



CANADIAN ANIMAL HEALTH COALITION
COALITION CANADIENNE POUR LA SANTÉ DES ANIMAUX

**ECONOMIC IMPACTS OF A
POTENTIAL OUTBREAK OF FOOT
AND MOUTH DISEASE IN CANADA**

**PREPARED FOR
CANADIAN ANIMAL HEALTH COALITION
CALGARY, ALBERTA**

This document has been prepared with the support and assistance of:



Canadian Animal Health Coalition
Coalition canadienne pour la santé des animaux



Alberta Agriculture, Food & Rural Development



Canadian Cattlemen's Association
Canadian Cattlemen's Association



Manitoba Agriculture & Food
Agriculture et Alimentation Manitoba



Canadian Livestock Genetics Association
l'Association canadienne de l'industrie du bétail et de la
génétique



Ministry of
Agriculture and
Food

Ministère de
l'Agriculture et de
l'Alimentation

Ontario Ministry of Agriculture & Food
Ontario L'Agriculture et de l'Alimentation



Agriculture, Food
and Rural
Revitalization



Ministère de l'Agriculture,
de l'Agroalimentaire
et de la Revitalisation rurale
de la Saskatchewan

Saskatchewan Agriculture, Food & Rural Revitalization



Canadian Pork Council
Conseil canadien du porc



Government
of Canada

Gouvernement
du Canada



Gouvernement
du Canada

Government
of Canada

Canada

Canada

Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada

Canadian Food Inspection Agency
Agence canadienne d'Inspection des aliments

Farm Credit Canada
Financement agricole Canada

Industry Canada
Industrie Canada

Office of Critical Infrastructure Protection & Emergency
Preparedness
Bureau de la protection des infrastructures essentielles et de
la protection civile

Parks Canada
Parcs Canada



Dairy Farmers of Canada
Les Producteurs laitiers du Canada



RBC
Royal Bank



RBC
Banque Royale

RBC Royal Bank
RBC Banque Royale

**ECONOMIC IMPACTS OF A
POTENTIAL OUTBREAK OF FOOT AND MOUTH DISEASE
IN CANADA**

**PREPARED FOR
CANADIAN ANIMAL HEALTH COALITION
CALGARY, ALBERTA**

**PREPARED BY
SERECON MANAGEMENT CONSULTING INC.
EDMONTON, ALBERTA**

NOVEMBER 8, 2002

FOREWORD

This report has been prepared on behalf of the Canadian Animal Health Coalition (CAHC), its members and other stakeholders, together with a number of federal and provincial government departments / agencies. In April, 2002, the CAHC commissioned Serecon Management Consulting Inc. to undertake an assessment of the economic impacts of a possible outbreak of Foot and Mouth Disease (FMD) on the Canadian livestock industry and the Canadian economy.

This report assesses the direct and indirect impacts of a range of hypothetical FMD outbreaks on both the agriculture and agri-food sector, and the non-agricultural sectors in Canada. The research involved interviews and consultations with a cross-section of stakeholders in Canada. Stakeholders included CAHC members and experts from various government agencies. In addition, this analysis has drawn on previous studies of possible FMD outbreaks and experiences from FMD outbreaks in foreign countries.

A central purpose of this report was to provide baseline data to be used in developing an understanding of the range of impacts a FMD outbreak could potentially have on the Canadian economy. This would assist industry and government in their preparation of appropriate control and eradication strategies for emergencies, thereby mitigating the economic consequences.

Three scenarios are described according to the size and duration of the outbreak. A small-scale outbreak represents the 'ideal' -- a limited, isolated scenario. A medium-scale outbreak was developed from the small-scale outbreak, by modelling the case in which each week there were 24% fewer new cases than in the previous week. This could reflect a highly effective control strategy. A large-scale outbreak was also developed from the small-scale outbreak, by modelling the case in which each week there were 16% fewer new cases than in the previous week. This could reflect a less effective control strategy, or a simultaneous and widely dispersed outbreak that might result from an act of bioterrorism using FMD.

The report evaluates the difference in impact between the large-scale and medium-scale outbreak as a measure of the benefit of a more effective control strategy. That control strategy could include several tactics, such as pre-emptive slaughter or vaccination. The analysis does not evaluate or compare specific disease control tactics. Rather, it indicates the benefit of an effective control strategy as a whole.

The medium- and large-scale outbreak scenarios were evaluated further, to assess the impacts in the presence and absence of an effective zoning strategy. The difference between impacts – with or without zoning -- for either scenario, is interpreted as a measure of the benefit of an effective zoning strategy.

The report incorporates the results from an economic model and consultations with stakeholders from across the country in assessing the direct and indirect impacts of a range of hypothetical FMD outbreaks on both the agriculture and food sector, and non-agricultural sectors in Canada.

Serecon Management Consulting Inc. wishes to thank all those involved in the study for their participation, cooperation, and willingness to share information with the members of the Consulting Team.

Serecon Management Consulting Inc.
November 8, 2002

GLOSSARY OF TERMS AND DEFINITIONS

Contact premises

Contact premises are premises that contain susceptible animals which have been in contact with an infected premise or an infected animal. Direct contact implies the movement of an infected animal whereas indirect contact means the movement of a potentially contaminated thing (fomite).

Control and disposal costs

Control costs are defined to include the cost of detection, surveillance, livestock movement and control, disposal of infected animals and feed on infected premises, disinfecting of premises, and the costs of a zoning, and vaccination strategy. Only some of these costs are covered by the CFIA.

Control area

Legal definition under Section 27(1) of the *Health of Animals Act and Regulations*, and referred to in the Ministerial declaration.

Dangerous contact animal

An animal showing no clinical signs of disease but which will be, by reason of its possible exposure to disease, subject to disease control measures (which may include slaughter of all or some of such animals).

Direct contact premises

Premises containing dangerous contact animal(s) and on which some or all susceptible animals may be slaughtered.

Endemic

Disease regularly occurring in a particular region, country or population group.

Exposed premises

A contact premise which received animals (direct contact), products, by-products or things including animal feed and manure, vehicles or equipment from an infected premise (indirect contact).

Fomites

Objects or materials which are likely to carry infection, such as clothes, etc.

FMD-free zone

Part of a country that has been established to be free of a disease. To obtain recognition as a disease-free zone, countries must demonstrate that they have a reliable system of disease control, the disease is compulsorily notifiable, and that they have an effective veterinary organization. Within the zone and at its borders, appropriate official veterinary control is effectively applied for animals and their transportation in order to bring the definition in line with Office International des Epizooties (OIE) requirements.

Infected place

Legal term for a place which has been declared an infected place by an inspector (under section 22 of the *Health of Animals Act and Regulations*) and consequently restrictions have been imposed by section 25 of the *Health of Animals Act and Regulations* limiting the movement of animals, animal products and by-products, things, etc. A declared infected place may be an infected premise, an exposed premise, a contact premise, or more simply, a premise that is declared infected because of its close proximity to an infected premise. An infected place is suspected of having an infection, but not necessarily confirmed to have an infection.

Infected premise, infected herd

A premise, where a herd with the disease has been identified, with or without confirmation from laboratory results.

Infected zone

The zone established pursuant to the Ministerial declaration and which includes all infected premises. The outer boundary is at least three kilometres from any infected premise adjusted to geography, epidemiology, climatology and resources to control the epidemic. A surveillance zone will separate the infected zone from the remainder of the country. Movement of susceptible livestock must be strictly controlled.

Movement controls

Restrictions placed on movement of animals, people and things to prevent the spread of disease.

Outbreak

Outbreak of FMD - means an occurrence of foot-and-mouth disease virus infection in an agricultural establishment, breeding establishment or premises, including all buildings and all adjoining premises, where animals are present (source=OIE Code 2002)

Quarantine

Legal restrictions imposed on a place or tract of land, limiting access or movement of specified animals, persons, vehicles or things.

Rendering

Destruction of the carcass or animal by-products by heating.

Special premises

Premises such as an abattoir, artificial insemination centre, sales yard, zoo, game farm, shipping yard or any other premises where animals are kept or assembled.

Stamping out

Stamping-out policy means on confirmation of FMD, the killing of all susceptible animals, vaccinated or unvaccinated which are infected or suspected of being infected with FMD in a herd on an infected premises. And, where appropriate, killing of other herds, which have, been exposed to infection by direct animal to animal contact, or by indirect contact of a kind likely to cause the transmission of the causal pathogen under the competent authority. (source=OIE Code 2002)

Surveillance zone

The zone immediately surrounding the infected zone(s). For FMD, the limits of the surveillance zone must be at least 10 km from an infected premise, the generally accepted distance for airborne spread, but may extend up to 60 km depending on epidemiology, climatology, geography, etc. Vaccination is not permitted. Freedom from infection should be confirmed by appropriate tests. Animal movements must be strictly controlled. It must have an advanced degree of disease control and surveillance.

Trade losses (opportunity trade costs)

The costs of lost export sales until full recovery of export revenue to the levels experienced before the outbreak.

Welfare slaughter and disposal

The slaughter and disposal of livestock due to the necessity of the industry to meet the reduced demand for livestock products as a result of trade restrictions from a FMD outbreak. These are not infected animals.

TABLE OF CONTENTS

1.0 INTRODUCTION, SCENARIOS AND STUDY APPROACH.....	1
1.1 INTRODUCTION	1
1.2 DISEASE CONTEXT.....	1
1.2.1 Relative Level of Exports.....	1
1.2.2 Reliance on High Quality Standards	2
1.2.3 Canada’s Unique Geophysical Characteristics.....	2
1.2.4 Canada’s System of Animal Collection	2
1.3 OUTBREAK SCENARIOS.....	2
1.4 APPROACH AND METHODOLOGY OF STUDY	3
1.5 OUTLINE OF REPORT	4
2.0 ANALYSIS FRAMEWORK	5
2.1 CONCEPTUAL FRAMEWORK FOR THE ECONOMIC ANALYSIS	5
2.1.1 Factors Influencing Cost and Outbreak Scale	6
2.2 OUTLINE OF ECONOMIC VARIABLES AND ANALYSIS COMPONENTS	7
2.2.1 Outbreak Control Costs.....	7
2.2.2 Direct Primary Sector Impacts	7
2.2.3 Indirect Primary Sector Impacts.....	8
2.2.4 Direct Processing Sector Impacts.....	8
2.2.5 Indirect Processing Sector Impacts	8
2.2.6 Trade Opportunity Costs	8
2.2.7 Tourism and Other Economic Impacts.....	8
2.2.8 Economic Gains From a FMD Outbreak.....	8
2.3 SCENARIO APPROACH AND ASSUMPTIONS	9
2.3.1 Specific Scenario Development Factors.....	10
2.3.2 Small-Scale Outbreak.....	11
2.3.3 Medium-Scale Outbreak.....	11
2.3.4 Large-Scale Outbreak.....	12
3.0 ECONOMIC IMPACT ANALYSIS	14
3.1 ECONOMIC IMPACT RESULTS	14
3.1.1 Small-Scale Outbreak.....	14
3.1.2 Medium-Scale Outbreak.....	15
3.1.3 Large-Scale Outbreak.....	17
3.2 COMPARATIVE SUMMARY RESULTS	18
3.3 IMPACT OF RESPONSE TIME ON CONTROL AND DISPOSAL COSTS AND NEI.....	20
3.3.1 Pattern of Costs and Impacts Over a Six-Month Outbreak Period.....	20
3.4 SENSITIVITY ANALYSIS	21
3.5 CONTROL AND ZONING STRATEGY MANAGEMENT.....	23
4.0 SECONDARY FINANCIAL IMPACTS	25
4.1 PRODUCTION SECTOR	25
4.1.1 Financial Risk.....	25
4.2 INCOME DIVERSIFICATION.....	28
4.3 IMPACT ON REVENUE AND CAPITAL	29
4.4 EXPECTED REVENUE AND CAPITAL LOSSES.....	30
4.5 PROCESSING SECTOR FINANCIAL ANALYSIS.....	31
4.6 EMPLOYMENT SECTOR ANALYSIS	33
4.7 COMPENSATION IMPLICATIONS.....	33

5.0 SUMMARY AND CONCLUSIONS	36
5.1 KEY IMPACTS	36
5.2 ECONOMIC IMPACT	36
5.3 CONTROL AND ZONING STRATEGY IMPACTS.....	37
5.4 OPERATIONAL IMPACTS	37
5.5 EMPLOYMENT IMPACTS	38
5.6 CURRENT COMPENSATION PROGRAMS	38
5.7 KEY FACTORS TO CONSIDER	38
REFERENCES.....	40

APPENDICES

LIST OF TABLES AND FIGURES

Table 1.1	Comparative Livestock Production and Trade Statistics, 2001	2
Table 2.1	Small-Scale Outbreak Assumptions	11
Table 2.2	Medium-Scale Outbreak Assumptions	12
Table 2.3	Large-Scale Outbreak Assumptions	12
Table 3.1	Small-Scale Outbreak (\$ millions)	14
Table 3.2	Medium-Scale Outbreak (\$ millions)	16
Table 3.3	Impact of Changing Import Restrictions of FMD Economic Outcomes	17
Table 3.4	Large-Scale Outbreak (\$ millions)	18
Table 3.5	Response Time Impacts.....	20
Table 3.6	Sensitivity Analysis of Selected Assumptions	22
Table 4.1	Canadian Cattle Farms' Financial Profiles	26
Table 4.2	Canadian Hog Farms' Financial Profiles.....	27
Table 4.3	Industrial Statistics - Meat and Meat Products Industry (Except Poultry).....	32
Table 4.4	Employment Impact of FMD Outbreak, by Scenario.....	34
Table 4.5	Type I and Type II Primary Sector Impacts	34
Table 5.1	Outbreak Results Summary	36
Figure 2.1	Conceptual Overview of Economic Impact Analysis Model	5
Figure 2.2	Logic Flow of FMD Impact Analysis.....	6
Figure 2.3	Overview of Outbreak Progression and Scenario Analysis.....	9
Figure 3.1	Small-Scale Outbreak: Relative Impacts of All Factors	15
Figure 3.2	Medium-Scale Outbreak, Relative Impacts of All Factors.....	16
Figure 3.3	Large-Scale Outbreak Impacts of All Factors	18
Figure 3.4	Relative Comparison of the Total Economic Impacts Across all Scenarios Relative to the Small-Scale Outbreak Base Case	19
Figure 3.5	Impact Variance From Small-Scale Outbreak	19
Figure 3.6	Average Cumulative Cost of Control and Disposal/Day.....	21
Figure 3.7	Relative Change in Costs, Impacts in Outbreak Period.....	21
Figure 3.8	A Comparison of Relative Change Between the Initial Net Impact and Trade Impacts Over Time	21
Figure 3.9	Economic Impact of FMD Outbreak in Canada, Impact of Control and Zoning Strategies.....	24
Figure 4.1	Distribution of Farmers and Revenue, Cattle Farms	27
Figure 4.2	Distribution of Farmers and Revenue, Hogs	28
Figure 4.3	Degree of Income Diversification, Hogs and Beef.....	28
Figure 4.4	Probability of Farm Failure, Cattle and Hog Farms Due to a FMD Outbreak.....	29
Figure 4.5	Expected Revenue Loss, Beef and Hog Farm Enterprises	30
Figure 4.6	Expected Capital Loss, Cattle and Hog Farms, Due to a FMD Outbreak	31
Figure 4.7	Small-Scale Outbreak Economic and Recovery Costs	35
Figure 4.8	Medium-Scale Outbreak Economic and Recovery Costs	35
Figure 4.9	Large-Scale Outbreak Economic and Recovery Costs	35
Figure 5.1	Allocation of Net Economic Impacts for a Small-Scale Outbreak	37
Figure 5.2	Allocation of Net Economic Impacts for a Medium-Scale Outbreak	37
Figure 5.3	Allocation of Net Economic Impacts for a Large-Scale Outbreak	37
Figure 5.4	Allocation of Costs Borne by Primary, Processing, and Public Sectors, Medium-Scale Outbreak.....	38

1.0 INTRODUCTION, SCENARIOS AND STUDY APPROACH

1.1 INTRODUCTION

The Canadian Animal Health Coalition (CAHC), in partnership with the Canadian livestock industry, and several federal and provincial government departments/agencies, commissioned Serecon Management Consulting Inc. to conduct an assessment of the economic impacts of a possible outbreak of Foot and Mouth Disease (FMD) on the Canadian economy and livestock industry. Contributing organizations are shown in the introductory pages to this report.

Foot and Mouth Disease is an acute, highly contagious viral disease of cloven-hoofed animals. The disease affects animals such as pigs, cattle, sheep, goats, and deer. The disease does not generally kill healthy, mature animals, but it can cause death in younger animals and reduces livestock productivity. The disease is not contagious to humans, nor is the meat of infected animals considered harmful for human consumption.

The most significant impact of a potential FMD outbreak on Canada is how it affects its trade with other countries. Any country where FMD has been detected, is excluded from the meat and livestock export markets for the duration of the infected period, plus an additional three months after the last case is detected, where stamping out and serological surveillance are applied. It should be noted that this applies only to countries normally free from FMD without vaccination. Countries not recognized internationally as normally FMD-free without vaccination do not qualify for these conditions¹. The actual duration of exclusion from export markets will be impacted by the disease control strategies practised.

The impact of the exclusion from the meat and livestock trade markets has immediate and significant direct and indirect impacts on the meat processing sector, as it scales back to reflect the reduced export demand. This, in turn, has an impact on the livestock

¹ OIE, 2002.

breeding and production sectors. Additionally, there are economic impacts on related input supply industries, on rural communities, and on other sectors in the Canadian economy, such as tourism.

1.2 DISEASE CONTEXT

While it is true that any country with livestock or livestock product exports would be impacted by a FMD outbreak, Canada's agriculture industry is especially vulnerable because of its relatively high level of net exports, and its reliance on the international recognition of high quality standards in defining and branding its products. Compounding this problem is the fact that Canada's geographic characteristics, and system of animal collection and movement, increase the difficulties associated with identifying and containing the disease in the event of an outbreak.

1.2.1 Relative Level of Exports

Canada is one of the world's most important exporters of agricultural products. This is significant as the magnitude of the economic consequences of a FMD outbreak is affected by the degree to which a country is dependent on export markets for its meat and livestock products. The degree of Canada's dependence can be illustrated by observing the ratio of net exports to production for Canada, the United States (US), and Australia in Table 1.1.

In 2001, Canada had net exports of 275,000 tonnes of beef and veal (46% of total production) and 636,000 tonnes of pork (42% of total production). The US is a net importer of beef and veal (404,000 tonnes), but a net exporter of pork (278,000 tonnes). This represents about 8% of the quantity of US production of hogs. Australia is a net exporter of both beef and pork, although its beef exports are significantly higher as a percentage of production (69%) than its pork exports (15%). Australia's annual net exports of beef and pork are 1,449,000 tonnes. The impact of a FMD outbreak in Australia would be somewhat mitigated by the fact that they have greater access to meat and livestock markets within FMD-infected countries.

Table 1.1
Comparative Livestock Production and Trade
Statistics, 2001

	Canada	United States	Australia
<i>1,000 Tonnes, Carcass Wt. Equivalent</i>			
Beef and Veal			
Production	1235	11983	2070
Consumption	961	12349	650
Exports	574	1030	1425
Imports	299	1434	0
P/C ratio ¹	1.29	0.97	3.18
Net Exports	275	-404	1425
Export/prod²	0.46	0.09	0.69
Pork Sector			
Production	1720	8691	379
Consumption	1082	8476	360
Exports	727	709	56
Imports	91	431	32
P/C ratio ¹	1.59	1.03	1.05
Net Exports	636	278	24
Export/prod²	0.42	0.08	0.15

Source: Statistics Canada - Cat. no. 23-603-XIE,
Australia Pork Corporation

¹ Ratio of annual production to consumption

² Ratio of exports to annual production

Canada's dependence on US markets for its meat product exports, and its physical proximity to this market, will have profound implications in the event of an outbreak.

1.2.2 Reliance on High Quality Standards

Canada has effectively branded its image as a country of amazing landscapes with clean air, water, and high standards of food safety. This image has helped to create value in the Canadian brand, thus increasing the value of its exports. It is difficult to estimate the potential impact that an outbreak of FMD would have on this image, and how this would translate into economic costs. However, it undoubtedly would have an impact, and it is also highly probable that the extent of the impact would be closely related to international perceptions regarding the national strategy on addressing the outbreak. Scenes of piles of dead animals burning in farmer's fields would not help the value of Canada's brand in the international marketplace. On the other hand, a quick and effective response to an outbreak might help to support our claims that our agriculture and agri-food system is one of the best and safest in the world.

