.068 per kg of MBM). The latter is based on the expected number of cattle oral ID_{50} s remaining after rendering in what is considered a conservative quantity of 500 kg of MBM. If the three-day MBM consumption is *m* kg, then the number (*n*) of ID_{50}s contained in *m* kg follows an exponential distribution with λ=1/(0.068×*m*) = 15/*m*, where the mean of exponential distribution is 1/λ. The probability of *m* kg containing at least one ID_{50} is the tail probability P(*n*≥1) = exp(-3/*m*). If, in turn, the above is taken as the probability that one ID_{50} is eaten entirely by a single susceptible animal, i.e., the input for the Poisson distribution, then the λ parameter for the Poisson distribution is -ln[exp(-3/*m*)]=3/*m*.

The probability of various values of x, the number of individual animals (or animal feeding periods) sharing the same ID_{50} is as follows:

P(x=1) = P(y=0) = exp(-λ) = exp(-15/*m*)

P(x=2) = P(y=1) = exp(-λ)×λ = exp(-15/*m*)×15/*m*

P(x=3) = P(y=2) = exp(-λ)×λ^2 /2! = exp(-15/*m*)×15^2/(2m^2), etc.

For each *x* value, an ID_{50} is more or less equally shared by the *x* susceptible individuals (more precisely, *x* susceptible animal feeding periods), each receiving 1/*x* of the original ID_{50} dose. The dose-response curve for cattle oral BSE infectivity is necessary in order to calculate the ID percentage of this divided dose. Without an exact dose-response curve, a conservative alternative was used by assuming a linear dose-response relationship, namely 1/*x* of the original ID_{50} dose represents a dose of ID_{50} /*x*. The probability that the particular ID_{50} would cause at least one infection, after factoring in susceptibility (p_s), is:

P(Oral transmission ≥ 1) =

1-(1-(P(*x*=1)×P_s×0.50 + P(*x*=2)×[1- (1- P_s×0.50/2)^2]+ P(*x*=3)×[1- (1- P_s×0.50/3)^3]+ P(*x*=4)×[1- (1- P_s×0.50/4)^4]+ P(x=5)×[1- (1- P_s×0.50/5)^5]))^n, where *n* = the number of cattle oral ID50s contributed by a rendered BSE-infected carcass.

Given that a very conservative model of a linear dose-response relationship was used, the first five or six terms in the above formula suffice to give an estimate of the probability of oral transmission.

The following evidence and data interpretation represent the model inputs into the sub-model for the probability of at least one oral transmission.

4.5. Number of ID_{50} s Presented by a BSE-Infected Rendered Carcass

BSE Infectivity

Simulation software (@RISK) was employed to determine the month of infection, the month of export, duration of BSE incubation, duration of clinical BSE, month of death and month of slaughter for the imported cattle that died or were slaughtered and their carcasses or inedible carcass parts rendered. The months pertain to the age of the imported BSE-infected animal.

In order to estimate the amount of BSE infectivity introduced by an imported BSE-infected animal, a probability distribution of the incubation period (in months) for cattle was used. This distribution was based on the model of Medley and Short (1996) and the parameter values of Ferguson et al. (1997), as presented by Cohen et al., (2001). The probability density function for the incubation period (months) is *f(t)*, and,

$$f(t) = \left(\frac{\alpha_2 e^{-t/\alpha_1}}{\alpha_3} \right)^{\frac{\alpha_2^2}{\alpha_3}} e^{\frac{-\alpha_2 e^{-t/\alpha_1}}{\alpha_3}}$$

where $\alpha_1 = 1.146$, $\alpha_2 = 0.0241$ and $\alpha_3 = 5.71 \times 10^{-4}$, representing the best-fit parameter values for the incubation distribution C of Ferguson et al. (1997). The input *t* is expressed in years. The 5th percentile of this distribution is about 31 months, the median 49 months, the mean 52 months and the 95th percentile 83 months.