1.2.3 Canada's Unique Geophysical Characteristics

Canada is unique in terms of its relative size and density of population. Agricultural production is similar in structure, with much of the input base spread across the country. Unfortunately, international consumers of Canadian export products do not tend to differentiate products on a regional basis. As a consequence, a problem in Newfoundland is a problem in British Columbia from the perspective of international trade.

The vastness of the country also leads to increased difficulties in terms of monitoring the movement and trade of commodities and the potential for disease transmission. A smaller, more contained country can monitor its borders much more efficiently than a country the physical size of Canada.

1.2.4 Canada's System of Animal Collection

The nature of the agricultural system in Canada results in the need to develop collection points in the various geographical areas in order to maximize the efficiency of transportation and handling. As a result, there is a significant number of animal input sources that feed into individual collection points, thus increasing the complexity of tracing and monitoring movement. The contagious nature of FMD magnifies the potential problems associated with managing the disease in the event of an outbreak.

1.3 OUTBREAK SCENARIOS

The approach involved the evaluation of the economic impacts of three scales of outbreaks:

- ➡ a small-scale outbreak in which 50 herds become infected, and which is controlled within a six week outbreak period;
- ➡ a medium-scale outbreak in which up to 325 herds become infected, and which runs over a period of 3.5 months; and,
- ➡ a large-scale outbreak in which 1,500 herds become infected, that occurs over a six-month outbreak period.

The difference in scale of the medium- and large-scale outbreaks was established to reflect the relative consequences of an effective response as opposed to

a less effective response effort. It was simulated by reducing the disease dissemination rate by 24% per week for the medium-scale and 16% per week for the large-scale outbreaks respectively.

The small-scale outbreak scenario is based on the assumption that there is a small outbreak in a localized area of central Alberta. The medium-scale outbreak is the progression of this small-scale outbreak as a result of undetected movement of infected livestock to Manitoba. In the large-scale outbreak, infected livestock are found in several other areas across Canada as could arise from either less effective control or the deliberate introduction of the disease at multiple points as might result from an act of bioterrorism

An economic model was used to evaluate the impact of changes in key factors on the ultimate costs of the outbreak. As such, the results illustrate the relative importance of addressing each of these factors in terms of cost reduction.

While the size of the modeled outbreaks and ultimate impacts are discrete in nature, the actual magnitudes of potential outcomes form a continuous range from smallest to largest. Specific points (scenarios) along this range can be estimated. It is important to recognize that the change from one point to another is directly related to a number of key factors. While some of these are outside the control of stakeholders, many can be controlled. It is the relative cost/benefit of these controllable factors that is of interest in this analysis. These factors would include, but are not limited to the following:

- the time it takes to detect the initial outbreak;
- the relative concentration of livestock in the infected zone;
- the relative co-operation of the agricultural sector, particularly producers, in responding to control measures and disclosing potentially infected animals;
- the ability to specify and clearly delineate the infected zone;
- the willingness of trading partners to recognize the zone as identified by Canadian authorities and/or the time required for trade recovery;
- the impact of the disease on domestic consumption, prices, and imports;

- the ability of the processing sector to adjust to the structural change issues; and,
- the assumed availability of resources to contain and eradicate the outbreak.

1.4 APPROACH AND METHODOLOGY OF STUDY

The approach used in this study was both participative and iterative. In the first research phase, a summary and review of various FMD outbreak incidents around the world was conducted. This provided information to assist in the structuring of the economic models, derive insights as to how outbreaks were managed in other jurisdictions, and in helping to develop quantitative assumptions for this study.

The second major part of the research phase involved individual consultations with industry and government stakeholders. This feedback included their opinions regarding the impacts and implications of a FMD outbreak occurring in Canada. Approximately 30 consultations were held in this phase.

A draft set of scenario outlines and assumptions was developed and used as a prelude to the subsequent economic model design and analysis. The scenarios and assumptions were presented in a series of three stakeholders' meetings in Ottawa, Toronto, and Winnipeg, in May 2002. A broad cross-section of representatives from federal government departments (CFIA, AAFC, Industry Canada, Canada Customs and Revenue Agency, Tourism Canada), attended these meetings in addition to representatives from the processing industry, the financial community, and primary producers.

A preliminary economic model with initial simulations was then prepared. The results of these initial simulations were presented and discussed with the CAHC project management team, in Winnipeg, on June 26, 2002.

The feedback from these consultations was used to develop a draft final economic analysis and report. This analysis was supported with economic simulations using Statistics Canada's National Input-Output Model.

This analysis formed the basis for discussion with the project management team in Winnipeg on August 26, 2002. From this meeting and feedback the final report was prepared for presentation in October, 2002.

1.5 OUTLINE OF REPORT

The balance of this report is organized within three chapters as follows:

- Chapter 2 outlines the general approach of the impact analysis, and discusses the conceptual framework of the analysis. The rationale used to develop the incidence and spread of the FMD outbreaks is also provided. Included in the analysis is an outline of the scenarios and assumptions used.
- Chapter 3 provides the quantitative results of the economic analysis from the three outbreak scenarios.
- Chapter 4 undertakes a specific analysis of the financial and structural impacts on the primary production sector, and the meat processing sector. There is a qualitative analysis of the various implications as to their subsequent recoveries, employment impacts, and compensation implications.
- Appendix A includes an economic overview of the structure and performance of the Canadian livestock industry.
- Appendix B includes the limitations of the economic analysis, and the mechanics of the analysis used.

2.0 ANALYSIS FRAMEWORK

2.1 CONCEPTUAL FRAMEWORK FOR THE ECONOMIC ANALYSIS

The evaluation of the economic impacts of a FMD outbreak in Canada is used to provide an estimate of the value to society (as a whole) of an effective control, prevention and management strategy. This net impact to society is identified as a Net Economic Impact (NEI). The analysis identifies both the main areas where costs would accumulate in a potential outbreak and the key factors that have a direct impact on these costs. Cost accumulation centres have been broken into five main categories, including:

- disease control costs;
- primary sector impacts;
- processing sector impacts;
- tourism and non-agriculture-related impacts; and,
- trade loss opportunity impacts.

In addition to negative impacts, a potential FMD outbreak would also generate some economic gains to society in terms of consumer surplus, and these are also considered in the analysis. Figure 2.1 provides a conceptual overview of how the NEI on society would be estimated.

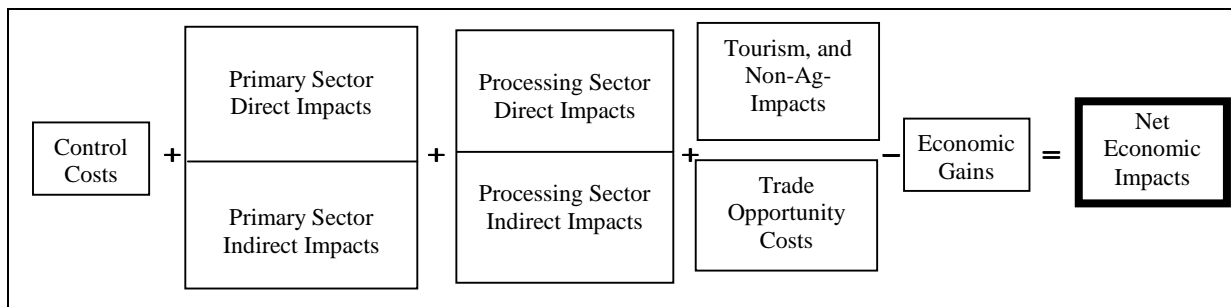
A dynamic impact model is used to measure the NEI of an outbreak under various circumstances. The inputs and assumptions to the model were derived from four sources:

- 1) parameters extracted from those used in other FMD outbreaks (the United Kingdom, Taiwan, and the Netherlands);
- 2) assumptions provided through consultations with industry and government stakeholders;
- 3) economic statistics on the Canadian livestock and trade sectors; and,
- 4) economic multipliers and coefficients from simulations of the Statistics Canada National Input-Output Model.

The first three sources provide the data and information for the assessment of the direct economic impacts for the control costs, trade opportunity costs, primary and processing sector impacts, and the estimate of the consumer surplus.

The Statistics Canada National Input-Output Model was used to provide estimates of the indirect impacts for both the primary and processing sectors, the impact on the tourism and other non-agricultural sectors, and employment.

Figure 2.1
Conceptual Overview of Economic Impact Analysis Model



2.1.1 Factors Influencing Cost and Outbreak Scale

The magnitude of an outbreak is based on the number of animals infected, the geographic dispersion of the disease, and the length of time it takes to eliminate it. These distinct states were broken into a small-scale, medium-scale, and large-scale outbreak. In effect, these discrete outbreak size categories represent day one starting points of potential disease outbreaks.

Measuring the NEI for each of the three scales of outbreak involves estimating/modeling the magnitude of the five main cost categories as per Figure 2.1, inclusive of consumer surplus. The ultimate magnitude of these categories is affected and influenced by a number of variables, including:

- Zoning Efforts: Activities associated with limiting the time and extent of the embargos placed on Canadian products by developing internationally recognized trade zones. This includes the ability to ship products from zones within Canada defined to be free of the disease during the outbreak.
- Slaughter Process/Control Activities: These would include infected herd slaughter, welfare slaughter is not a control mechanism in addition to any other control mechanisms used to

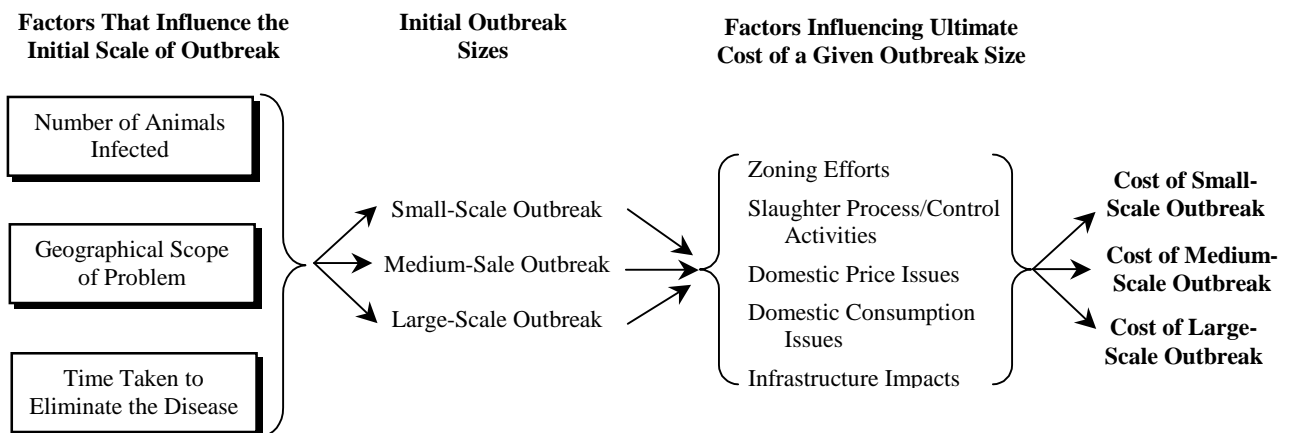
contain and/or eliminate the disease after detection.

- Domestic Price Issues: This represents the impacts on consumer prices at the retail and producer level due to the shifting of consumer preferences.
- Domestic Consumption Issues: The change in domestic consumption of meat products due to FMD.
- Infrastructure Impacts: These factors would include the impacts on tourism and other non-agriculture-related industries.

For the purpose of this analysis, the magnitude of the initial outbreak scenario is deemed to be fixed. Its size is determined by a pre-established number of animals infected, the geographical scope of the problem on diagnosis, and the time estimated to eliminate the disease. The progression of the outbreak scale from small to large is a reflection of a control strategy which is less than optimal, resulting in a slower rate of detection of new herds, from 24% to 16% per week.

The logical flow of factors to impacts by scenario can be observed in Figure 2.2.

Figure 2.2
Logic Flow of FMD Impact Analysis



2.2 OUTLINE OF ECONOMIC VARIABLES AND ANALYSIS COMPONENTS

A general discussion of the main components and economic variables used in this analysis, and outlined in Figure 2.1, is given below. The more detailed mechanics of how variables are used and interpreted in the model are discussed in Appendix B.

2.2.1 Outbreak Control Costs

The outbreak control costs estimated in the economic impact analysis include:

- **Detection and surveillance costs:** Costs are estimated for initial detection and surveillance in the infected zone, the surveillance zone, and in the overall control area. Administrative overheads, the costs of inspections and costs for control of livestock movements are included. These costs are dynamic to the size of the control area, the radius of the infected and surveillance zones, the livestock density of the control area, the number of infected herds, and the duration of the outbreak.
- **Control and disposal costs:** These costs include cleaning and disinfecting the infected premises, disposing of feed and other possibly contaminated fomites, and the slaughter and disposal costs of the animals in the infected herds. In addition, slaughter and disposal costs on possible exposed premises within the infected zone are included in this category. The analysis is dynamic to the estimated proportion of exposed premises in the zone. Not all of these costs are borne by the CFIA, notably the cleaning and disinfecting of infected premises
- **Zoning costs:** Where zoning is included in the scenario simulation, an estimated cost for establishing the FMD-free zone is included as an outbreak control cost. Costs in zoning include, but are not limited to, the costs of establishing a national livestock tracking and tracing system such as an EIS (Electronic Identification System) supported by a Geographic Positioning System (GPS); enforcement of zone border controls for animals and animal products by appropriate official veterinary control, adequate veterinary infrastructure and surveillance to international standards within and external to the defined FMD-free zone.

- **Vaccination cost:** When vaccination is considered as a control strategy, the direct costs of administering a vaccination program are included. These costs include the unit costs of administering the vaccination, the cost of the vaccine, the vaccinated animal disposal costs, and the economic business disruption costs of the animals, if slaughtered. It is noted that vaccinates do not have to be eliminated under OIE Code 2002 2.1.1.7 provided an internationally accepted discriminating test exists for structural or non-structural proteins that are not a consequence of vaccination.

2.2.2 Direct Primary Sector Impacts

A FMD outbreak results in a reduction in export demand for livestock and meat products. This in turn requires a contraction of the industry, leading to the costs of animal welfare disposal and feed disposal if necessary. Business disruption and recovery costs are also considered.

Welfare slaughter and disposal: The extent of welfare slaughter is determined in the model, based on the net impact on the supply and disposition balances of beef and livestock meat products. The export market reduction required is determined based on the duration of the expected trade embargo. Domestic production is also adjusted according to the supply and disposition balance. Unit disposal costs are based on values determined by Ekboir (1999), augmented with actual values spent in the United Kingdom (UK) outbreak, adjusted to Canadian conditions.

Feed disposal costs: Cost estimates of disposing of excess feed are calculated based on the amount industry has scaled back, using industry and Ekboir (1999) estimates. The costs of feed disposal are used as a proxy for disposal of other animal products and by-products.

Direct economic loss: A measure of the direct economic loss is estimated based on the size of the industry scale-back requirements. An estimate of the market value of the different types of animals which would have to be disposed of, is provided for the pork and beef industries. While other sectors will incur costs, specifically the dairy industry, these are not included in the analysis. The economic loss represents a value relating to the future costs of

rebuilding the industry. Other direct economic impacts relate to the disposal of surplus feed and business disruption costs.

2.2.3 Indirect Primary Sector Impacts

These are the impacts on the input supply, trucking, and other rural industries which support the primary sector. Impacts are estimated using output multipliers obtained from simulations of the Statistics Canada National Input-Output Model.

2.2.4 Direct Processing Sector Impacts

The direct impacts on the processing sector are measured based on the annualized degree of scale-back required due to the exclusion from export markets. The analysis also considers changes in the net domestic demand. The direct impact is based on the economic value of this reduction. In addition to the direct revenue loss due to a scale-back, additional direct costs are included with respect to the need to dispose of surplus processed products. The estimates separate processing capacity in eastern and western Canada, and pork and beef products.

2.2.5 Indirect Processing Sector Impacts

Indirect processing sector impacts consider the effects of a FMD outbreak on the processing sector supply chain. This would include players in the paper products, transportation and logistics, financial services, and other related industries.

2.2.6 Trade Opportunity Costs

A major component of the economic impacts of a FMD outbreak relate to the trade that is lost during the restricted period, in addition to the reduction in trade, from current levels, once the restrictions are lifted. The first year's trade impact is already included as the major part of the processing sector's direct impact. As a result, the trade opportunity cost estimate represents the cost of the subsequent series of annual losses from the end of year one, until a more normalized trading pattern resumes.

Trade opportunity costs are calculated by quarter, and are based on the difference between the current level of beef, hog, and dairy export products, and the actual level of trade recovery over the future years after the lifting of the trade embargos. The model is sensitive to both trade from eastern and western Canada, and the duration of the FMD restricted

period, and the rate of recovery after the lifting of embargos. The model is also dynamic to trade within the North American marketplace and the rest of the world.

2.2.7 Tourism and Other Economic Impacts

Tourism impacts were identified based on the experience in the UK, where it was estimated that these impacts were greater than the direct economic impacts on the agricultural sector.

Direct tourism impacts: These impacts are based on the scale of the Canadian tourism industry, and how it is structured between western and eastern Canada, and domestic and international tourism. The direct impacts are determined from estimates of the percentage impact on the current levels of tourism revenue in eastern and western Canada respectively. The analysis recognizes the fact that 78% of the value of international tourism is generated with the US. The coefficients used in the Australian study² were in the order of 2%, but have been rejected as being low given the specific nature of Canada's tourism sector. The UK tourism impacts were extremely high, however, much of the tourism in that country is directly integrated with the rural economy. As a result, the estimates used in this study are balanced between the levels used in Australia and those from the UK experience.

Other indirect economic impacts: A measure of the indirect impacts of an outbreak on other sectors of the Canadian economy was determined through the use of the Statistics Canada National Input-Output Multipliers.

Employment impact: Although included in dollar terms within the economic impact analysis, a subsequent analysis was completed on the direct and indirect employment impacts (number of people) of a FMD outbreak.

2.2.8 Economic Gains From a FMD Outbreak

It is also necessary to quantify any potential positive economic benefits a FMD outbreak may have on the Canadian economy.

² Productivity Commission, Impact of Foot and Mouth Disease Outbreak on Australia, Research Report, 2002.



Consumer surplus gains: This measure of consumer benefit (consumer surplus) is related to the added capacity of consumers to purchase meat products assuming a price reduction occurs. A fall in retail meat prices, particularly beef and pork, increases the purchasing power of consumers. They can take that saved portion of their meat food dollar, and spend it either on additional lower-priced meat or on other consumer goods.

Other gains: There are other possible gains from a FMD outbreak. These have not been included in this report, but include the positive impacts on investment and employment as the sector rebuilds during the recovery phase. Other possible gains include substitution effects on other livestock production and consumption sectors. The estimates of consumer gains partially capture these impacts.

2.3 SCENARIO APPROACH AND ASSUMPTIONS

The analysis includes simulations of outbreaks at three different levels, to reflect major economic assumptions. A diagrammatic overview of this process is presented in Figure 2.3. This representation illustrates a number of important factors about the

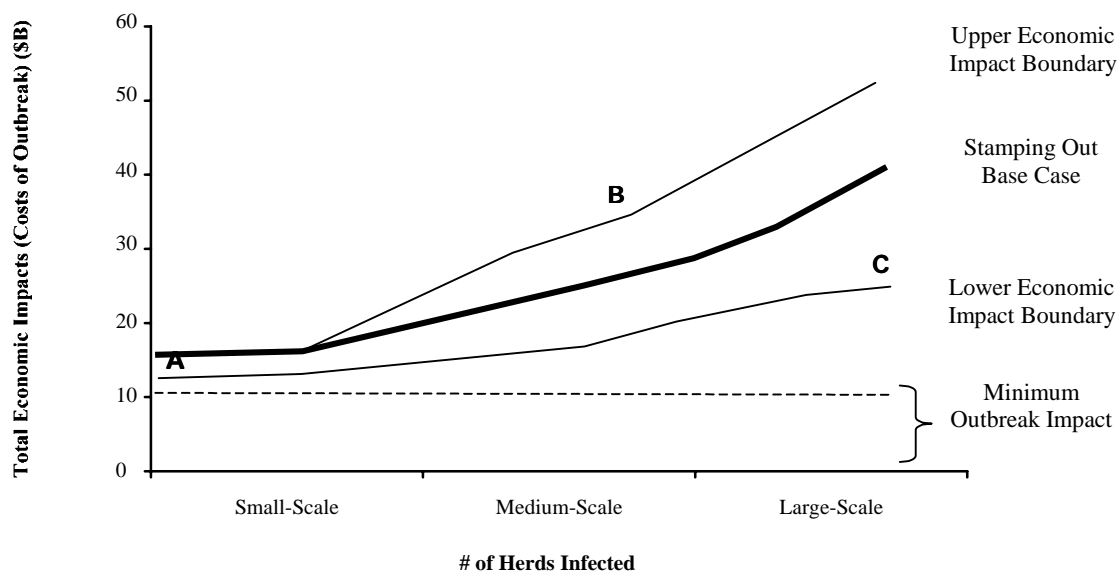
ultimate impact of a disease outbreak. These are as follows.

There is a minimum level of outbreak impacts, regardless of initial outbreak size: The economic impact analysis, validated with the qualitative analysis conducted, clearly indicates that the moment Canada has a single infected animal, there is a significant fixed cost associated with the disease. This is represented in the figure as point “A”, and is approximately \$13.7 billion.

The progression of impact levels is not smooth: While any level of outbreak is sure to cause a significant impact on the livestock industry and society as a whole, there is a point beyond which costs begin to climb significantly. This point occurs when the outbreak extends long enough to force radical and permanent changes to the current industry structure.

There are factors that can have a significant impact on outbreak impact levels: The analysis clearly illustrates that certain activities can have a positive or negative effect on impact size. Figure 2.3 clearly illustrates that with the appropriate circumstances, effective zoning, and control measures, a large-scale outbreak can in fact cause less damage than a medium-scale outbreak (point “C” < point “B”).

Figure 2.3
Overview of Outbreak Progression and Scenario Analysis



2.3.1 Specific Scenario Development Factors

The economic analysis involves a series of different scenarios at each outbreak scale, reflecting economic assumptions. Tables 2.1, 2.2, and 2.3 summarize the relevant variables.

A total of eight different scenarios are evaluated under the three outbreak size categories. Each of the three size categories has a base case scenario in addition to at least one alternative scenario that measures the economic impact of zoning. There are two scenarios for the small-scale outbreak, three under the medium-scale outbreak, and three under the large-scale outbreak.

As discussed in the previous chapter, there are a number of factors that can impact the ultimate size of the impact from the model's perspective:

Duration (months): This reflects the time that has elapsed between the first diagnosis and the last animal being detected and stamping out applied. It reflects the earliest point at which the OIE would initiate the three month waiting period prior to declaring Canada to be FMD-free without vaccination.

Infected herds: This reflects the total number of herds in which the disease was found during the outbreak period.

Trade embargo (various trading partners): A FMD outbreak results in a closure of the border to exports with all trading partners. There are two components that affect the term of this closure. The first relates to the period of time until the OIE deems Canada to be FMD-free again, and the second relates to a political decision on the part of the trading partner. As defined in the model, the trade embargo period includes both of these components and is broken into two regions of the world, North America (NA) and the rest of the world (ROW). For example, if the duration in a specific scenario is defined to be 1.5 months and the Trade Embargo (to all countries) was set at 4.5 months, this means that trade commenced immediately after the OIE declared Canada to be FMD-free. It is important to note trade embargo periods can vary within a single scenario by region (NA vs ROW). This variance is a result of having a better trading relationship with one partner, or having negotiated agreements in advance of a disease outbreak, outlining the nature of the zone definition.

In cases where zoning is recognized, it may be that the trade embargo period is actually less than the duration as previously defined for specific regions within Canada.

Trade recovery rate (TRR) (%): The model makes the assumption that the resumption of historical/normal trade levels occurs over an extended period of time after the trade embargo is lifted. The figure provided under this category represents a compound annualized percentage of trade resumption based on historical trade levels within the specific geographic regions. As in the case of the Trade Embargo period, the TRR may vary by geographic region under certain circumstances.

Period until full trade recovery (years): This factor provides the summary of the amount of time that it would take under a given scenario, to get trade levels back to where they were prior to the FMD outbreak. This figure includes the time already allocated for duration and trade embargos in addition to the amount of time that would be required per the specific TRR relevant to the scenario.

Tourism impact (%): Tourism impacts are measured based on current tourism patterns. The impact is measured as a percentage change from current levels. The figures range from a low of 5% to a high of 20%, representing the impacts felt/estimated in other regions that have had FMD.

Change in beef/pork prices (%): This figure provides an estimate of the relative change in beef/pork prices due to the FMD outbreak on a quarterly basis for a period of one year. It is important to understand that the figure represents the quarterly average price change. While there are likely to be more extreme changes within the initial period after the outbreak, the average change for the initial entire three-month, and following period(s), is assumed to begin to adjust to the rationalization of industry production as defined by the model. In other words, the more significant the outbreak, the larger the adjustment in the number of farmers impacted, ultimately leaving fewer producers to provide for domestic consumption, which would in turn have an impact on price. The price reduction is from the current market price. An important reference point is with respect to the fall in hog prices in the Taiwan outbreak. The magnitude of the hog price fall was in the range of 60%. In this Canadian analysis, hog prices are projected to fall by a similar amount in the large-scale outbreak.

Change in beef/pork consumption (%): This figure provides the estimate of the relative change in domestic beef/pork consumption due to the FMD outbreak on a quarterly basis for a period of one year from commencement of the outbreak.

Meat import change (%): Not all of the impact of a FMD outbreak would be shouldered by the domestic industry. The literature review analysis suggests that imports would also be affected by the outbreak of a contagious disease in the livestock agriculture sector. This figure represents the percentage change in the imports of meat products during the first year after the outbreak occurs. This figure is adjusted back to normal levels per the trade recovery rate in the specific scenario.

It is important to emphasize that the analysis has been organized to observe the marginal differences in the impact of the outbreak from one with a relatively small impact, to one with an extremely large impact. However, a sensitivity analysis has been provided for the main variables to address specific questions within a single outbreak size category. For example, there may be a question regarding the fact that pork prices, under the small-scale outbreak, only decline by a maximum of 25% in the base case. The sensitivity analysis allows the reader to estimate the impact of a different level of price changes on the NEI.

2.3.2 Small-Scale Outbreak

There are two scenarios modeled under the small-scale outbreak scenario: a base case, and an alternative case scenario measuring the impact of a zoning strategy. The specifics of each scenario can be observed in Table 2.1. The main difference relates to assumptions regarding the reduced time out of the market under the zoning strategy.

Under the small-scale outbreak base case scenario, the assumption is that there is immediate world/North American recognition of Canada's FMD-free status and thus, Canada would be completely out of the export market for only a total of 4.5 months, and back to historical levels in a period of 2.9 years. Under the zoning simulation, it is assumed that after one month, the trade embargo with the North American trading partners is lifted for the disease-free portion of Canada, in this case eastern Canada. The trade embargo for other export markets is assumed to remain for 4.5 months.

Table 2.1
Small-Scale Outbreak Assumptions

	Base Scenario	Zoning Case
	Stamping Out	
Duration (mo)	1.5	1.5
Infected Herds	50	50
Trade Embargo NA (mo)	4.5	1.0
Trade Embargo ROW (mo)	4.5	4.5
Trade Recovery Rate (%)	36	36
Period until full Trade Recovery (yrs)	2.9	2.9
Tourism Impact (%)	5	5
Quarterly Change in Beef Price	-25,-10,0,0	-10,-5,0,0
Quarterly Change in Pork Price	-25,-10,0,0	-10,-5,0,0
Quarterly Change Beef Consumption	-20,-10,0,0	-10,-5,0,0
Quarterly Change Pork Consumption	-20,-10,0,0	-10,-5,0,0
Meat Import Change %	-10	-50

2.3.3 Medium-Scale Outbreak

A total of three scenarios were identified and modeled in this outbreak scale category. In the base scenario, Canadian product is totally out of the export market for 6.5 months, and recovers at a rate of 22%, resulting in a 4.2 year period of disrupted trade.

The other two scenarios incorporated the effects of a zoning strategy. In both of these, certain regions in Canada (east of Manitoba) are able to access the North American market in three months vs. 6.5 months for the rest of the country. Access to the ROW is restricted to a 6.5 month period in both cases for all regions. The trade recovery rate is also higher for the NA market (36%) than that experienced in the ROW (22%). The main difference between the two scenarios is the fact that in the more optimistic scenario, the fall in beef/pork prices and domestic consumption are smaller.



Table 2.2
Medium-Scale Outbreak Assumptions

	Base Case Stamping Out	Stamping Out, Zoning	Stamping Out, Zoning, Optimistic
Duration (months)	3.5	3.5	3.5
Infected Herds	325	325	325
Trade Embargo NA (months)	6.5	3.0	3.0
Trade Embargo ROW (months)	6.5	6.5	6.5
Trade Recovery Rate NA/ROW(%)	22	36/22	36/22
Period until full Trade Recovery NA/ROW(yrs)	4.2	2.75/4.1	2.75/4.1
Tourism Impact (%)	12%	12	12
Quarterly Change in Beef Price	-35,-15,-5,0	-35,-15,-5,0	-20,-7,0,0
Quarterly Change in Pork Price	-35,-15,-5,0	-35,-15,-5,0	-20,-7,0,0
Quarterly Change Beef Consumption	-20,-10,0,0	-20,-10,0,0	-10,-5,0,0
Quarterly Change Pork Consumption	-20,-10,0,0	-20,-10,0,0	-10,-5,0,0
Meat Import Change %	-10	-10	-10

2.3.4 Large-Scale Outbreak

A total of three scenarios are modeled under the large-scale outbreak category (Table 2.3). Under the base scenario, the trade embargo period is estimated to be 10 months, with a recovery rate of 13%. It should be noted that the ten-month period includes a one-month period when Canada's trading partners do

not immediately recognize OIE provisions. This results in Canada facing a total of 6.8 years before complete recovery. The beef/pork price declines and domestic consumption figures are also extreme at a maximum of 50%, 60%, and 30% respectively. Pork prices are estimated to fall further due to the fact that exports are more important to the pork industry.

Table 2.3
Large-Scale Outbreak Assumptions

Control Strategy	Base Case Stamping Out	Stamping Out, Zoning	Stamping Out, Zoning (Can/US)
Duration (months)	6	6	6
Infected Herds	1500	1500	1500
Trade Embargo N/A (months)	10	3	1
Trade Embargo ROW (months)	10	10	10
Trade Recovery Rate NA/ROW (%)	13	22/13	22/13
Period until full Trade Recovery NA/ROW (yrs)	6.8	4.35/6.8	4.3/6.8
Tourism Impact (%)	20	20	20
Quarterly Change in Beef Price	-50,-30,-10,0	-50,-30,-10,0	-50,-30,-10,0
Quarterly Change in Pork Price	-60,-35,-10,0	-60,-35,-10,0	-60,-35,-10,0
Quarterly Change Beef Consumption	-30,-10,-5,0	-30,-10,-5,0	-30,-10,-5,0
Quarterly Change Pork Consumption	-30,-10,-5,0	-30,-10,-5,0	-30,-10,-5,0
Meat Import change %	-10	-10	-10

As with the medium-scale outbreak, there are two separate zoning strategies tested. Under the first, the disease is confined to western Canada and a disease-free zone is created in eastern Canada. Exports from this eastern zone commence recovery to the NA market after three months. No exports are sent from any zone of Canada to the ROW for 10 months. The recovery rates are forecast to be higher in NA (22%) than in the ROW (13%), resulting in a 4.4 year period of export disruption in trade within NA and a 6.8 year disruption with the ROW.

The assumptions under the second zoning scenario are the same as the first, with the exception that the trade embargo with NA is reduced to one month for eastern Canada. This is consistent with the zoning experiences faced by both Italy in 1993, and Greece in 1994, when FMD-free zones were recognized within one month and dependent on Canada having an equivalent FMD agreement to that in the EU.³ This has the impact of reducing the effective period of recovery to 4.3 years for NA trade, with no change for the ROW. This scenario would likely be the result of a NA-wide outbreak where trade agreements have been pre-established, otherwise this one month period, in reality, would likely be too short.

The next two chapters of the report focus on empirical results of the NEI analysis. The outcomes for each of the scenarios are presented and compared in Chapter 3. Chapter 4 presents a summary of the secondary impacts on the primary and processing sectors, and provides a micro-economic analysis of outbreak impacts.

³ Garner et al., 1997.

3.0 ECONOMIC IMPACT ANALYSIS

3.1 ECONOMIC IMPACT RESULTS

3.1.1 Small-Scale Outbreak

The small-scale outbreak represents an industry consensus as to the minimum costs and impacts that a FMD outbreak would have on the Canadian economy. The small-scale outbreak is represented with a base case scenario and base case with a zoning strategy in place. The assumptions used in these scenarios are outlined in Table 2.1, Chapter 2. Results are summarized in Table 3.1 and Figure 3.1.

Under the small-scale outbreak, 50 infected herds are detected over a six week period. Canada is completely out of the export markets for a period of 4.5 months, reflecting the duration of the infected period and the additional minimum three-month waiting period as prescribed by OIE.

The beef and hog sectors are forced to contract by 20% and 18% respectively in the base case. This adjusts to 10% and 13% under the alternative case scenario.

A total of 10,244 infected animals are slaughtered. Domestic prices of beef and pork are assumed to drop by 25% from the pre-outbreak levels in the first three months. They recover to 10% below pre-outbreak levels in the second half of the year, and fully recover in the third quarter.

Consumption of both beef and pork is assumed to drop by 20% in the first quarter, by 10% in the second quarter, and fully recover by the third quarter. The estimated drop in demand for beef and pork was based on input from stakeholder consultations, in addition to the experience from other outbreaks. In Taiwan, pork prices declined by 60%, and in other countries by lesser amounts⁴. A more conservative estimate is used in the small-scale outbreak scenario, but is adjusted for the large-scale outbreak scenario.

⁴ T.Wilson, C. Tuszyński, Foot and Mouth Disease in Taiwan, 1977 Overview, Emergency Programs and CEAH:VS-APHIS-USDA

3.1.1.1 Results

The total NEI ranges from \$13.7 to \$8.3 billion for the base and zoning scenarios respectively. Approximately \$4 billion of the impact is due to the future trade losses in the base case, and \$1.2 billion in the zoning scenario. It is important to recognize that this trade loss represents a minimum amount as Canada would be classified as having FMD even if only a single animal was diagnosed.

Direct and indirect primary sector losses are estimated at \$4.5 billion and \$3.2 billion in the base and zoning scenarios respectively. Processing sector impacts vary between \$4.3 billion and \$3.3 billion in the base and zoning scenarios.

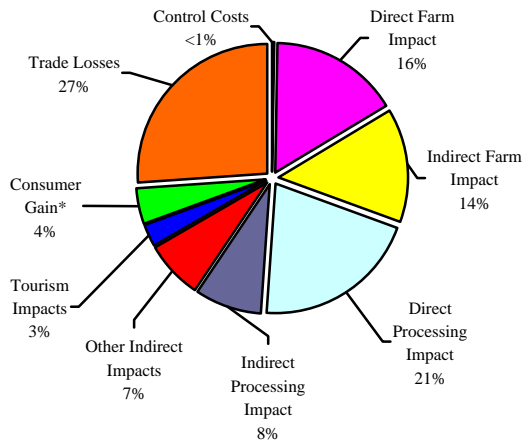
Table 3.1
Small-Scale Outbreak (\$ millions)

	Base Case	Zoning Case
Control Costs	30.7	30.7
Direct Farm Impact	2,430.9	1,713.1
Indirect Farm Impact	2,114.9	1,490.4
Direct Processing Impact	3,116.3	2,357.6
Indirect Processing Impact	1,246.5	943.1
Other Indirect Impacts	1,059.5	801.6
Tourism Impacts	450.8	450.8
Total Impacts and Costs	10,449.7	7,787.3
Consumer Gain	(659.3)	(659.3)
Initial Net Impacts	9,759.7	7,097.3
Trade Losses	3,915.3	1,207.1
Net Economic Impact	13,675.0	8,304.4
Infected Animal Disposal (# of animals)	10,224	10,224
Welfare Disposal (# of animals)	4,182,119	2,946,959
Total Livestock Disposal (# of animals)	4,192,343	2,957,183
Beef Sector Adjustment Factor	20%	14%
Hog Sector Adjustment Factor	18%	13%
Years to Full Trade Recovery	2.9	2.9

Non-agricultural sector impacts, including tourism and induced sector impacts, are estimated to range between \$1.5 and \$1.3 billion respectively for the base and zoning scenarios. These non-agricultural sector impacts represent about 10% of the total impacts in the small-scale outbreak scenario.



Figure 3.1
Small-Scale Outbreak: Relative Impacts of All Factors



*Consumer gain is a positive factor in the NEI calculation.

Approximately 4.2 million livestock will need to be slaughtered or otherwise disposed of in the base case. Under the zoning scenario, this number is reduced to 3.0 million animals.

3.1.2 Medium-Scale Outbreak

The medium-scale outbreak simulations represent the situations where the outbreak could not be contained. As a result, it is postulated that the initial infected herd(s) in Alberta had exported cattle/hogs to Manitoba for finishing or slaughter. This resulted in a cluster of infected herds in Manitoba, together with additional infected herds being found in Alberta. This results in a total of 325 herds becoming infected in two relatively localized areas in Alberta and Manitoba. Control areas are established in each of these provinces, and the detailed assumptions and characteristics of these scenarios are listed in Table 2.2, Chapter 2.

This scale of outbreak is evaluated with respect to a base case and two zoning strategies:

- **Base Case Simulation:** A traditional stamping out control strategy is applied, without a zoning strategy attempted. The period of time for which Canada is excluded from its export markets is estimated to be 6.5 months. This is a minimum exclusion period, reflecting the 3.5 month

outbreak duration, plus the OIE mandate of an additional three months. Pork prices are anticipated to fall by 35% in the first quarter, increasing to 15% in the second, and fully recovering in the third.

- **Zoning Simulation:** Under this simulation, the eastern zone of Canada is attempting to be designated as FMD-free. The zoning strategy is moderately successful in that it is recognized by the US and Mexico. It has to be assumed that Canada has made an investment in a zoning strategy in advance of the outbreak. The CFIA zoning document⁵ suggests that establishing an EIS and GPS supported traceback system for the industry could cost in the range of \$100 million. A more conservative estimate of \$75 million is used in this scenario. It is noted that EIS and GIS do not represent the only significant costs of zoning. The eastern zone of Canada is accepted as a FMD-free zone by the US and Mexico markets within a three month period (versus 6.5 months exemption period as in the base case). However, the remaining export markets do not recognize this zone and only begin to remove their restrictions after 6.5 months.

- **Zoning, Optimistic Conditions Scenario:** This scenario incorporates more optimistic assumptions with respect to the impact on domestic meat prices and consumption. The detailed assumptions can be observed in Table 2.2, Chapter 2.

3.1.2.1 Results

The detailed economic impact results for the various scenarios covered under the medium-scale outbreak are presented in Table 3.2. A summary of the results is presented below.

- NEI for the base case is estimated at \$24.9 billion, of which \$14.3 billion are initial net impacts, and \$10.6 are trade losses.
- The sectoral adjustment factors driving these economic losses vary from 15% for the optimistic zoning scenario, to 46% under the vaccination scenario.
- A total of 21% of the NEI is from the primary sector, 22% from the processing sector, and 40% related to trade loss. Tourism and other non-

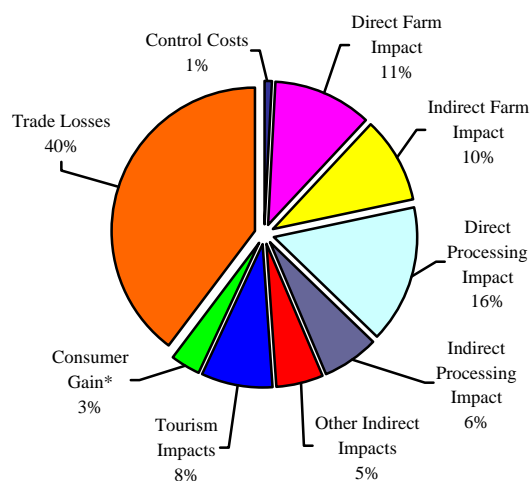
⁵ Dr. John Kellar, Zoning Canada, from Principle to Practice, Animal Disease Surveillance Unit, Science Division, CFIA, March, 2002.



agricultural impacts represent 13% of the total. Control costs only represent 1% of the total impact.