For cattle that died or were slaughtered, probability distributions as to the age at death and slaughter were obtained by simulation using 10,000 iterations of Latin hypercube sampling. The objective was to obtain a distribution of the truncated incubation periods, truncated according to age at death and age at slaughter, respectively. All mortality in beef breeding female cattle was set at a constant rate of 0.0008 for 6–23 months of age, a constant rate of 1.5% for 2–10 years of age, and the function $1\text{-}e^{-0.006 \times a}$, where *a* = age in years from 11–20 years and the annual slaughter rate was set at 0.025 in year 2, 0.1 in years 3–10 and the function $1\text{-}e^{-0.001 \times a}$ for years 11–20 (NAHMS 1997a, 1998; Radostits 2001). Similarly, the mortality rate in female dairy cattle was set at a constant rate of 0.002 for 6–23 months of age, 3.8% for 2–6 years of age, and the function $1\text{-}e^{-0.004 \times a}$ for years 7–20, and the annual slaughter rate was set at 0.05, 0.2, 0.3, 0.3 and 0.1 for years 2–6 and $1\text{-}e^{-0.0003 \times a}$ for years 7–20 (NAHMS 1996; Ontario DHI 2002; Radostits 2001).

Cattle from the United Kingdom and Ireland were attributed an age at export of 6–24 months (discrete uniform distribution (6,7, ..., 24)), while cattle from the other European countries were attributed an age at export of 6–10 months (discrete uniform distribution (6, 7, ..., 10)). Cattle from Continental Europe exported to Canada during the 1970s and 1980s had been restricted to cattle less than 11 months of age (APFRAN 2002). The imported BSE-infected cattle were assumed to have been infected between 2 and 12 months of age (discrete uniform distribution (2, 3, ..., 12)). Appropriate 'IF' functions of the spreadsheet computer software Excel (Microsoft Corporation, Redmond, Washington) were used to ensure that month of infection preceded month of export.

The duration of clinical BSE was attributed a period of 2–6 months (uniform distribution 2, 6), a period of disease not curtailed by either disease control measures or the owner's intervention.

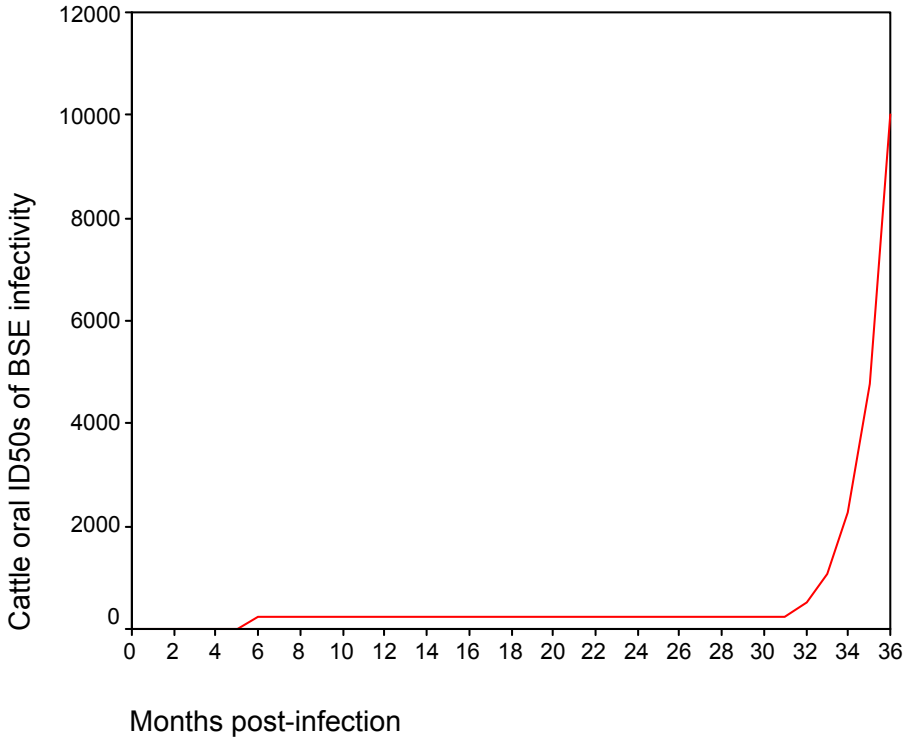
Truncated incubation periods were obtained by deleting those iterations of the simulation in which the following argument was true: month of infection + incubation period in months + clinical duration in months < age at death or age at slaughter. For each distribution, truncated by mortality or slaughter rates, the months of incubation were transformed and scaled to a 36-month axis, employing the VLOOKUP function of the Excel spreadsheet software (Microsoft Corporation) and data from an experimental pathogenesis