- ➡ The existence of an accepted FMD-free recognized trade zone within Canada is found to have a dramatic impact on reducing the overall impacts of a medium-scale outbreak. The zone results in a reduction of the NEI from \$25 to \$18 billion, or 28%. This suggests that the investment of an estimated \$75 million in preparing the sector for a zoning strategy would have an impact of \$7.0 billion, representing an excellent return on investment. This estimate of zoning costs may be low due to additional costs of zoning – enforcement of zone borders by appropriate official veterinary control and surveillance within and external to zone.
- ➡ The zoning scenario with more optimistic assumptions reduces the NEI by an additional \$1.5 billion.

Figure 3.2
Medium-Scale Outbreak, Relative Impacts of All Factors



*Consumer gain is a positive factor in the NEI calculation.

Table 3.2
Medium-Scale Outbreak (\$ millions)

	Base Case	Zoning	Zoning, Opt
Control Costs	224.6	299.6	299.6
Direct Farm Impact	2,977.4	2,226.4	1,754.9
Indirect Farm Impact	2,590.4	1,936.9	1,526.7
Direct Processing Impact	4,142.1	3,235.3	2,664.1
Indirect Processing Impact	1,656.9	1,294.1	1,065.6
Other Indirect Impacts	1,408.3	1,100.0	905.8
Tourism Impacts	<u>2,164.0</u>	<u>2,164.0</u>	<u>2,164.0</u>
Total Impacts and Costs	15,163.7	12,256.2	10,380.8
Less Consumer Gain	<u>(854.9)</u>	<u>(854.9)</u>	<u>(443.1)</u>
Initial Net Impacts	14,308.8	11,401.4	9,937.7
Trade Losses	<u>10,576.1</u>	<u>6,566.5</u>	<u>6,566.5</u>
Net Economic Impact	24,884.9	17,967.9	16,504.2
Infected Animals Disposal (# of livestock)	66,454	66,454	66,454
Welfare Disposal (# of livestock)	<u>5,852,291</u>	<u>4,375,808</u>	<u>3,456,083</u>
Total Animal Disposal (# of livestock)	<u>5,918,745</u>	<u>4,442,262</u>	<u>3,522,537</u>
Beef Sector Adjustment Factor	28%	21%	16%
Hog Sector Adjustment Factor	26%	19%	15%
Years to Full Trade Recovery	4.2	2.75/4.1	2.75/4.1
Years Trade Exclusion	2.36	0.80	0.80

- The number of animals which would have to be disposed of varies from 3.5 million under the most optimistic zoning scenario, to nearly six million for the base scenario. In either case, the vast majority of animals slaughtered would be classified as welfare slaughter.

3.1.2.2 Sensitivity of Results

It is important to evaluate the impacts of critical assumptions on these outcomes. One important assumption made is the extent to which Canada is able, or willing, to restrict imports as a mechanism to protect the domestic industry. For the above results, it has been assumed that imports would be reduced by 10% from pre-FMD outbreak levels. Table 3.3 illustrates a comparison of a range of import reductions on the NEI of the medium-scale base case simulation.

Table 3.3
Impact of Changing Import Restrictions of FMD
Economic Outcomes

Restriction on Imports	Net Economic Impact \$ millions	\$ Change \$ millions	% Change
90%	21,125.1	4,275.0	16.8%
50%	23,005.1	2,395.0	9.4%
0%	25,400.1		

This table suggests that a 90% reduction of meat imports would have a \$4.3 billion net reduction of the negative economic consequences of an outbreak. This represents a 17% reduction in NEI. Imports of beef (in volume terms) represent 26% of Canadian production in 2001. In the hog sector, imports as a percentage of production were less, at about 5%. It is recognized that it would be difficult to justify limiting imports due to Canada's international trade obligations, but voluntary domestic substitution would ultimately have the same impact. This suggests that a well-planned media campaign might be of significant value to the industry.

3.1.3 Large-Scale Outbreak

This set of FMD outbreak simulations is based on the premise that the infected herds from the medium-scale outbreak could not be contained. As a result, infected animals are detected in most of the livestock-producing regions of Canada. In the zoning scenario below, it is assumed that infected animals are restricted to only western Canada. A total of

1,500 herds are detected as being infected with FMD. The outbreak duration is estimated to be six months.

Within this large-scale outbreak, three related and comparative simulations have been evaluated.

- **Base Simulation:** Stamping out is identified as the main control strategy under this scenario. The trade embargo is estimated to be ten months. This includes the six-month outbreak period, the minimum three-month OIE regulated period, and an additional month in anticipation of the reluctance of trading partners to accept Canadian product after being declared FMD-free by the OIE.
- **Zoning Scenario:** Under this scenario for the large-scale outbreak, it is assumed that infected herds are confined to western Canada, and that Canada has an effective livestock traceback system. As a result, Canada creates a FMD-free zone in eastern Canada. The zoning is found to be effective and trade in the FMD-free zone resumes within three months, but the ten-month embargo remains for western Canada.
- **Canada-US Free Trade Zone:** This scenario assesses the impact of Canada establishing a joint FMD-free trade zone strategy with the US in advance of an outbreak. The simulation assumes that this zone becomes effective for the eastern region of Canada. Trade within this region is assumed to be disrupted for one month. This period of one month is based on the establishment of a zone between Canada and the US in advance of an outbreak.

3.1.3.1 Results

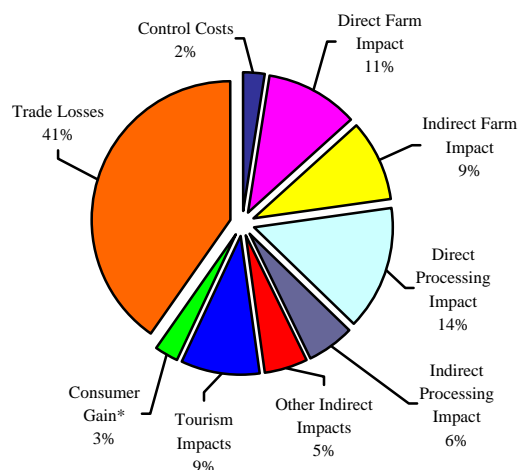
The detailed results are presented in Figure 3.3 and Table 3.4.

- For the base simulation, a trade embargo period is limited to ten months, the total impacts are estimated at \$46.0 billion. A total of \$26.4 billion are initial net impacts, and \$19.6 billion are trade losses.
- The beef and hog sector adjustment requirements are a contraction of 51% and 45% respectively for the base case, that drops to between 17% and 19% under the zoning scenarios.
- The overall impacts are reduced substantially under the conventional zoning program to \$25 billion from the base case scenario of \$46 billion



(46%). The main factor behind this reduction is the reduced need for the primary and processing sectors to contract.

Figure 3.3
Large-Scale Outbreak Impacts of All Factors



* Consumer gain is a positive factor in the NEI calculation.

Table 3.4
Large-Scale Outbreak (\$ millions)

	CAN/US		
	Base	Zoning	Zoning
Control Costs	1,207.3	1,282.3	1,282.31
Direct Farm Impact	5,288.9	2,433.7	2,027.69
Indirect Farm Impact	4,601.4	2,117.3	1,764.09
Direct Processing Impact	6,937.9	3,485.9	2,995.66
Indirect Processing Impact	2,775.2	1,394.4	1,198.26
Other Indirect Impacts	2,358.9	1,185.2	1,018.52
Tourism Impacts	4,508.3	4,508.3	4,508.33
Total Impacts and Costs	27,677.9	16,407.1	14,794.88
Less Consumer Gain	(1,300.0)	(748.1)	(748.10)
Initial Net Impacts	26,377.9	15,659.0	14,046.8
Trade Losses	19,565.9	10,730.3	10,730.29
Net Economic Impact	45,943.8	25,182.0	23,569.75
Infected Animal Disposal (# of livestock)	400,607	400,607	400,607
Welfare Disposal (# of livestock)	10,316,048	4,782,443	3,984,387
Total Animals Disposal (# of livestock)	10,716,655	5,183,050	4,384,994
Beef Sector Adjustment Factor	51%	23%	19
Hog Sector Adjustment Factor	45%	21%	17%
Years to Full Trade Recovery	6.8	4.4/6.8	4.3/6.8
Years Trade Exclusion	3.42	1.31	1.31

When a pre-established zone between Canada and the US is considered, the overall impacts are reduced by 49% from the base scenario to an estimated \$23.6 billion.

In all the large-scale outbreak scenarios, large numbers of animals would be disposed of, principally due to the need for welfare slaughter on farms. The number of livestock in this category ranges from 5 million to 10.7 million. This is higher than the UK experience, where four million were slaughtered for disease control reasons, and an additional 2.6 for welfare disposal reasons, totalling 6.6 million head.⁶

3.2 COMPARATIVE SUMMARY RESULTS

The following figures provide a comparison of the results of the various scenarios. Figure 3.4 summarizes the NEI for each of the scenarios within each of the three outbreak size categories.

The NEI varies from a minimum of \$8.3 billion in the small-scale zoning scenario to \$46 billion in the large-scale base case. Dramatic reductions in NEI are observed in the medium- and large-scale outbreaks, particularly if Canada plans in advance, and has the ability to establish an internationally-recognized FMD-free trade zone.

Figure 3.4 provides a relative comparison of the total economic impacts across all scenarios compared to the small-scale outbreak base case. The most important result is that there is considerable cost variability, and opportunity to influence and control the costs of an outbreak. The impacts of an outbreak are found to vary by as much as 280% from the small-scale outbreak impact.

Figure 3.5 provides a measure of the absolute dollar variability of impact from the small-scale outbreak base case. The range of impact variability ranges from \$5.4 billion in the small-scale outbreak with zoning, to \$11.2 billion in the medium-scale outbreak without zoning, and to \$32 billion in the large-scale outbreak without zoning.

⁶ DEFRA and DCMS (2002). Other estimates in the UK have been as high as 8 million to 10 million head.



Figure 3.4
Relative Comparison of the Total Economic Impacts Across all Scenarios Relative to the Small-Scale Outbreak Base Case

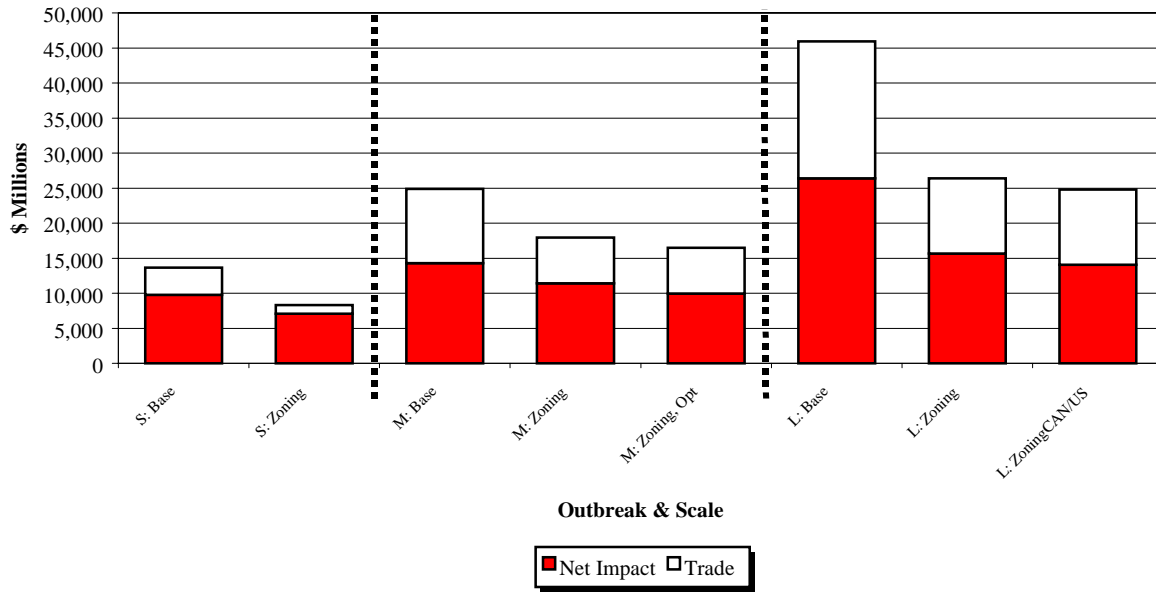
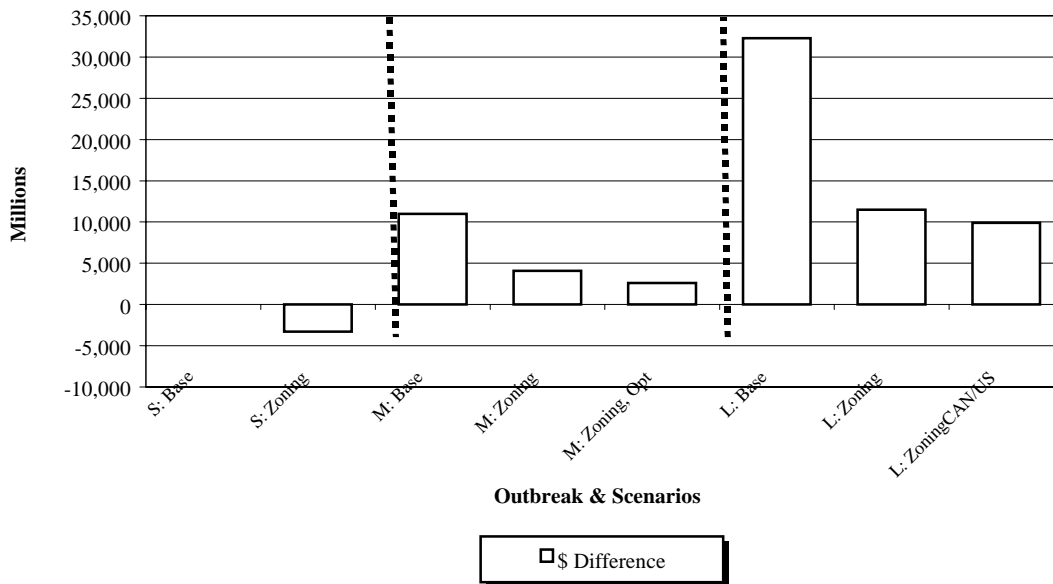


Figure 3.5
Impact Variance From Small-Scale Outbreak



3.3 IMPACT OF RESPONSE TIME ON CONTROL AND DISPOSAL COSTS AND NEI

3.3.1 Pattern of Costs and Impacts Over a Six-Month Outbreak Period

An effective disease response strategy has the capacity to respond in a timely and effective manner once an initial infected animal has been detected.

A special series of simulations was done based on an outbreak growth pattern, which measured control and disposal costs, and NEI. The outbreak is simulated to expand over a six-month period, during which time the number of infected herds accelerates and then declines within a prescribed distribution, regardless of the control measure employed.

The resultant control and disposal costs, net impacts, and trade losses are reported for this period (Table 3.5). One important result is the pattern by which control and disposal costs increase. After a steady rate of increase in the first two months of the six-month outbreak period, these costs accelerate

dramatically as the outbreak expands. If the infected herds are prevented from expanding beyond 300 herds, the control and disposal costs can be kept below \$100 million. After the outbreak has passed this threshold, these costs accelerate, and can exceed \$1.0 billion. This pattern of cost expansion is best illustrated in Figure 3.6, showing the average daily control and disposal cost being accumulated as the outbreak period extends.

The initial net impacts and estimated trade losses have a different profile. Immediately upon the determination of a single positive FMD-infected animal, the livestock industry, and Canada, face a huge fixed cost. Canada will know immediately that the agriculture livestock exporting sector will be out of the markets for a three- to six-month period, and cannot expect a full trade recovery for at least another one to two years. This high fixed cost is indicated by the initial net impacts of \$9 billion, and trade losses of \$3.9 billion within the first month, even if the disease could be completely controlled and eradicated within this short period. A comparison of the relative change between the initial net impact and trade impacts over time can be observed in Figure 3.7.

Table 3.5
Response Time Impacts

Epidemiology of Outbreak							
Outbreak Period (months)	1	1.5	2	3	4	5	6
Projected Detection Rate (%)	4	10	18	25	23	15	5
Infected Herds, Cumulative (#)	60	210	480	855	1200	1425	1500
Costs and Impacts							
Control and Disposal Costs (\$m)	27	110	190	740	1300	1900	2300
Net Economic Impacts (\$B)	8.9	9.7	10.6	12.4	14.4	16.5	18.7
Trade Impact (\$B)	3.9	3.9	4.2	8.2	11.5	15.6	19.5
Time to Full Trade Recovery (Qrts)	9	10	11	12	13	14	15
Average Cost of control and disposal per day (\$m)							
	0.90	2.44	3.17	8.22	10.83	12.67	12.78
Average Initial Net Impacts/day (\$m)							
	296.67	323.33	353.33	413.33	480.00	550.00	623.33
Average Trade Impact (\$m)							
	130.00	130.00	140.00	273.33	383.33	520.00	650.00
Relative Change in Costs and Impacts (Index)							
	1	1.5	2	3	4	5	6
Control and Disposal	100	407	704	2741	4815	7037	8519
Net Economic Impacts	100	109	119	139	162	185	210
Trade Impacts	100	100	108	210	295	400	500

Figure 3.8 shows the relative changes in the growth of initial net impacts and trade costs over this outbreak period. Over the first several months of the outbreak, both these impacts rise at about the same rate. After this period, while the net economic impacts rise at a more constant rate, trade losses accelerate.

Figure 3.6
Average Cumulative Cost of Control and Disposal/Day

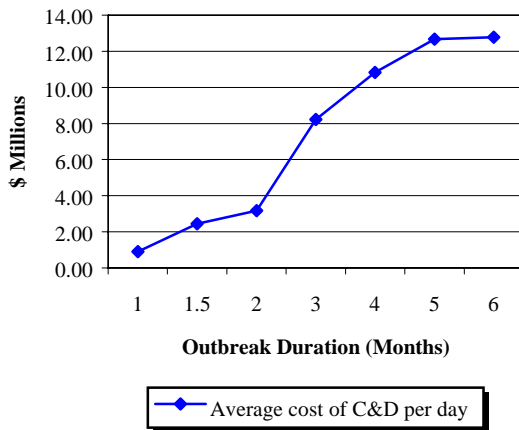


Figure 3.7
Relative Change in Costs, Impacts in Outbreak Period

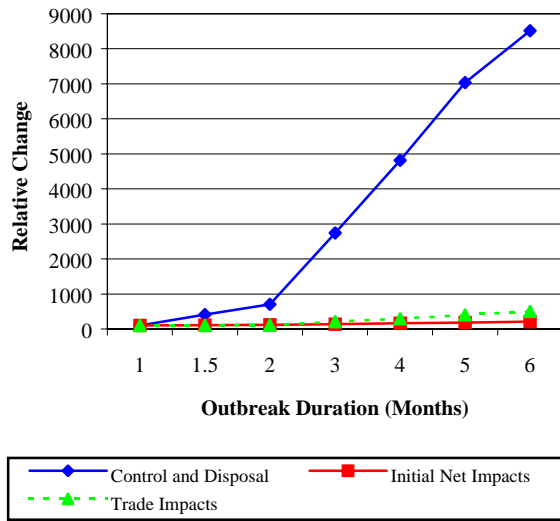
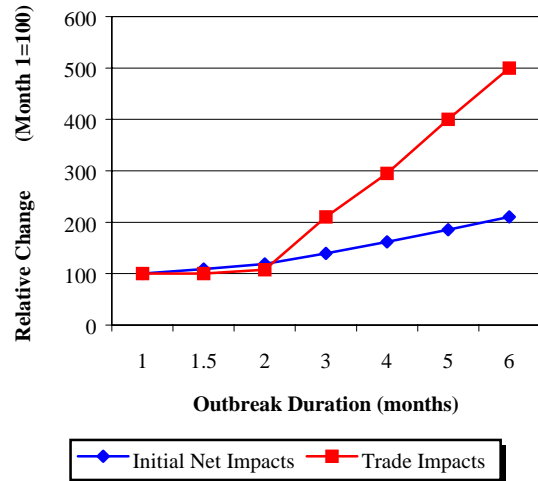


Figure 3.8
A Comparison of Relative Change Between the Initial Net Impact and Trade Impacts Over Time



3.4 SENSITIVITY ANALYSIS

A sensitivity analysis has been completed to analyze the relative impacts of some of the more important assumptions used.