study on BSE (Wells et al. 1998, 1999; Cohen et al. 2001). In this study, the time course of infectivity was evaluated through oral exposure with 100 g of BSE-infected brain tissue of 30 4-month-old calves. The study revealed increasing infectivity in the distal ileum, where there is a considerable amount of lymphoid tissue (called Peyers' Patches) at 6 months post-infection (pi), 10, 14 and 18 months pi. Then infectivity was not detectable in the distal ileum until 36 months pi. Infectivity was not detected in other parts of the gastrointestinal tract or in any other non-neural tissues at any stage with the exception of trace infectivity in sternal bone marrow collected during the clinical stage at 38 months pi. Infectivity was detected in the brain, spinal cord, dorsal root ganglia, and trigeminal ganglia at 32, 36, 38 and 40 months pi and in the distal ileum at 36, 38, and 40 months pi (Wells et al. 1998, 1999; SSC 2002).

Estimates of the infectivity levels in tissues of an infected bovine (near the end of the incubation period or during the clinical phase) have been presented in cattle oral infectious dose 50% (SSC 1998, 1999). The cattle oral infectious dose, $ID_{50,}$ indicates the oral dose at which 50% of challenged cattle would become infected, where infection means evidence of replication of the BSE agent. The ID_{50} is expressed as the product of the titre ID_{50}/g of tissue ingested by cattle and the amount of tissue (g) (SSC 2000). It is estimated that in a clinical case of BSE, about 8,000 ID_{50}s of infectivity would be present in the carcass. The percentage of the total infectivity and the number of cattle oral ID_{50}s in a 537-kg clinical case, represented by the various tissues, is brain 64.1% and 5,000 ID_{50} s, spinal cord 25.6% and 2,000 ID_{50}s, trigeminal ganglia 2.6% and 200 ID_{50}s, dorsal root ganglia 3.8% and 300 ID_{50} s, distal ileum 3.3% and 260 ID_{50}s, spleen 0.3% and 26 ID_{50}s and the eyes 0.4% and 3 ID_{50}s (SSC 1998, 1999). Figure 3 presents the total infectivity found in the experimentally infected animals according to month post-infection. The infectivity level in the distal ileum from 6 months of age up to 31 months of age was attributed an estimated quantity of ID_{50}s found in an adult BSE clinical case.

Computer simulation using 100,000 iterations of the risk analysis software @RISK with Latin hypercube sampling gave an output distribution of the number of cattle oral ID_{50}s present in carcasses of BSE-infected cattle that died or were slaughtered. Normal distributions of the $\log_{10}$ total infectivity obtained for cattle that died or were slaughtered were normal (3.13, 0.73) and normal (2.92, 0.70), respectively.

Figure 3: Total cattle oral ID_{50}s of BSE infectivity according to month post-infection (adapted from Cohen et al., 2001).



4.6. Rendering Reduction in ID_{50}s

Reduction of the infectivity of BSE and scrapie agents by different rendering processes was investigated using small-scale equipment and quantities of MBM to simulate full-scale production (Taylor et al. 1995, 1997). For batch rendering, a 1:20 representation of full-scale production was achieved, whereas for other rendering processes the scale was 1:100. In the study in which BSE agent was incorporated into MBM at appropriate proportions of BSE-infected brain tissue, bovine or porcine intestine and bovine bone, a titre of $\log_{10}$ 1.7 ID_{50}/g resulted. BSE agent inactivation was obtained with batch processing at atmospheric pressure, 2 of 4 continuous processes at atmospheric pressure and containing natural fat, 2 continuous processes at atmospheric pressure using high fat, 3 continuous wet rendering processes containing high fat and 3 batch rendering processes under pressure and with natural fat. The inactivation in these 11 processes represented a reduction in titre of about $\log_{10}$ 1.4 ID_{50}. Infectivity was detected following 2 of 4 continuous processes at atmospheric pressure and with natural fat content and following 2 continuous high-fat vacuum processes. In one of the latter vacuum processes, the infectivity titre was only reduced to $\log_{10}$ 1.6 ID_{50} per ml.

In the study in which the scrapie agent was incorporated into MBM using brains of sheep clinically affected with scrapie and porcine bone and intestine, a titre of $\log_{10}$ 3.1 ID_{50} per gram was achieved.
The reductions in scrapie titre in the MBM following processing were as follows: $\log_{10}$ 1.5 ID_{50} for batch processing at atmospheric pressure, $\log_{10}$ 1.6 ID_{50} and $\log_{10}$ 2.3 ID_{50} for 2 continuous processes at atmospheric pressure and containing natural fat, $\log_{10}$ 2.3 ID_{50} for a continuous process at atmospheric

pressure using high fat, $\log_{10}$ 1.6 ID_{50} for a continuous process with high fat content and under vacuum, $\log_{10}$ 2.0 ID_{50} and $\log_{10}$ 2.8 ID_{50} for 2 continuous wet rendering processes containing high fat and inactivation ($\log_{10}$ 2.8 ID_{50}) for 5 batch rendering processes under pressure and with natural fat. The overall reduction in titre was a mean of $\log_{10}$ 1.6 ID_{50} and a standard deviation of $\log_{10}$ 0.58 ID_{50}.

The rendering industry in Canada, comprising 32 plants, utilizes batch and continuous rendering under atmospheric pressure, and vacuum rendering. The proportions of MBM rendered by the different processes is known currently, but not for the principal period of interest — prior to 1997 — when the Feed Ban was implemented. It was considered reasonable to employ the titre reductions for both the BSE and scrapie agents for the batch and continuous processes excepting the batch processes under hyperbaric steam. A normal distribution based on the mean $\log_{10}$ 1.6 ID_{50} and standard deviation $\log_{10}$ 0.58 ID_{50} of the reduction in titre was employed to represent the effects of rendering processes in Canada, normal (1.6, 0.58).

Computer simulation with @RISK to estimate the total infectivity titre following rendering was conducted on the difference between the total infectivity titre before rendering and the effects of different rendering processes. The resulting distributions were achieved with 10,000 iterations of Latin hypercube sampling, as normal (1.53, 0.93) with a 95% confidence interval of (0.0015–3.033) for slaughtered animals and normal(1.32, 0.91) with a 95% confidence interval of (-0.17–2.81).

The number of cattle oral ID_{50}s remaining following rendering an animal that was slaughtered or that died was estimated from the distribution with the highest level of infectivity, normal (1.53, 0.93). Hence, the expected number of cattle oral ID_{50} s per rendered carcass was 34, with a 95% confidence interval of (1–1,079).

4.7. Average Daily Consumption of MBM by Age (months)

The daily consumption of MBM by dairy cattle was estimated according to month of age based on the following feeding assumptions, which were proposed to be representative of dairy feeding in Canada. For dairy heifers before their first calf, the feeding regime comprised hay of 88% dry matter (DM) and 20% crude protein (CP) (DM basis), haylage of 50% DM and 15% CP (DM basis), a supplement at the rate of 22% of the grain mix fed from 1 month of age to 7 months of age, the supplement at the rate of 15% of the grain mix for calves 8–12 months of age and the incorporation of MBM in the supplement at 4.5%. The age in months according to body weight in kilograms and the average daily gain were obtained from heifer growth charts for Holstein and brown Swiss cattle (Clapp 1990). The nutrient requirements as the daily grams of CP, daily grams of undegradable intake protein (UIP), and dry matter intake (DMI) were based on the 1989 “Nutrient Requirements of Dairy Cattle” (NRC 1989) and the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) dairy ration balancer (OMAFRA 2002). The OMAFRA dairy ration balancer increases the NRC requirements for CP, calcium and phosphorous to account for the higher skeletal growth and weight of Canadian heifers versus U.S. heifers. From 12 to 27 months, 27 months being the 50^{th} percentile age at first calving (Ontario DHI 2002), feeding haylage alone was assumed.

Protein feeds of animal origin such as meat meal, meat-and-bone meal and blood meal were considered too expensive and of limited availability in the 1970s and 1980s. The principal protein supplements for dairy rations included soybean, linseed, canola and corn gluten meals; canola seed; cottonseed; corn gluten; brewer’s grains; distiller’s grains and non-protein nitrogen such as feed-grade urea. Commercial protein supplements, such as 36% dairy supplement, were formulated under a least-cost approach determined by the feed mills (Droppo 1984). The assumptions for feeding dairy cows were based as well on the 1989 dairy cattle requirements (NRC 1989) and the OMAFRA dairy ration balancer. A representative ration

comprising legume hay, grass hay, mixed hay, alfalfa haylage, corn silage, high moisture corn, soybean meal and commercial supplement containing MBM at 15% of the supplement was formulated for a Holstein cow calving at 28 months of age, weighing 700 kg at the beginning of her third lactation, producing a peak in milk yield of 45 kg/day at 45 days in milk from the third lactation onwards and having a calving interval of 13.5 months. The latter parameter represented the 50th percentile of the 65–70% of the dairy herds in the province of Ontario enrolled in the Ontario Dairy Herd Improvement Corporation for 1996 (Ontario DHI 2002).