The medium-scale base case scenario has been used as the basis and the sensitivity has been performed for the following variables and assumptions:

1. An increase in the trade recovery rate to a compound annual rate of 36%, versus the 22% used in the base scenario.
2. A reduction in meat consumption by 10% versus 20% in the base case.
3. A decline in consumer beef and pork prices by 25% and 5% in the first two quarters, versus 35% and 15% in the base case.
4. A reduction in imports by 20%, versus the 10% used in the base scenario.

The results of this analysis are presented in Table 3.6. The upper third of the table presents the actual dollar value of the respective sensitivity simulations. The middle third of the table presents the percentage change each sensitivity assumption has made. The bottom third of the table presents the absolute change resulting from a change in the assumption.



The most sensitive assumption in the model is the trade recovery rate. Increasing this rate from 22% to 36%, results in a total reduction in the total trade and economic impacts of about 21%. This change resulted in a reduction of impacts of \$5.3 billion.

The next most sensitive variable in the analysis is the impact of domestic consumption. Improving the rate of domestic meat consumption by ten percentage

points results in a reduction in overall impacts of almost 9% or \$2.1 billion. Any strategy to maintain domestic consumption of meats will pay handsome dividends to the agricultural sector.

Changes in domestic prices do not have a great impact on the overall economic impacts. The primary impact is to provide consumer and retailer benefits.

Table 3.6
Sensitivity Analysis of Selected Assumptions
(*\$ millions*)

	Base Case Results	10% Less Reduction in Meat Consump.	10 Percentage Points Less <i>Price Reduction</i>	Increase In TRR ²	Imports Reduced by 10 Points
Actual Dollar Value of Analysis					
Control Costs ¹	224.6	224.6	224.6	224.6	224.6
Net Impact	14,308.8	12,269.2	14,554.7	14,308.8	13,838.9
Trade Loss	10,576.1	10,576.1	10,576.1	5,331.7	10,576.1
Net Economic Impact	24,884.9	22,845.3	25,130.8	19,640.5	24,415.0
Percentage Change From Base Case					
Control Costs ¹	0	0.00	0.00	0.00	0.00
Net Impact	0	-14.80	1.07	-0.64	-3.90
Trade Loss	0	0.00	0.00	-49.59	0.00
Net Economic Impact	0	-8.53	0.62	-21.36	-2.25
Absolute Change From Base Case (\$ millions)					
Control Costs ¹	0	0	0	0	0
Net Impact	0	-2,131.1	1,54.4	-91.5	-561.4
Trade Loss	0	0	0	-5,244.4	0
Net Economic Impact	0	-2,131.1	1,54.4	-5,335.9	-561.4

¹ Control costs included in Net Economic Impact

² TRR is Trade Recovery Rate

3.5 CONTROL AND ZONING STRATEGY MANAGEMENT

This analysis has provided levels of economic impacts for three major scales of FMD outbreaks, with the overall effectiveness of the control strategy declining from the medium-scale to the large-scale outbreaks, and with a zoning strategy applied in each case. While that control strategy consists of a number of different tactics, such as pre-emptive slaughter and vaccination, these were not evaluated. Nor was the effectiveness of these different tactics compared, one to the other.

The analysis does allow for an evaluation of the benefits of having effective control and zoning strategies. This section interprets the economic impact results in terms of the relative impacts of both an effective disease control and zoning strategy.

In principle, if Canada had well-prepared disease control and zoning strategies in place, while not necessarily preventing an FMD outbreak, they would significantly reduce the impacts of an outbreak on the Canadian economy.

An effective and responsible control strategy (technical capacity for early detection of infected animals, monitoring livestock movements, enhanced surveillance, the appropriate use of vaccination, pre-emptive slaughter, and effective collaboration between industry and government), will result in an accelerated reduction in new infected cases, leading to a shorter outbreak duration, and therefore lower direct and indirect costs to the industry and the nation's economy.

In the economic model, the large outbreak reflects the results of an only partially effective control strategy, with the number of new cases confirmed per week declining at a slow rate of 16% per week, a long outbreak period of six months, 1,500 infected herds, and a minimum of ten months time to regain disease-free status. The medium-scale outbreak represent the results which would likely be achieved under a relatively effective control strategy, in which the number of new cases declines at a rapid rate of 24% per week, resulting in only 325 infected herds, a short outbreak period of about 3.5 months, and 6.5 months to regain disease-free status.

In addition to optimizing the disease control strategy, if Canada had pre-established conditions leading to an early recognition of a FMD-free zone with its major trading partners, this would result in a reduction of impacts, primarily in lower trade losses.

Figure 3.9 measures the expected impacts of both an effective disease control and zoning strategy. It is implied that there is no control strategy which can prevent the base impact of \$7.0 billion as represented by the small-scale outbreak situation under zoning. From this point, the costs and impact on the sector and the Canadian economy will increase depending on the relative effectiveness of the control and zoning strategies applied. The movement from the base case position to a longer period of time to regain disease-free status, is primarily a function of the effectiveness of the control strategy, using either a 24% detection rate (relatively effective control strategy), or a 16% detection rate (less effective control strategy).

As the figure indicates, with no zoning, the lowest expected impact on the Canadian economy of a FMD outbreak is in the order of \$13.7 billion. This position would represent an extremely effective control strategy, and as well, good fortune. The economic impact will increase beyond this level depending on the effectiveness of disease control measures applied. If these measures are relatively effective (a 24% detection rate), the impact is expected to increase to a level of \$24.9 billion. If the control strategies are not effective (a 16% detection rate), the economic impact could increase to \$45.9 billion in the no zoning situation.

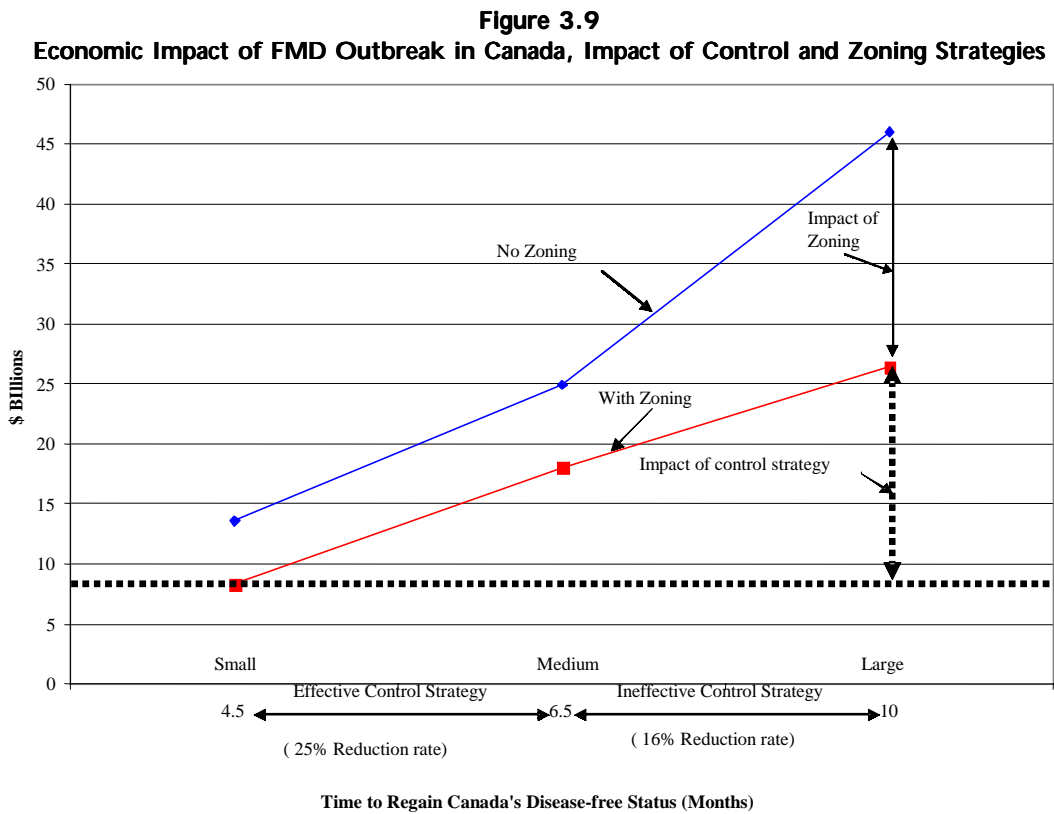
Under a situation where Canada is successful in establishing a FMD-Free zone, the lowest expected impact under ideal control conditions is \$8.3 billion. Under a relatively effective control strategy, the impact with zoning increases to \$18 billion, and under a less effective control strategy, the total economic impacts increase to \$25 billion.

In summary, the relative effectiveness of the disease control strategy could change the impacts on the Canadian economy from \$24.9 billion with relatively effective control (medium-scale outbreak) to \$45.9 billion with less effective control (large-scale outbreak), or a net amount of up to \$21.1 billion. As well, the potential gains from an effective zoning strategy could be as high as \$20.7 billion in the event



of a less effective control strategy (large-scale outbreak), and \$7 billion for a relatively effective control strategy (medium-scale outbreak).

Overall, the potential gains to having a very effective disease control strategy in place, concurrently with a successful zoning strategy, could reach as high as \$28 billion.



4.0 SECONDARY FINANCIAL IMPACTS

The purpose of this chapter is to look more closely at some of the micro-economic impacts of a FMD outbreak on the primary production and processing sectors. The analysis includes an assessment of the relative levels of income diversification and resulting financial risk faced by the beef and pork industries. A specific analysis of employment impacts and operational considerations is included, in addition to an analysis of the issue of financial compensation.

4.1 PRODUCTION SECTOR

The impact of FMD will not be uniform across producers within either the beef or hog sector. Different levels of investment and leverage have a significant influence on the ultimate impact of the outbreak. Industry consultations and financial theory suggest that highly-leveraged, larger, intensive livestock operations will be less able to hold animals in the event of a FMD outbreak and will be subject to greater risk.

The following analysis has been done to assess the impact of a FMD outbreak on farms with different revenue classes and debt structures. The investment and income structure profile of Canadian farmers is available from the Statistics Canada/Agriculture and Agri-Food Canada Whole-Farm Data Base⁷, and provided the base data for this analysis.

4.1.1 Financial Risk

A profile of the hog and beef production industries has been prepared (Tables 4.1 and 4.2). This profile provides a summary of total income by source, in addition to expenses, assets, and debts for the various revenue classes.

The following structural characteristics of these sectors are apparent:

- The top 3.5% of beef producers, as defined by gross revenue, generate 52% of the beef sector's total revenue (Table 4.1). The top 9% produce 64% of the sector's revenue and the top 29% produce 82% of the sector's revenue.
- Correspondingly, the largest 26% of hog producers generate 75% of the sector's revenue. This implies that the hog sector is slightly more concentrated.
- The average debt to asset ratio of beef farmers increases as the revenue class increases. At the highest levels of revenue (average over \$2.2 million per farm), the debt to asset ratio is .29. The next lower class falls significantly to .19.
- In the hog industry, the debt to asset ratios are higher for essentially all revenue classes, but importantly, are much higher for the higher revenue classes.
- This implies that the hog industry is more exposed to the risk of a FMD outbreak. A highly-leveraged farm operation has a much lesser capacity to hold on in the event of a required production cutback, given their higher relative levels of fixed costs.
- This implies that an FMD outbreak could quite likely result in the elimination of the small percentage of highly-leveraged but large operations, that would in turn permanently reduce the production capacity of the Canadian livestock industry.
- A graphical comparison (Figures 4.1 and 4.2) better illustrates the relative distribution of revenue and number of farmers for the beef and hog sectors.

⁷ Statistics Canada, Whole-Farm Data Base. This data base has detailed operating income, expense, asset and liability structure of Canadian farmers by provinces, by enterprise type, and revenue class, between 1988 and 2001.

Table 4.1
Canadian Cattle Farms' Financial Profiles¹

	\$10,000- \$24,999	\$25,000- \$49,999	\$50,000- \$99,999	\$100,000- \$249,999	\$250,000- \$499,999	\$500,000 and Over
Number of Farms	9,365	12,985	12,095	9,865	2,725	1,695
Operating Revenue						
Total Crop Revenue	2,863	6,724	12,818	27,320	50,887	140,769
Total Livestock & Product Revenue	13,046	26,557	52,654	112,195	264,333	1,893,255
Other Revenue	798	2,472	6,929	12,658	25,591	194,418
Total Operating Revenue	16,707	35,753	72,401	152,173	340,811	2,228,442
Operating Expenses						
Total Crop Expenses	1,484	3,249	6,567	14,199	27,082	62,018
Total Livestock Expenses	5,718	10,889	22,784	54,920	179,887	1,782,475
Total Operating Expenses	17,986	32,984	62,914	129,677	310,777	2,166,082
Net Operating Income	-1,140	2,847	9,680	22,495	31,458	62,360
Farm Assets						
Total Current Assets	11,771	24,127	36,931	95,413	238,063	945,406
Total Long-term Assets	304,922	370,557	522,308	821,202	1,304,094	2,193,064
Total Farm Assets	315,486	393,597	558,003	915,117	1,541,721	3,132,909
Farm Liabilities						
Total Current Liabilities	12,729	19,410	23,474	50,671	115,007	664,755
Total Long-term Liabilities	41,571	66,231	77,647	147,421	249,836	475,769
Total Farm Liabilities	39,025	65,434	86,404	162,055	300,215	924,085
Farm Net Worth	296,797	353,560	492,744	782,631	1,272,353	2,331,129
Debt to Asset Ratio	0.12	0.17	0.15	0.18	0.19	0.29
Gross Revenue	156,461,055	464,252,705	875,690,095	1,501,186,645	928,709,975	3,777,209,190
Gross Livestock Revenue	122,175,790	344,842,645	636,850,130	1,106,803,675	720,307,425	3,209,067,225
Percentage of Total	1.99	5.62	10.37	18.03	11.73	52.26
Percentage of Farmers	19.22	26.65	24.82	20.24	5.59	3.48
Probability of Business Failure	2.50	3.00	4.00	15.00	30.00	45.00
Expected Income Loss	3,911,526	13,927,581	35,027,604	225,177,997	278,612,993	1,699,744,136
Degree of Diversification	28.06	34.63	37.50	35.63	28.93	17.70
Capital Loss (Cattle)	73,863,160	178,879,997	337,452,314	993,039,213	756,214,151	1,858,598,264

¹ Average per farm.

Source: Statistics Canada, Whole-Farm Data Base, 2001, CD-ROM.

Table 4.2
Canadian Hog Farms' Financial Profiles¹

	\$10,000- \$24,999	\$25,000- \$49,999	\$50,000- \$99,999	\$100,000- \$249,999	\$250,000- \$499,999	\$500,000 and Over
Number of Farms	290	195	445	1,560	1,275	1,335
Operating Revenue						
Total Crop Revenue	3,605	4,723	13,091	22,091	43,030	135,246
Total Livestock & Product Revenue	10,462	24,006	55,886	124,741	271,317	1,270,937
Other Revenue	2,949	6,871	8,624	19,749	38,586	94,355
Total Operating Revenue	17,016	35,600	77,601	166,581	352,933	1,500,538
Operating Expenses						
Total Crop Expenses	1,319	3,501	8,350	15,861	28,471	79,742
Total Livestock Expenses	9,280	15,876	41,703	78,519	184,043	942,371
Total Operating Expenses	21,042	29,736	81,155	146,812	321,164	1,438,350
Net Operating Income	-4,026	5,863	-3,554	19,769	31,769	62,187
Farm Assets						
Total Current Assets	8,336	14,781	47,751	80,874	139,928	444,737
Total Long-term Assets	260,591	316,984	383,435	530,817	770,300	2,823,753
Total Farm Assets	268,065	331,766	430,113	610,655	909,679	3,266,831
Farm Liabilities						
Total Current Liabilities	5,248	8,935	26,207	39,759	76,141	247,482
Total Long-term Liabilities	43,449	74,906	97,935	158,919	289,502	960,952
Total Farm Liabilities	31,056	77,289	109,925	162,910	341,427	1,125,747
Farm Net Worth	256,286	272,313	365,887	464,453	589,675	2,204,092
Debt to Asset Ratio	0.12	0.23	0.26	0.27	0.38	0.34
Gross Revenue	4,934,640	6,942,000	34,532,445	259,866,360	449,989,575	2,003,218,230
Gross Livestock Revenue	3,033,980	4,681,170	24,869,270	194,595,960	345,929,175	1,696,700,895
Percent Revenue by Class	0.13	0.21	1.10	8.57	15.24	74.75
Percent # Farmers	5.69	3.82	8.73	30.59	25.00	26.18
Degree of Diversification	62.65	48.30	38.86	33.54	30.08	18.07
Probability of Loss	3.5	8	12	37	47	55
Expected Revenue Loss	172,712	555,360	4,143,893	96,150,553	211,495,100	1,101,770,027
Capital Loss (Hogs)	2,720,860	5,175,550	22,968,034	209,576,796	487,133,105	2,703,956,019

¹ Average per farm.

Statistics Canada, Whole-Farm Data Base, 2001, CD-ROM.

Figure 4.1
Distribution of Farmers and Revenue, Cattle Farms

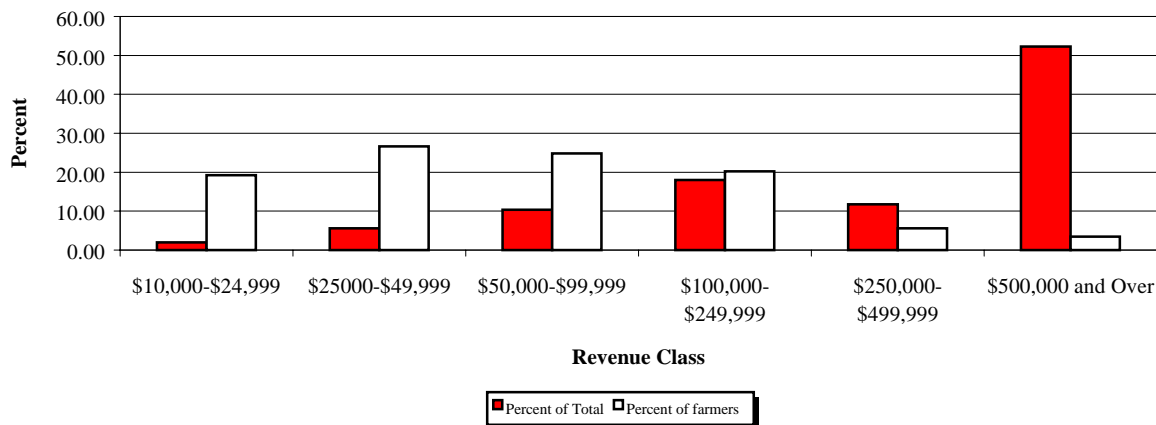
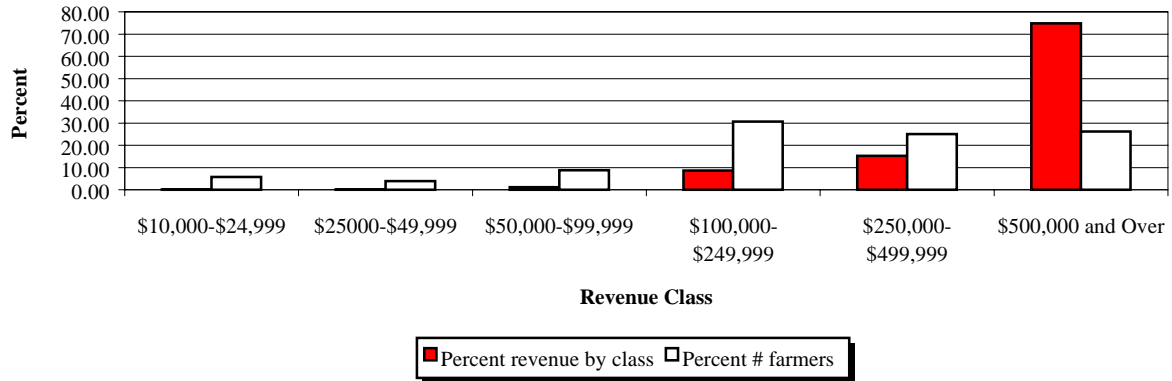


Figure 4.2
Distribution of Farmers and Revenue, Hogs



4.2 INCOME DIVERSIFICATION

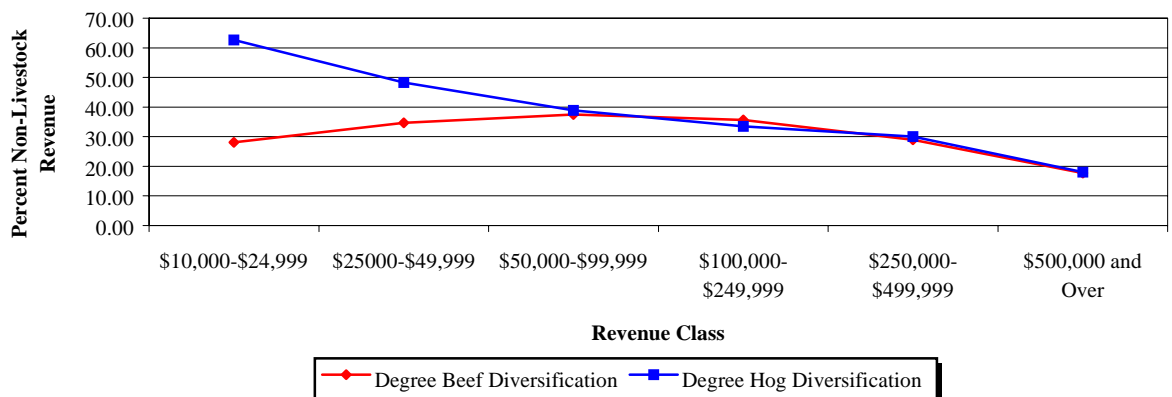
Income diversification is yet another important consideration in the ability of a producer to handle a FMD outbreak. In general, the more diversified an operation is, particularly with respect to non-livestock enterprises, the greater its ability to withstand a FMD outbreak.