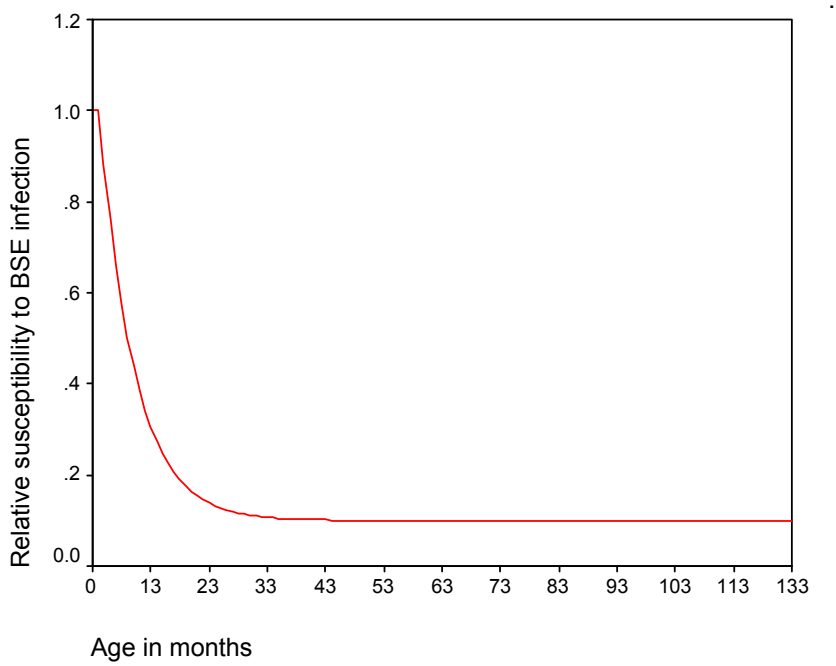
4.8. Proportion of Dairy Cattle Population by Age (months)

The number of dairy cattle by age in months was based on the July 1, 2001, number of female dairy calves under one year of age (490,800), the number of dairy heifers (473,000), the number of dairy cows (1,131,000) (Statistics Canada 2002) and the distribution of over 492,000 dairy cows in August 2002 that qualified for genetic evaluation under the Canadian Dairy Network (CDN 2002). The numbers of calves and heifers from 0 to 27 months were estimated using a mortality rate of 10.8% for the first 2 months of age and 2.4% for heifers from weaning age (8.4 weeks) to first calving (NAHMS 1996; Radostits 2000) plus the number of replacement heifers between 12 and 27 months of age.

4.9. Age-Dependent Susceptibility of Cattle to BSE Infection (p_s)

Young cattle were estimated to be 10 times more susceptible than adults, susceptibility declining exponentially with an annual rate constant of 0.85 after the age of 4 months to as low as 10% of its peak value. The susceptibility function is represented by the equation $\beta(a) = 0.1 + 1.8e^{-2a}$ where a is age in years (Figure 4) (Cohen 2001). Another model for age-dependent susceptibility indicated a peak in susceptibility between 6 to 18 months of age (Anderson et al 1996; Ferguson et al 1997; Donnelly and Ferguson 2000).

Figure 4: The relative susceptibility of cattle to BSE infection according to age in months (Cohen et al, 2001).



5. CONSEQUENCE ASSESSMENT

Consequence assessment consists of a description of the relationship between specified exposures to a risk agent and the economic consequences of those exposures. Disease outbreaks and the economic consequences associated with animal losses, production losses, control and eradication costs, monitoring and surveillance costs, and losses from trade embargoes and trade restrictions are notable impacts in the animal health field.

5.1. Direct Consequences

5.1.1. Animal Health Impact

Animals with BSE exhibit a combination of neurological and general signs of disease. The neurological signs fall into three categories (U.K. Government 2000): (a) Changes in mental status, which are most commonly seen as apprehension, frenzy and nervousness when confronted by doorways and other entrances — about 98% of all cases show altered behaviour in this category; (b) Abnormalities of posture and movement, which occur in 93% of cases (the most common manifestations are hind limb ataxia, tremors and falling); and (c) Changes in sensation, which are a feature of about 95% of all cases. This is exhibited in many different ways, but the most striking is hyperaesthesia to touch and sound.

A large majority of cases (87%) exhibit signs that fall into all three neurological categories, consistent with a diffuse central nervous system disorder. In addition, other general clinical signs associated with BSE include loss of body condition (78%), weight loss (73%) and reduced milk yield (70%). The clinical signs are progressive over a period of weeks, leading to recumbency and death; however, slaughter of the great majority of affected animals becomes necessary at an earlier stage because of unmanageable behaviour and injury from repeated falls (Kimberlin 1992).

In July 2002, the Department for Environment, Food & Rural Affairs (DEFRA) in Great Britain indicated that 179,361 total cases had been reported on a total of 35,551 farms (DEFRA 2002). Most of the herds (63%) affected were dairy herds, 27% were beef suckler herds, and the balance were of mixed beef and dairy type. The within-herd incidence peaked in 1992 at 2.7% (DEFRA 2002).

5.1.2. Public Health Impact

In 1996, the U.K. government announced that there was a possible link between BSE and a new variant of Creutzfeldt-Jacob disease (vCJD) in humans, similar to BSE in cattle and scrapie in sheep. Like classical CJD, vCJD is a neurodegenerative disease; however, the peak incidence in patient age is much lower (around age 27). There is no treatment and no cure. As of September 2002, the number of definite and probable vCJD cases was 137 people, including 127 in the U.K., 6 in France, 1 in Ireland, 1 in Italy, 1 in the U.S., and 1 in Canada. (Scientists have concluded that the patients in the U.S. and Canada contracted vCJD in the U.K.) To date, the disease has occurred almost exclusively in people under the age of 55, a number of whom were teenagers (NCBA 2002; U.K. Department of Health 2002).

The cost to the Department of Health in the U.K. of staff time spent on BSE/CJD-related activities from 1988 to 1996 was approximately £820,000. The average cost per vCJD patient, estimated by DH's Economics and Operational Research Division, is about £20,000 in the U.K. Depending on the type of care, this could vary from £6,500 to £40,000 per year (U.K. Government 2000).

5.2. Indirect Consequences

5.2.1. Economic Considerations

5.2.1.1. Surveillance, Control and Eradication cost

In France, the surveillance of cattle at risk represents an average cost of €112,300 per case. The testing of healthy slaughtered animals required to declare meat fit for human consumption is extremely costly (€1.8 million per detected case). The yearly direct costs are estimated at approximately €835 million, or €75 per bovine animal older than 24 months or €2 million per positive case detected. Eradication measures involve culling of the entire herd of origin and all cattle originating from that herd. The total direct cost of eradication measures represents 13% (€108 million) of the total cost of control measures (Chmitelin 2001).

In the United Kingdom, expenditures on diagnosis and surveillance totalled approximately £7.7 million from 1988 to 1996. The removal of suspect cattle or carcasses from a property, their valuation and the subsequent incineration of carcasses cost £44 million between 1988 and 1996. The cost of compensation in the U.K. from 1986 to 1996 was £136.4 million. Other costs, including rent, utilities, wages and equipment costs, totalled £90.8 million. Adding to the above was a dramatic rise in compensation expenditures in the U.K. after the adoption, in April 1996, of a scheme to slaughter cattle over 30 months old. In April 2000, government officials estimated that the total net cost of the BSE epidemic will be £3.7 billion by the end of the 2001–2002 financial year (U.K. Government 2000).

5.2.2. Potential Trade Losses

5.2.2.1. Trade Impact

On March 27, 1996, the European Commission prohibited all U.K. exports of beef and cattle and their by-products to all other EU Member States and to the rest of the world. What had become a beef export market worth almost £600 million per year collapsed, resulting in severe economic difficulties for those dependent on it. European Community partners of the U.K. and many other countries, including Canada and the U.S., have banned the importation from the U.K. of all live cattle. Export markets were completely lost (U.K. Government 2000). In 1995, the United Kingdom exported 77,000 tonnes of beef and veal around the world. In 2000, the U.K. was forecast to export less than 2,000 tonnes (USDA, FAS 2001).