A measure of diversification was developed based on the proportion of non-livestock revenue to livestock revenue. As this ratio increases, the implication is that the business is better diversified and has more options in the event of a FMD-induced production contraction.

The results of this analysis for Canadian hog and beef enterprises can be summarized as follows:

- For small-scale enterprises (up to \$50,000 in revenue), hog enterprises are more diversified than similar sized operations in the beef sector. The proportion of non-livestock revenue to livestock revenue is approximately 66% versus 30% for the beef industry.
- As the level of farm revenue exceeds \$50,000, the relative level of revenue diversification is virtually the same between beef and hog farms.
- Larger operations tend to be less diversified, in both beef and hog sectors, and hence less able to withstand a FMD-induced contraction.
- These results are illustrated in Figure 4.3.

Figure 4.3
Degree of Income Diversification, Hogs and Beef



4.3 IMPACT ON REVENUE AND CAPITAL

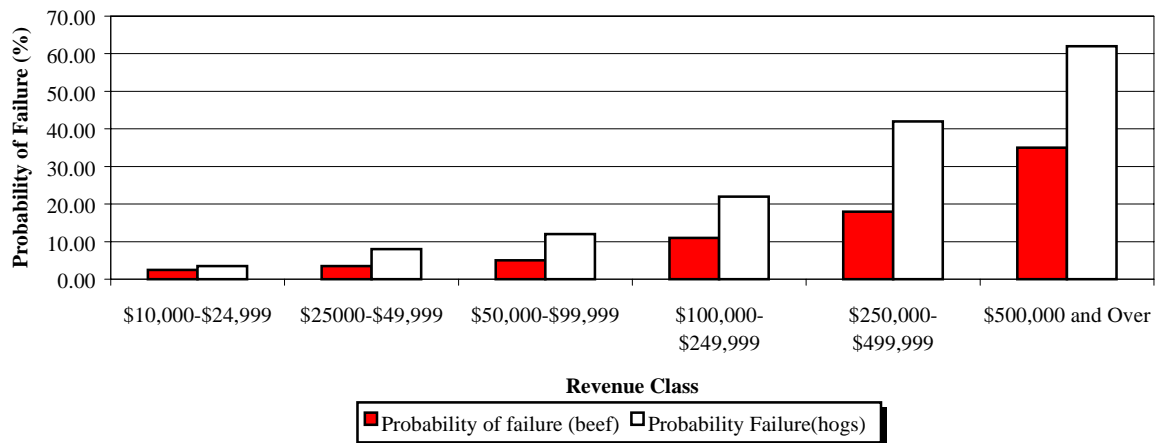
An important consideration is the potential level of farm defaults in the event of a FMD outbreak, and the resulting loss in revenue and capital. A statistical analysis has been done on the beef and hog farms in Canada to determine the possible rate of failure in the event of an outbreak. This has been done by simulating the production impacts expected under a medium-scale FMD outbreak and considering actual farm capital and income structure. This analysis assumes an output contraction, determined within the economic model, of approximately 34%. This scale-back is used to determine the implications on farm revenue, operating costs, short-term borrowing requirements, and farm equity. From this, and based on the statistical variability of farm income, it was possible to determine the proportion of the population

that would fall into a debt to asset category which would be considered unviable. In this analysis, a debt to asset ratio exceeding 0.7 was considered to constitute business failure, based on the experience of the financing institutions supplying credit to farmers.

Figure 4.4 shows the expected rates of business failure for revenue classes of beef and hog enterprises. This analysis suggests that over 60% of the highest revenue hog farms could be expected to fail. Within the beef sector, a somewhat lower number of the highest revenue class farmers, 35%, could expect to fail in the event of a medium-scale FMD outbreak.

The high level of failures anticipated among these large operations are made more likely due to these operations generally being highly leveraged and with little diversification in their sources of income. This was indicated in the previous two sections.

Figure 4.4
Probability of Farm Failure, Cattle and Hog Farms Due to a FMD Outbreak



4.4 EXPECTED REVENUE AND CAPITAL LOSSES

The probability of business failure as previously described, has been applied to the current revenue structure of the beef and hog sectors, to estimate the expected value of the revenue and capital losses in each industry. Figures 4.5 and 4.6 provide the results of this analysis. The important findings are:

- The expected revenue and capital losses are anticipated to be quite modest for the small-scale farms – those currently with revenue under \$50,000.
- The greatest losses for both sectors of revenue and capital are concentrated with the highest

revenue class (revenue greater than \$500,000 annually). In fact, the losses within this revenue class are more than double the losses of all the other revenue classes in the industry.

- The total revenue loss expected for the beef and hog sectors is estimated to be \$1.7 billion and \$1.5 billion, respectively.
- The total capital loss expected for beef and hogs is estimated to be \$4.2 billion and \$3.4 billion, respectively.
- These losses can be compared to the primary sector impacts determined by the economic analysis in Chapter 3.0. The direct primary sector impacts were found to be in the range of \$2.4 billion to \$5.3 billion in the large-scale outbreak.

Figure 4.5
Expected Revenue Loss, Beef and Hog Farm Enterprises

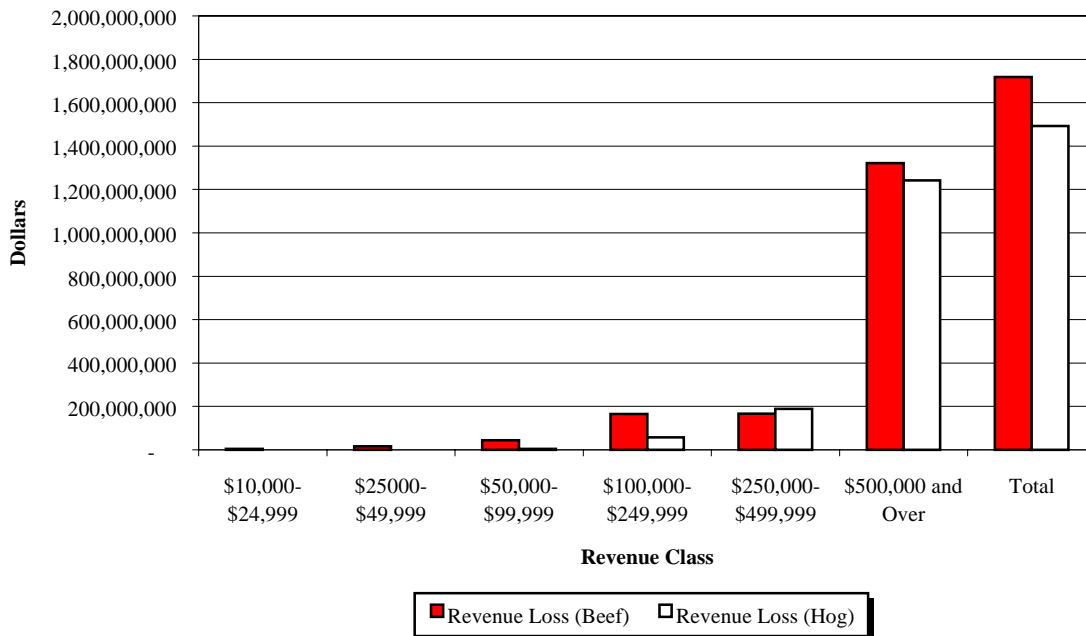
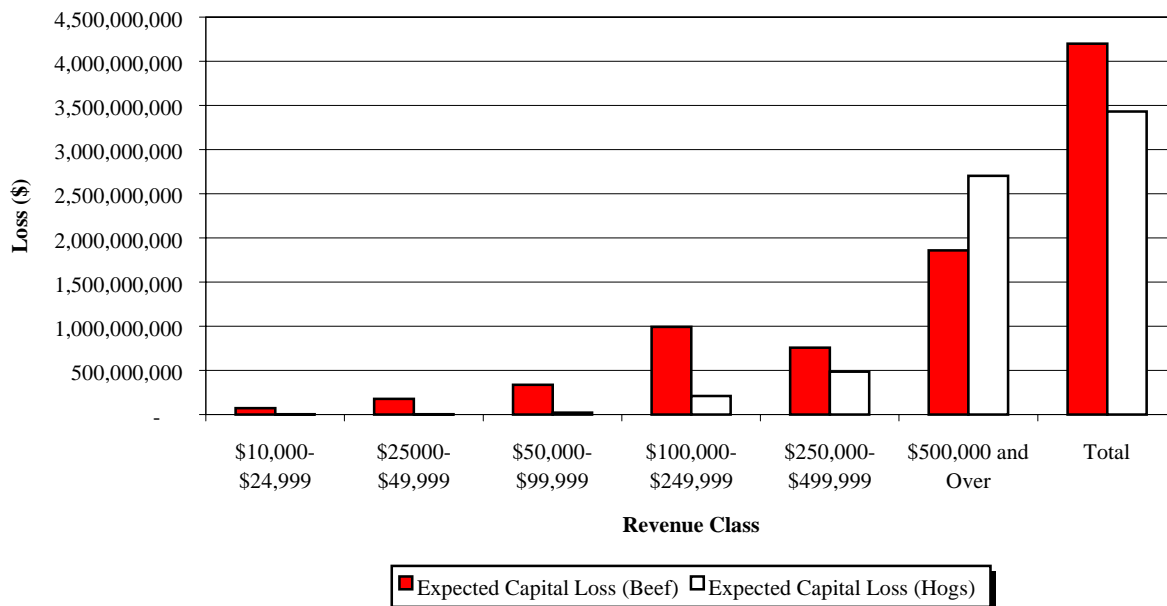


Figure 4.6
Expected Capital Loss, Cattle and Hog Farms, Due to a FMD Outbreak



4.5 PROCESSING SECTOR FINANCIAL ANALYSIS

The meat processing sector is a major contributor to the agriculture and agri-food sector in Canada. The estimated gross sales, as measured by the value of manufacturing shipments, is estimated to be over \$13 billion in 2001 (Table 4.3). The value of total food and beverage shipments in 2000 was \$67 billion⁸, and was forecasted to increase to \$71 billion in 2001. The meat processing industry, excluding poultry, represents about 18% of all food and beverage shipments in Canada.

In addition, this sector has a significant impact on both direct and indirect employment. The direct employment is estimated at about 46,000 in 2001, which does not include the indirect employment impacts of this industry. A more detailed employment impact analysis is presented in the next section.

The economic and financial impact of a FMD outbreak will have significant consequences on this sector.

⁸ Statistics Canada, Cat Number 31-001-XP3.

- ➔ The disposal/storage of excess product in the event of a FMD outbreak cannot be managed with current capacity and facilities. The freezer and cold-storage facilities across Canada are typically at, or near, full capacity, with little ability to handle excess products under any level of outbreak. Rendering capacity in Canada is limited, and as indicated by this industry, would not voluntarily be made available to dispose of excess products or livestock in the event of an outbreak.
- ➔ Certain large-scale plants who currently operate multiple shifts, would reduce to one shift.
- ➔ As a FMD outbreak was seen to be expanding and likely resulting in export market embargos of over six to nine months, some of the major processors would take a number of defensive actions. This has been confirmed in discussion with corporate leaders. This would include the possible permanent closure of plants that are currently dedicated to supplying export markets. Permanent closure of additional, domestically-oriented plants would also be considered, depending on the scale of the outbreak.

- ➡ The economic breakeven levels of processing output of most plants is extremely high, given the high level of fixed capital costs and low operating margins. The financial ability of even the largest processing companies to operate a facility for more than a few months at a 20% to 30% reduced level of through-put would be limited.
- ➡ A reduction in total demand (export and domestic) of 40% to 50% of processing capacity for a period of time, would likely lead to the permanent closure of a majority of firms in the industry.
- ➡ Where firms operate in both Canada and the US, or are owned by a US parent, the capacity to weather a FMD outbreak is much greater. However, few people in the industry anticipate that a Canadian FMD outbreak would be restricted to Canada: probably the US would also be impacted.
- ➡ It is very likely that the higher value cuts would be more significantly impacted than other products due to the disproportionate impact on exports. However, processors need to sell the whole carcass, not just portions of it. The loss of the higher value markets, even for a short period of time, would have a significant impact on operating margins and plant closure decisions. This is an important consideration, given that the shortest period of time that Canada would be out of the export market in the absence of a zoning strategy is estimated to be four to five months.
- ➡ The operational structure of the industry would also be impacted significantly by a FMD outbreak. In the absence of a clear pre-outbreak plan/agreement, the processing industry would be forced to scramble to maintain whatever level of relative profitability was available to it. The potential long-term damage that might occur in terms of industrial organizational considerations suggests that there is a need for the government to work with the sector in advance of an outbreak. This would include addressing product allocation, pricing, and product movement responsibilities, and allotments in case of an outbreak, as well as discussions regarding the responsibility of the retail food sector.
- ➡ Another important consideration is the fact that none of the current compensation programs would be available to the processing sector, despite their importance to the industry.
- ➡ Finally, the processing sector supply chain involves much more than just the primary producers. The transportation, container/box, and utilities industries are just a few examples of industry players that will feel a significant impact if the meat processor has to adjust. While the NEI has estimated the direct economic impact on these sectors, the operational reality for these suppliers also needs to be considered.

Table 4.3
Industrial Statistics - Meat and Meat Products Industry (Except Poultry)
Canada, 1990-2001
(Billions of Canadian Dollars)

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Manufacturing Shipments	9	8.5	8.5	9.2	9.5	9.6	10.2	10.9	11.1	11.8	12.5	13.3
Total Costs	7.2	6.6	6.5	7.4	7.6	7.5	8.1	8.6	8.9	9.5	10.0	10.7
Material Costs	7.1	6.5	6.4	7.3	7.5	7.4	8	8.5	8.8	9.4	9.9	10.5
Manufacturing Value Added	1.8	1.9	2	1.9	2	2.1	2.2	2.3	2.4	2.6	2.7	2.9
Employment (Number)	32,716	31,095	31,799	31,897	31,940	33,271	36,613	37,377	38,095	40,497	42,900	45,645
Fuel & Electricity Costs (\$M)	90.2	92.3	97.6	103.5	113.5	108.5	114.8	117.3	121.8	129.5	137.2	145.9

Source: Statistics Canada, Industry Canada and Values for 1999-2001 extrapolated from manufacturing shipments



4.6 EMPLOYMENT SECTOR ANALYSIS

Another important measure of the consequences of a FMD outbreak would be the effect on employment.

As a processing plant eliminates one of two operating shifts, direct labour would be reduced by 50%, and overall employment reduced by some factor, depending on the ratio of total employment to direct labour. In addition, there would be indirect employment consequences. The industries that supply the processing plant, including transportation, packaging, and other materials industries, would be immediately affected.

A similar chain of events occurs for the primary production sector. First, there are the direct employment impacts as farm businesses contract in scale or close completely. Secondly, there are impacts on employment in the feed supply sector, the transportation systems, the livestock marketing system (auction marts), and suppliers of other inputs, including fuel, fertilizers, chemicals, financial services, etc. Many of the farm input suppliers who would be affected by a FMD outbreak are located in small towns and villages across Canada. This would, in the event of a medium- or large-scale outbreak, impair the viability of local rural communities, with impacts on educational and health services.

Even a modest outbreak would result in a proportion of permanent employment impacts. If the outbreak reaches the large-scale scenario, the greater proportion of this employment reduction would likely be permanent.

An assessment of employment impacts has been made for the three levels of outbreaks evaluated in this study.

To support this analysis, employment multipliers from the specific Statistics Canada Input-Output simulations on the Canadian economy multipliers have been extracted for primary agriculture, processing and the balance of the economy. Multipliers have been applied to the levels of impacts expected under the different scenarios to derive an estimate of the incremental employment impacts.

There are both positive and negative employment impacts. For example, the expenditures on the control

and disposal activities will result in a positive impact on employment. Additional veterinarians, technical assistants, movement control personnel, administrators, and lab technicians will be needed as an outbreak expands.

The negative impacts on employment are directly related to the level of direct and indirect economic impacts expected under each scenario.

Table 4.4 shows the results of this analysis. For the small-scale baseline, a net employment reduction of 59,519 is expected. The largest employment impact is expected to be from the direct and indirect processing sector adjustments.

For the medium-scale outbreak, the net employment impact is 78,654 people, while in the large-scale outbreak, the net employment reduction is estimated to be in excess of 136,534. As indicated, it is postulated that the proportion of permanent employment losses would increase as the scale of the outbreak enlarges. For a large-scale outbreak, the industry at both the primary and secondary levels is being permanently scaled back.

4.7 COMPENSATION IMPLICATIONS

In the event of a FMD outbreak, the primary and processing sectors will have direct economic losses and costs of two types:

1. Type I: Loss of the economic value of the infected animals slaughtered, in addition to those animals disposed of under pre-emptive and welfare slaughter conditions, e.g. the value of the assets lost; and,
2. Type II: The cost of the welfare slaughter, business disruption costs during the period of the outbreak and trade restriction period, and the costs to rebuild after removal of trade restrictions, e.g. the loss of additional productive assets, and expenses associated with these losses and the subsequent rebuilding.

An estimate of the Type I and II economic costs has been approximated for the primary sector, for the small-, medium-, and large-scale outbreak base simulations.

Table 4.4
Employment Impact of FMD Outbreak, by Scenario

	Small-Scale Outbreak		Medium-Scale Outbreak		Large-Scale Outbreak	
	\$ Millions	Employment	\$ Millions	Employment	\$ Millions	Employment
Summary Economic Analysis						
Detection & Surveillance	23.4		190.0		1,003.7	
Control and Disposal	5.9		38.4		229.5	
Vaccination/Zoning Cost	-		0.0		0.0	
Sub total C&D Costs	30.7	213	224.6	1,559	1,207.0	8,377
Direct Farm Impact	2,430.9		2,977.0		5,289.0	
Indirect Farm Impact	2,114.9		2,590.0		4,601.0	
Sub-total Primary Sector Impacts	4,545.8	(28,411)	5,567.0	(34,794)	9,890.0	(61,813)
Direct Processing Impact	2,569.3		3,595.0		6,391.0	
Indirect Processing Impact	1,027.7		1,438.0		2,556.0	
Sub-total, Processing Sector	3,597.0	(23,381)	5,033.0	(32,715)	8,947.0	(58,156)
Other Indirect Impacts	873.6		1,222.0		2,173.0	
Tourism Impacts	270.5		608.6		1,421.0	
Sub-total Other Impacts	1,144.1	(7,940)	1,830.6	(12,704)	3,594.0	(24,942)
Total Impacts and Costs	3,939.1	-	7,806.3		16,191.2	
Net Employment Impacts (#)		(59,519)		(78,654)		(136,534)

These costs and impacts are summarized in Table 4.5 below. The sum of the Type I and II costs equals a large portion of the total direct primary sector economic impacts, and does not reflect any processing or related industry economic impacts.

The compensation policy under the *Health of Animals Act and Regulations* provides for the compensation for livestock, feed, and other materials ordered destroyed for the purpose of disease control (Type I). Currently, this policy does not allow for compensation for economic loss, nor the costs of business disruption, or the future costs of rebuilding and recovery (Type II).

The relative proportions of these different costs are shown for each of the three outbreak sizes in Figures

4.7, 4.8, and 4.9. Only 10,000 infected animals are disposed of in the small-scale outbreak. Together with the detection and surveillance costs, this represents less than 2% of the total primary sector impacts. The percentage is very low due to the high level of direct impacts on the sector that even a minor outbreak will inflict.

In the medium- and large-scale outbreaks, 7% and 19% of the total control, economic and recovery costs are potentially covered by existing compensation policies. The dramatic increase in costs covered is due to the acceleration of control costs, and the number of compensated animal slaughters rising to over 400,000.

Table 4.5
Type I and Type II Primary Sector Impacts
(\$ millions)

Cost	Small-Scale Outbreak	Medium-Scale Outbreak	Large-Scale Outbreak
	Base Scenario	Base Scenario	Base Scenario
Detection and surveillance	23	186	977
Infected animal disposal/value	7	38	230
Type I Costs			
Welfare economic loss	1,238	1,423	2,544
Type II Cost			
Welfare disposal, disruption	<u>1,193</u>	<u>1,546</u>	<u>2,145</u>
Primary Sector Direct Impact	2,430.9	2,969	4,689

Figure 4.7
Small-Scale Outbreak Economic and Recovery Costs

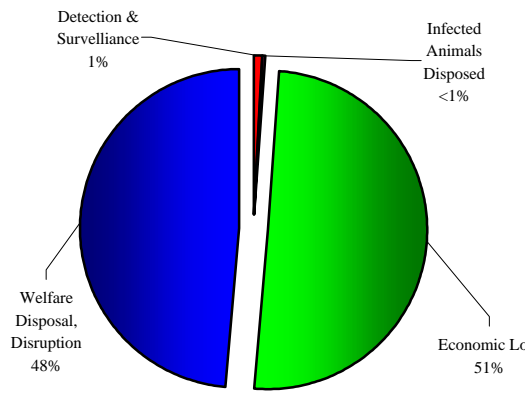


Figure 4.9
Large-Scale Outbreak Economic and Recovery Costs

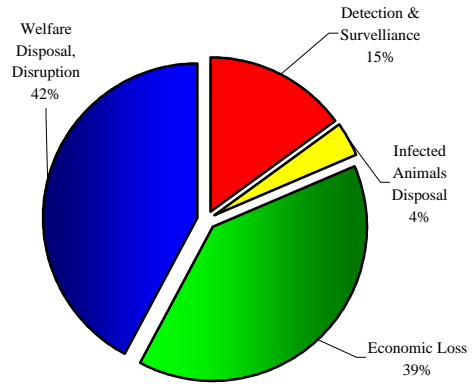
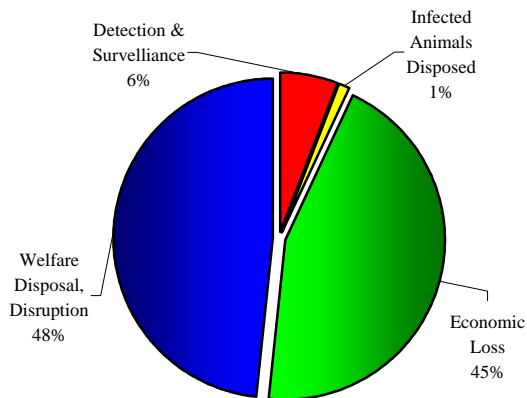


Figure 4.8
Medium-Scale Outbreak Economic and Recovery Costs



5.0 SUMMARY AND CONCLUSIONS

5.1 KEY IMPACTS

Immediate closure of all export markets for Canada's livestock and meat products, is the single greatest determinant of economic costs of a FMD outbreak.

The length of total export market closure varies from four to five months under optimistic conditions, to ten to twelve months or more for a major outbreak.

The greatest single impact will be the opportunity costs of lost trade. The next greatest impacts are the economic impacts on the farm and processing sectors which remain relatively evenly balanced at each scale of outbreak. Tourism and border dependent industries will also be significantly impacted.

Control and eradication costs – insignificant relative to other stakeholders' costs – far exceed those encountered in previous disease outbreaks in Canada.

Effective disease control and zoning strategies could significantly reduce the impacts on the Canadian economy, by up to \$21.1 billion and \$20.7 billion respectively. Employed in conjunction, they could reduce impacts by up to \$28 billion.

Due to the high level of export dependence, an outbreak of FMD in Canada would have unprecedented impacts on the structure and solvency of Canada's livestock industry. It would:

- decimate the current annual \$8.0 billion plus livestock and meat products export industry for a period of four to seven years;
- permanently damage the reputation, image, and brand of Canada as an exporter of clean, safe and high quality livestock and meat products;
- result in permanent closure of many of the nation's processing plants, given the tight margins in the processing industry, and the heavy reliance on the export sector.

It is critical to understand that while the impact would be related to the size and duration of the outbreak, a single animal testing positive for FMD anywhere in Canada will result in export markets being closed for at least three months. In all

likelihood, this would permanently change the structure of Canada's livestock sector.

A FMD outbreak is more than just an agricultural industry problem. The various supporting supply chain partners would be impacted, in addition to the tourism sector. The impact of the operational issues created at all customs points would be significant.

5.2 ECONOMIC IMPACT

In the absence of a zoning strategy, the total NEI of an outbreak was found to vary from a low of \$13.7 billion, assuming optimistic conditions under a small-scale outbreak, to \$45.9 billion in the event of a large-scale outbreak.

Table 5.1
Outbreak Results Summary

	Small-Scale	Medium-Scale	Large-Scale
Infected Animal			
Disposal (#)	10,224	66,454	400,607
Welfare Disposal (# M)	4.2	5.8	10.3
Farms Impacted (#)	12,983	18,167	32,304
Initial Net Impact (\$B)	9.8	14.3	26.4
Trade Impact (\$B)	3.9	10.6	19.6
Net Economic Impact (\$B)	13.7	24.9	45.9

- a \$26.4 billion cost to industry before the longer-term trade losses are accessed, representing 80% of the 2001 Canadian primary agriculture sectors' market cash receipts,⁹ or alternatively, three times the net cash income of Canadian farmers in 2001;
- a reduction in Canada's Gross Domestic Product (GDP) of approximately 2.6%, comparable to the total annual farm level contributions to GDP, based on Canada's 2001 GDP;
- a trade loss of approximately \$19.6 billion, comparable to 5% of Canada's total export sales from all sectors in 2001¹⁰;

⁹ Agriculture Economic Statistics, and Statistics Canada Cat No. 21-603.

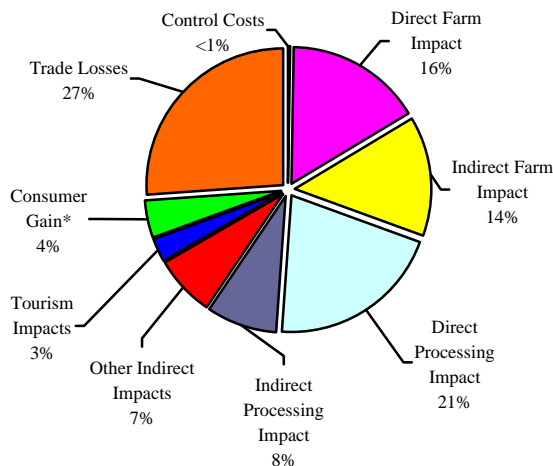
¹⁰ Ibid, Agriculture Economic Statistics.



► a significant loss in the tourism and other non-agricultural sectors of the economy, between \$6 and \$7 billion, an amount exceeding the direct costs of the outbreak to the primary sector.

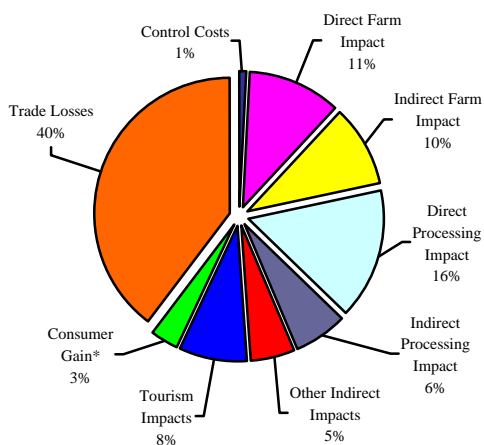
The following figures break down the direct economic impacts, expected trade losses, and control costs for a small-, medium-, and large-scale outbreak.

Figure 5.1
Allocation of Net Economic Impacts for a Small-Scale Outbreak



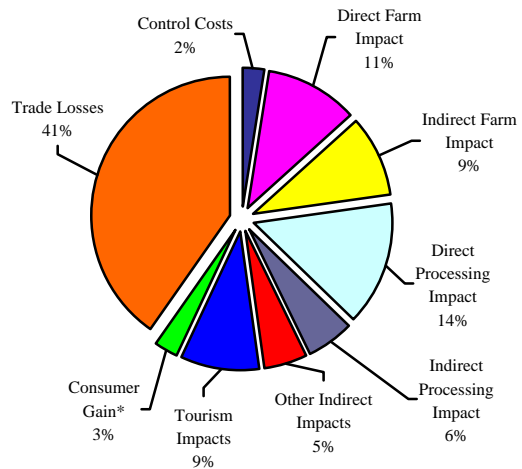
* Consumer gain is a positive factor in the NEI calculation.

Figure 5.2
Allocation of Net Economic Impacts for a Medium-Scale Outbreak



* Consumer gain is a positive factor in the NEI calculation.

Figure 5.3
Allocation of Net Economic Impacts for a Large-Scale Outbreak



* Consumer gain is a positive factor in the NEI calculation.

5.3 CONTROL AND ZONING STRATEGY IMPACTS

The relative effectiveness of the disease control strategy employed could change the impacts on the Canadian economy by up to \$21.1 billion. The potential gains from an effective zoning strategy could be as high as \$20.7 billion.

Overall, the potential gains to having a very effective disease control strategy in place, concurrently with a successful zoning strategy, could reach as high as \$28 billion.

5.4 OPERATIONAL IMPACTS

As well as disposing of infected animals, industry would be forced to dispose of livestock that are at risk of infection and those at risk of animal welfare problems. The latter could arise when animals are in excess of market requirements and / or when proper management can no longer be assured. This is referred to as 'welfare slaughter'.

► Welfare slaughter is estimated to vary from as low as 4.2 million animals in the small-scale outbreak scenario, to 10.3 million animals in a large-scale outbreak.

- There currently is no capacity or strategy by which such large numbers of livestock could be disposed of, nor is there any compensation program to support the industry in this effort.
- The burden of welfare slaughter will compound an extended period of “poor prices”. Some owners of intensive and highly leveraged farm operations may perceive that they have no alternative, other than to walk away from their operations and leave the responsibility for slaughter and disposal of their animals to society.

5.5 EMPLOYMENT IMPACTS

A FMD outbreak will also have significant direct and indirect impacts on employment.

- The net employment loss in Canada for a large-scale outbreak is estimated at nearly 137,000.
- For the medium-scale and small-scale outbreaks, the expected employment loss is 78,000 and 60,000, respectively. The proportion of permanent employment losses are deemed to be greater as the scale of the outbreak increases.

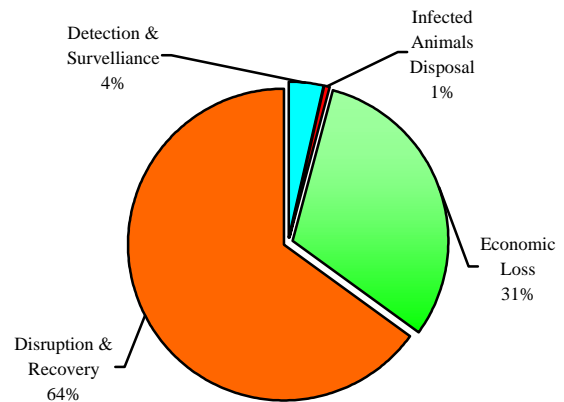
5.6 CURRENT COMPENSATION PROGRAMS

The current compensation program under the *Health of Animals Act* administered by the CFIA is limited to pre-set maximum values for the destruction of infected and suspect infected animals and things for disease control purposes. The purpose of the Health of Animals Act precludes any protection to the processing sector.

As seen in Figure 5.4, current compensation scenarios were just 5% of the total disease outbreak cost, leaving the remaining 95% of costs to be allocated among the various industry and public stakeholders.

This represents a huge contingent liability for the total livestock industry and government. If these costs are not fully anticipated and planned for, the consequences for the industry and Canada to rationally manage during and after an outbreak are extreme.

Figure 5.4
Allocation of Costs Borne by Primary, Processing, and Public Sectors, Medium-Scale Outbreak



5.7 KEY FACTORS TO CONSIDER

The study has provided a significant amount of information regarding the potential costs of a FMD outbreak in Canada. The analysis of the relative impact of specific actions on the net economic impact has led to the following key observations:

- Having a zoning policy prepared in advance according to the principles of the Office International des Epizooties (OIE) and recognized by Canada’s major trading partners, will pay huge dividends for Canada’s economy. The analysis found that a zoning strategy could reduce economic impacts by up to 45%, or \$20.7 billion, in the large-scale outbreak.
- An effective control strategy will also pay huge dividends for the Canadian economy. This analysis found that an effective control strategy could reduce impacts by up to \$21.1 billion.
- Tourism and other non-agricultural economic impacts are in excess of \$6 billion in a large-scale outbreak, an amount exceeding the direct impacts to the farm sector.
- The operational structure of the industry would be impacted significantly by a FMD outbreak. In the absence of a clear pre-outbreak plan/agreement, the processing industry would be forced to scramble to maintain whatever level

of relative profitability was available to them. The potential long-term damage that might occur in terms of industrial organizational considerations suggests that there is a need for the government to work with the industry in advance of an outbreak. This includes addressing product allocation, pricing, and product movement responsibilities and allotments, as well as identifying the responsibility of the food retail sector.

- The ultimate measure of the economic impact of a FMD outbreak is how long Canadian products remain out of export markets, not the size of the disease outbreak, although the latter would influence the timeframe of the outbreak and therefore the export restrictions.
- Control and eradication costs will be extremely variable, depending on the scale of the outbreak. For a large-scale outbreak these costs could be as high as \$1.2 billion.
- Control and eradication costs are insignificant relative to other costs faced by stakeholders. The greatest single impact within all outbreak scenarios remains trade opportunity costs – 41% in the large-scale outbreak. The next greatest impacts are the direct and indirect economic impacts on the farm and processing sectors which remain relatively evenly balanced at each scale of outbreak.

REFERENCES

- Productivity Commission Research Report (2002). Impact of a Foot and Mouth Disease Outbreak in Australia, June (2002)
- Government Office for the East Midlands UK (2001). The Economic Impact of Foot and Mouth Disease on The East Midlands.
- Abacus Research (2001). The Economic Impact of Foot and Mouth Disease on The South East Region
- Adam Blake, M. Thea Sinclair, Günter Sugiyarto (2001). The Economy-Wide Impact Effect of Foot and Mouth Disease in UK Economy
- Economic Cost of Foot and Mouth Disease in the UK
A Joint Working Paper By DEFRA / DCMS
- Trading Standards Institute, UK (2001). Foot & Mouth Disease Outbreak - Lessons Learned, Evidence to the Government Inquiry Chaired by Dr Iain Anderson
- E.J. Bos, M.G.A. van Leeuwen, J.J. de Vlieger (2001). Scenarios for Eradicating Foot-And-Mouth Disease.
- Indecon International Economic Consultants (2002). Economic Evaluation of Foot and Mouth Disease in Ireland
- Javier M. Ekboir (1999). Potential Impact Of Foot-And-Mouth Disease In California
- The Rural Task Force UK (2001). Tackling The Impact Of Foot-And-Mouth Disease On The Rural Economy (UK)
- USDA, World Trade Impacts of Foot and Mouth Disease in Taiwan
- USDA International Agricultural Trade Report, FMD Shatters Argentine and Uruguayan Hopes for Increased Beef Exports
- Foot and Mouth Disease, The Republic of Ireland, March 23, 2001 Impact Worksheet
- Foot and Mouth Disease, Brazil Impact Worksheet, August 2000
- Foot and Mouth Disease, Argentina March 16, 2001 Impact Worksheet
- Foot and Mouth Disease, United Kingdom Impact Worksheet, February 2001
- Foot and Mouth Disease, France Impact Worksheet, March 2001
- Foot and Mouth Disease, The Netherlands Impact Worksheet, March 23, 2001
- Taiwan's Hog Industry - 3 Years After Disease Outbreak (Economic Research Service/USDA)
- Report of the Session of the Research Group of the Standing Technical Committee of EUFMD
- Graeme Garner, Robert Allen And Chris Short (...). Foot-And-Mouth Disease Vaccination: A Discussion Paper On its Use to Control Outbreak In Australia
- Hassall & Associates PTY Ltd (1993). Impacts Of Exotic Animal Diseases On Regional Economics Within Australia
- Australian Veterinary Emergency Plan Ausvetplan 2001 Disease Strategy Foot-And-Mouth Disease
- Canadian Forum on Foot and Mouth Disease (2001). proceeding of the Canadian forum on foot and mouth disease
- Canadian Food Inspection Agency Emergency Book (2001)
- Canadian Food Inspection Agency Foot and Mouth Disease Strategy
- The Animal Disease Surveillance Unit (CFIA) 2001. Protecting Canadian Export Markets of Livestock and Animal Products Through Zoning.
- Statistics Canada, 2001 Census of Agriculture
- OIE, various information and articles
- USDA, Foot and Mouth Disease Section

- DEFRA, UK Department for Environment Food and Rural Affairs, Foot and Mouth Disease section
- AAFC, Canadian red meat industry website
- OIE. 2002 International Animal Health Code.
- The Netherlands Livestock and Products (2001). Attaché Report, GAIN Report #NL1069
- Impact of FMD Outbreaks in Korea/Japan on Japan's Pork Market and Trade (2000). Attaché Report, GAIN Report #JA0041
- Taiwan Impact Of FMD On Hogs & Pork (1997). Attaché Report
- Canadian Livestock Statistics, Statistics Canada
- Scenarios For Eradicating Foot And Mouth Disease (E.J Bos, M.G.A. van Leeuwen, J.J. de Vlieger) December 2001
- Potential Impact of Foot and Mouth Disease in California (Javier M. Ekboir) 1999
- The Epidemic of Foot-And-Mouth Disease in the Netherlands in 2001: Laboratory Examinations (A. Bouma, P. Eble, E. v. Rooij, A. Bianchi, A. Dekker)
- Foot-And-Mouth Disease Vaccination: a discussion paper on its use to control outbreaks in Australia (Graeme Garner, Robert Allen and Chris Short)
- Animal Disease Outbreaks and Their Impacts on Trade (Food and Agricultural Policy Research Institute)
- World Agricultural Outlook 2002 (Food and Agricultural Policy Research Institute)
- Foot-and-mouth disease in the UK - What can we learn? Are we prepared? (John H. Kirk, DVM, MPVM, University of California Davis)
- The Economic Impact of Foot and Mouth Disease On The East Midlands. (UK)
- Foot & Mouth Disease Outbreak - Lessons Learned (UK)
- The Economy Wide Effect of Foot and Mouth Disease in the UK Economy.
- Economic Impact of Foot and Mouth Disease in the South East Region (UK).
- World Trade Impacts of Foot and Mouth Disease in Taiwan
- Australian Veterinary Emergency Plan
- CFIA Foot And Mouth Disease Strategy
- APHIS FMD Emergency Response Plan
- EU Strategy for Foot and Mouth Disease
- European Commission for the Control of Foot-and-Mouth Disease (EUFMD) various articles.

ECONOMIC STRUCTURE OF CANADIAN LIVESTOCK INDUSTRY

The impacts of a possible FMD outbreak in Canada will impact directly on the livestock production and processing sectors. The impacts will be within the cattle industry (including dairy), the hog sector, and to a lesser extent, the sheep and lamb industry. As a foundation to the economic impact analysis, a brief summary of the production and economic characteristics and importance of these sectors is developed.

This summary reviews in turn the physical and economic characteristics of the livestock production sector, the processing sector, and finally an overview of the trade and consumption sectors.

LIVESTOCK PRODUCTION SECTOR

Cattle and Calves (Including Dairy)

Canada had 122,066 farms with 15.55 million cattle and calves (including dairy) in 2001 (Table A.1). By province, the number of cattle farms was greatest in Alberta, followed by Ontario, followed by Saskatchewan, Quebec, Manitoba, and then British Columbia (Figures A.1 and A.2). The cattle livestock farms in Quebec and Ontario are proportionately more dairy than beef farms. The Maritime provinces have relatively few cattle livestock farms. By number of cattle (versus number of farms), Alberta by far dominates all other provinces with 6.6 million head, or 42% of the national total. Saskatchewan is next

with 2.9 million, or 19% of the national total. Ontario and Quebec follow with 13.5 and 8.7% of the national cattle and calf numbers respectively.