The rendering industry faced the loss of markets for its major products — meat-and-bone meal (MBM) and tallow — as a result of the ban on using MBM in any farmed animal feed and the EU export ban on British beef derivatives. The slaughtering sector was also suffering, as the buildup of unsaleable stocks resulted in significant physical and financial blockages, and temporary financial measures were put in place for the rendering and slaughtering sectors to ensure that these key elements of the meat chain continued to operate. Around £97 million in support was provided to individual rendering companies for 1996–1997 (DEFRA 2002).

5.2.2.2. Impact on Industry

The occurrence of BSE in Canada would affect many sectors of the industry, including farmers, meat processors, renderers, transporters, distributors and retailers, among others. It could result in a substantial decline in the consumption of beef and beef products due to a perception of risk to human health and safety (AAFC 2002).

In the U.K., the economic consequences of BSE have been considerable. Complex changes in the economics of beef and beef products have been experienced by many sectors, including producers, retailers and consumers. The consumption of beef in the U.K. fell by as much as 25% between 1988 and 1993. In Denmark, two weeks after the first outbreak of BSE, Danes stopped eating beef. Supermarket surveys indicate that 80% of beef consumers no longer purchase the meat, which has also resulted in numerous job losses in the meat packaging sector.

The impact of the introduction and establishment of BSE in Canada would be extreme, based on the animal and human health impacts, trade impacts, effect on industry and costs of eradication.

6. RISK ESTIMATION

Risk estimation consists of integrating the results of the release, exposure, and consequence assessments to produce measures of the risk.

6.1. Risk Estimate

The mathematical model used to estimate the probability of at least one infection by oral transmission for *n* imported animals is as follows:

$$P(I \geq 1) = 1-((1-f_1)+f_1*((1-f_2)*((1-f_3)+f_3*((1-f_4)+f_4*(1-f_5)))+f_2*((1-f_6)+f_6*((1-f_7)+f_7*(1-f_8)))))^n$$

The estimated probability of at least one infection of BSE occurring prior to 1997 was 7.3 x 10^{-3} with a 95% confidence level of 2.0 x 10^{-2} (Figure 5). This estimate was based on the expected number of BSE-infected animals that may have been imported, then were slaughtered or died, with their carcasses subsequently rendered between 1979 and 1997. Therefore, the likelihood of establishment of BSE in Canada was negligible. If BSE was introduced, the consequences would be extreme.

The sensitivity analysis (Figure 6) identified the most critical inputs for the model. With the rank order correlation sensitivity analysis, the coefficient is calculated between the selected output variable and the samples for each of the input distributions. The higher the correlation between the input and the output, the more significant the input is in determining the output's value. The tornado graph (Figure 6) indicates that the "age in months," showing the longest bar and a positive coefficient of 0.368, was the most important input for the estimate of the probability of at least one infection. "Pf1," which represented the function assimilating the prevalence of infection by country and year of birth, was second in importance with a positive coefficient of 0.76. The input variable "ncoid50," representing the number of cattle oral ID_{50}s, revealed a correlation coefficient of 0.023.

Figure 5: Distribution of the probability of at least one infection as a simulation output of the @RISK risk analysis software, 100,000 iterations of Latin hypercube sampling.

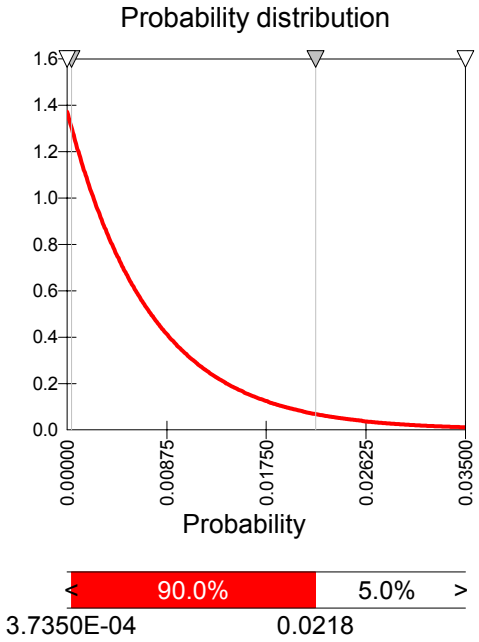
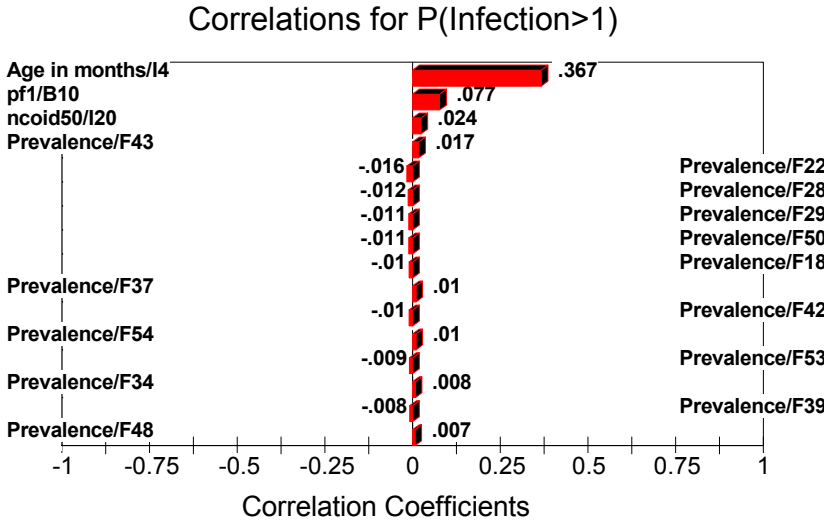


Figure 6: Sensitivity analysis (@RISK tornado graph) of the output (probability of at least one infection) and the model inputs.



The measures (import policies, disease control measures, detection systems on farm and at slaughter plants) that were in place or have been added since 1997, including the Feed Ban and import bans on all ruminants, meats of ruminant origin, all products containing rendered animal proteins, ruminant specific risk materials, and veterinary biological products containing bovine material from countries not recognized free of BSE by Canada further mitigate the likelihood of the introduction and establishment of BSE in Canada.

6.2. Mitigating Measures in Place Between 1997 and 2002

6.2.1. Import controls

- Requirement of permits for the import of all rendered products (1997).
- Initiation of a country evaluation process for BSE status (1997).
- Revision of BSE Import Policies (1998): Live bovine animals are only allowed from countries certified free from BSE by Canada; bovine embryos may be imported from BSE-infected countries (other than the U.K.) with conditions; bovine specified risk materials, livestock feeds containing mammalian protein, pet food and mechanically separated meat are not allowed from BSE-infected countries; bovine-origin meat, cell lines and veterinary biologics are allowed with conditions (note: to date, no permits have been issued for injectable veterinary biologics originating from BSE-infected countries for use in ruminants); the import ban on cattle is extended to sheep and goats; and sheep and goat embryos are banned from countries not certified free from BSE.
- Revision of BSE Import Policies (2000). Import ban is extended to all live ruminants and edible meat of ruminant origin.
- All ruminants imported into Canada from Denmark since 1992 are ordered removed or destroyed (2000).
- Ban on import of rendered animal protein from any species from countries not recognized free of BSE by Canada (2000).
- Imports of cattle from Japan via the U.S. are traced and placed under quarantine (2001).

6.2.2. Surveillance

- Since 1992, a total of 7,183 samples have been tested for BSE, consistently exceeding the annual minimum level of sampling required by the OIE since 1993 (with the exception of 1995).
- Livestock compensation and cattle identification programs are crucial parts of the surveillance program.
- Reporting of disease and suspect animals is facilitated by programs for education and awareness of veterinarians and producers.
- 96% of all cattle go through ante-mortem inspection in federally registered slaughter plants (Section 3.1, Part A).

6.2.3. Rendering practices

- Feed Ban (1997). The use of rendered animal proteins of ruminant origin (excluding milk, blood and fat) is banned in feed for ruminants.
- Structure of the rendering industry: 32 facilities in total with only 4 facilities with any potential risk of cross-contamination (prohibited and non-prohibited material on the same line) and these plants are not located in the main dairy areas of Canada.
- Since August 1997, a minimum of four complete inspections has been carried out at each facility, with 100% compliance.

6.2.4. Feed industry

- Procedures are in place to prevent cross-contamination. The level of compliance approaches 100% following immediate correction and any re-inspections.

6.2.5. Farms

- 96% of all farms in Canada rear one production animal and thus present a negligible risk for cross-contamination during on-farm feed mixing.
- The level of compliance of 100 farms inspected was 100%.

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