Hog Sector

In 2001, there were approximately 14 million hogs on 15,472 farms in Canada. The greatest number of hog farmers are in Ontario, followed Quebec and by Alberta. However, the greatest number of hogs are in Quebec at 4.3 million, or 31% of the national total. This is followed by Ontario with 3.5 million hogs (25% of total). This infers that the hog farms in Quebec are significantly larger than those in Ontario. Manitoba has the third greatest number of hogs at 2.54 million, or 18% of the national total (Table A.1, Figure A.1, A.2). Alberta and B.C have 14.5% and 7.9% of the national hog population respectively. The Maritime provinces have relatively few hogs.

Sheep and Lambs

In 2001, Canada had 1.26 million sheep and lambs on 13,232 farms (Table A.1). The larger number of farmers and sheep and lambs is in Ontario, representing 30% of the farmers, and 27% of the numbers. This is followed closely by Alberta, Quebec, and Saskatchewan with 24, 20, and 12% of the sheep and lamb population respectively.

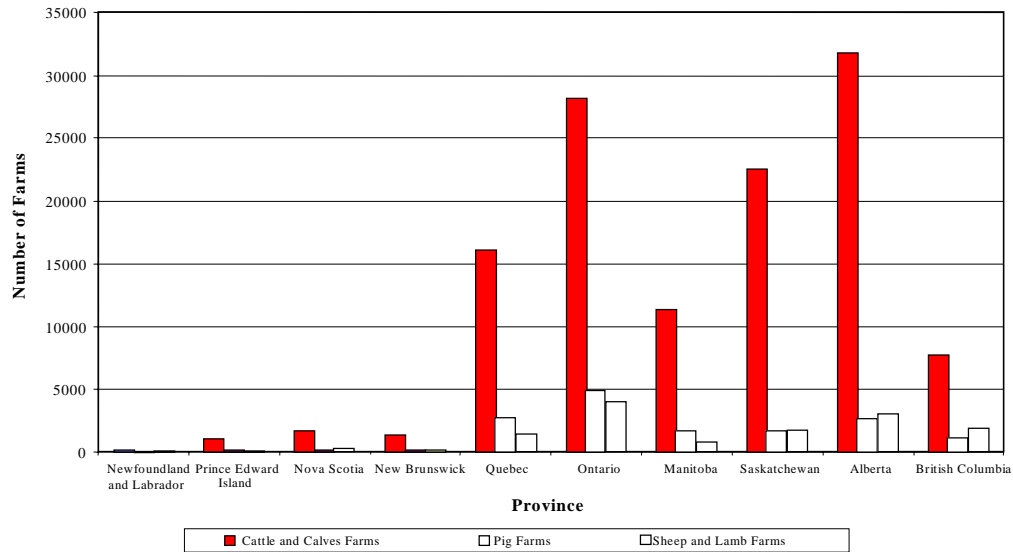
Table A.1
Canadian Livestock Numbers by Province (2001)

	Total Cattle and Calves		Total Hogs		Total Sheep and Lambs	
	# Farms	Number	# Farms	Number	# Farms	Number
Canada	122,066	15,551,449	15,472	13,958,772	13,232	1,262,448
Newfoundland and Labrador	171	9,483	31	2,689	109	7,888
Prince Edward Island	1,072	84,791	193	126,065	68	3,589
Nova Scotia	1,705	108,401	196	124,935	276	24,896
New Brunswick	1,421	91,176	195	137,006	148	9,601
Quebec	16,100	1,362,788	2,743	4,267,365	1,366	254,053
Ontario	28,209	2,140,731	4,972	3,457,346	3,978	337,625
Manitoba	11,333	1,424,427	1,668	2,540,220	733	84,798
Saskatchewan	22,555	2,899,502	1,677	1,109,797	1,702	149,389
Alberta	31,774	6,615,201	2,677	2,027,533	2,987	307,302
British Columbia	7,726	814,949	1,120	165,816	1,865	83,307

Source: Statistics Canada (2001 Census of Agriculture).

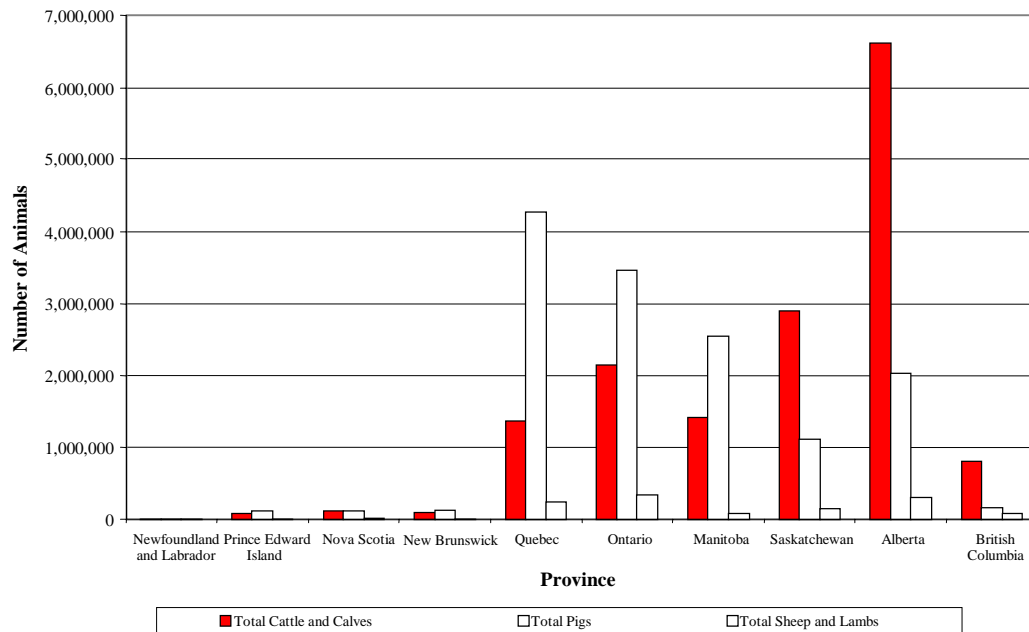


Figure A.1
Number of Livestock Farms by Province



Source: Statistics Canada (2001 Census of Agriculture).

Figure A.2
Number of Livestock by Province



Source: Statistics Canada (2001 Census of Agriculture).



East to West Livestock Movements

An important risk factor in the control of FMD in the event of an outbreak is the frequency and extent of livestock movements between different regions within Canada. Generally within Canada, there has been a movement of feeder cattle from the western provinces to eastern provinces, in particular to Ontario. Table A.2 provides a snapshot of the extent of these livestock movements in 2001. The table illustrates that the greatest number of livestock have been moving from Saskatchewan to Ontario, followed by shipments from Manitoba to Ontario and then Alberta to Ontario. The movement of animals from the west into Quebec has not been significant. It is important to note this information does not include the movement of livestock (cattle) from Manitoba and Saskatchewan into Alberta.

Table A.2
Movement of Livestock to Eastern Canada (2001)

Source Province	Destination			Total
	Ont	Que	Mar Prov	
British Columbia				
Fed Cattle	0	0	0	0
Feeder Cattle 550+ lbs.	691	0	0	691
Feeder Calves -550 lbs.	291	0	0	291
Alberta				
Fed Cattle	11,539	0	43	11,582
Feeder Cattle 550+ lbs.	23,583	1,518	0	25,101
Feeder Calves -550 lbs.	9,798	0	0	9,798
Saskatchewan				
Fed Cattle	3,976	0	0	3,976
Feeder Cattle 550+ lbs.	50,535	2,031	0	52,566
Feeder Calves -550 lbs.	26,073	96	96	26,265
Manitoba				
Fed Cattle	4,021	0	0	4,021
Feeder Cattle 550+ lbs.	43,678	5,452	70	49,200
Feeder Calves -550 lbs.	8,161	104	0	8,265
Total				
Fed Cattle	19,536	0	43	19,579
Feeder Cattle 550+ lbs.	118,487	9,001	70	127,558
Feeder Calves -550 lbs.	182,346	9,201	209	191,756
Grand Total - 2001	182,346	9,201	209	191,756

Source: AAFC Red Meat Information Website
(<http://www.agr.gc.ca/redmeat>)

MEAT PROCESSING SECTOR

Hog Processing Sector

There were 48 federally-certified hog slaughtering plants operating in Canada in 2000 (Table A.3). The greatest number were in Quebec (20) followed by ten in Saskatchewan and Manitoba, and eight in B.C and Alberta. Ontario has six plants, and there are four in the Maritimes. Annually, these plants are slaughtering over 19 million hogs.

The greatest proportion of hog slaughtering is done in Quebec, which in 2000, represented 39% of the national hog slaughter. The second greatest hog slaughtering was done in Ontario, representing 21% of the national total. Manitoba closely ranked third with 20% of the national totals. Alberta ranked a distant fourth, with 11% of the national slaughter (Table A.4, Figure A.3 and A.4). Most of the slaughter from these plants are within federally inspected plants, and therefore eligible for export outside the province of slaughter.

The slaughter activity within each plant is not necessarily from hogs produced in the province in which the plant is located. Table A.5 provides a comparison of the total slaughter within a province, and the province of origin of its supply. For example, while almost all the hogs slaughtered in Alberta and Saskatchewan come from that province, in other provinces such as B.C., Manitoba, Ontario and Quebec, a significant kill volume comes from neighbouring provinces.

The extent to which live animals are exported across provinces for the purpose of slaughter impacts on the ability to detect and control a FMD outbreak.

Table A.3
Distribution of Federally Inspected Hog Slaughtering Plants 2000

	BC/AB	SK/MB	ONT.	QUE	Maritimes	CDN
Number of Plants	8	10	6	20	4	48

Source: AAFC Red Meat Market Information Website
(<http://www.agr.gc.ca/redmeat>)



Table A.4
Hog Slaughtering at Federally and/or Provincially Inspected Plants
(2000)

	Federal Plants	Provincial Plants	Total
B.C	230,004	116,352	346,356
AB	1,908,440	183,032	2,091,472
SK	900,291	22,043	922,334
MB	3,802,265	119,415	3,921,680
ONT	3,462,521	575,979	4,038,500
QUE	7,586,903	18,033	7,604,936
Maritime Prov.	485,892	22,600	508,492
Total	18,376,316	1,057,454	19,433,770

Source: AAFC Red Meat Market Information Website (<http://www.agr.gc.ca/redmeat>)

Figure A.3
Hog Slaughtering in Canada by Province (2000)

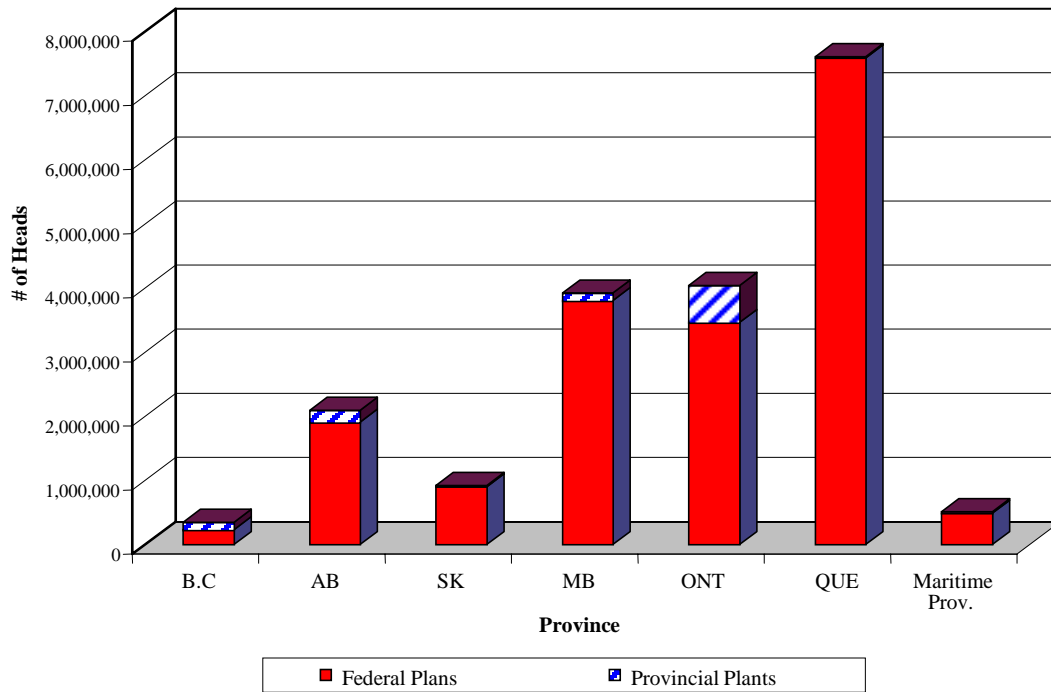


Table A.5
Hogs: Receipts at Packing Plants - by Province of Origin

Province of Slaughter	(Province of Origin)						
	B.C.	Alberta	Saskatchewan	Manitoba	Ontario	Quebec	Maritimes
B.C.	237,680	108,676	0	0	0	0	0
Alberta	0	2,091,472	0	0	0	0	0
Saskatchewan	0	55,667	880,580	1,089	0	0	0
Manitoba	571	696,791	157,760	3,064,509	3,932	317	0
Ontario	0	903	0	0	4,023,195	15,145	0
Quebec	0	0	0	0	743,601	6,756,163	105,172
Maritimes	0	0	0	0	0	0	508,492
Total	238,251	2,953,509	1,038,340	3,065,598	4,770,728	6,771,625	613,664

Source: AAFC Red Meat Market Information Website (<http://www.agr.gc.ca/redmeat>)

Beef Processing Sector

Table A.6 provides an overview of the distribution of beef cattle slaughter in 2000. In that year, some 3.0 million head were slaughtered. The amount of slaughter by 2001 increased to 3.4 million head. Approximately two-thirds (64.2%) of the slaughter is done in Alberta, mostly at the Cargill plant in High River, and the IBP Lakeside plant at Brooks. Ontario follows with slaughtering of about 27.1%, and the three other western provinces of B.C, Saskatchewan, and Manitoba slaughtering 5.8% of the total. A very

modest amount of cattle were slaughtered in either Quebec or the Maritimes.

The number of meat federally registered processing plants in 2000 was 412 (Table A.7). Of these, the greatest number were in Quebec, followed by Ontario, B.C, and Saskatchewan. Many of these are small plants, servicing local, domestic markets. There are in addition, many provincially-licensed processing establishments, whose products are limited to the domestic market.

Table A.6
Beef Carcasses Graded in Federally and Provincially Inspected Packing Plants (2000)

Grade	Alberta	BC, SK & MB	ONT	QUE	Maritimes	Canada
Total Graded	2,183,477	144,432	556,019	35,735	29,420	2,949,083
Carcass Basis	1,149,460	103,380	485,141	28,747	22,894	1,789,622
% By Province (Carcass Basis)	64.2	5.8	27.1	1.6	1.3	100.0

Source: AAFC Red Meat Market Information Website (<http://www.agr.gc.ca/redmeat>)

Table A.7
Federally Registered Meat Processing Establishments

	NS	NB	NFL	PEI	QUE	ONT	MB	SK	AB	BC	Nunavut
Number of Establishments	4	7	1	4	186	149	15	12	9	23	2

Source: AAFC Red Meat Market Information Website (<http://www.agr.gc.ca/redmeat>)

Sheep and Lamb Processing Sector

The sheep and lamb processing sector is weighted more toward eastern Canada. In Canada, 378,598 sheep and lambs were slaughtered in 2000. Of these, 241,136, or 64% were slaughtered in plants east of Manitoba, and 70,771 or 36% were slaughtered in western Canada, primarily at Innisfail, Alberta (Table A.8).

Table A.8
Sheep and Lambs Slaughterings at Federally or Provincially Inspected Packing Plants

(Number of head), 2000

	Federal	Provincial	Total
West	51030	19741	70,771
Ontario	8380	202073	210,453
Quebec	63496	24445	87,941
Maritime Provinces	2225	7208	9,433
East	74101	233726	241,136
Canada	125131	253467	378,598

Source: AAFC Red Meat Market Information Website (<http://www.agr.gc.ca/redmeat>)

MEAT AND LIVESTOCK EXPORTS AND IMPORTS

Meat and Livestock Exports

Meat Exports

Central to the evaluation of the impact of FMD on the Canadian agricultural economy, is the proportion of the production which is exported. Table A.9 provides a summary of the different meat products which were exported by country. By far, the largest export market, by volume, for beef and veal is to the US, approximately 73%, followed by 9.8% to Mexico, 7% to Korea, 5.2% to Japan, and 4.9% to other countries. While Japan ranks forth on a tonne basis, by value, Japan is the second most valuable market for Canada after the US.

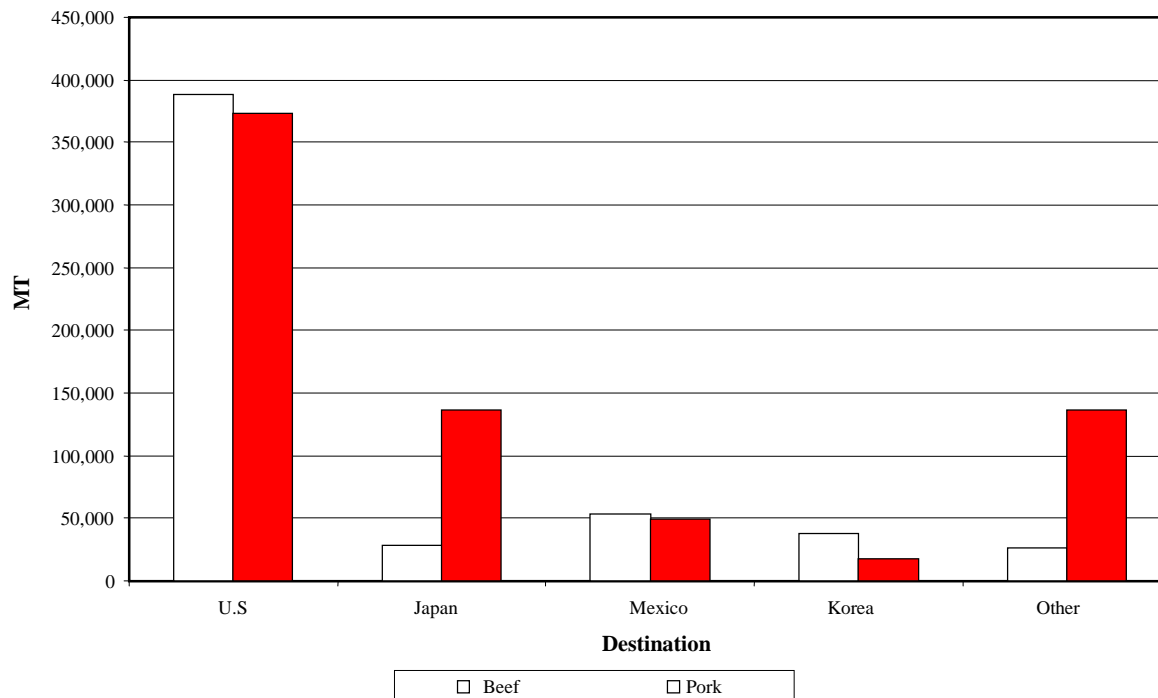
The markets for pork products are not as dominated by the US. Approximately 52% of Canadian pork is exported to the US, followed by 19% to Japan, and 7% to Mexico. Korea and a number of other countries take the remaining 19% of Canada's total exports. Figure A.4 graphically compares the export of beef and pork products to the main export countries.

Table A.9
Dressed Meat Exports 2000 (tonnes)

	US	Japan	Mexico	Korea	Other	Total
Beef	387,701	28,325	53,135	37,272	26,263	532,696
Veal	8,642	46	36	0	79	8,803
Lamb and Mutton	414	1	0	0	64	479
Pork	372,958	136,309	48,975	17,617	136,586	712,445
Edible Animal Fat	1,878	17,300	443	0	23,835	43,456
Pork Skins	0	18	11,135	0	1,242	12,395

Source: AAFC Red Meat Market Information Website (<http://www.agr.gc.ca/redmeat>)

Figure A.4
Canadian Dressed Beef and Pork Meat Exports (2000)



Almost all the lamb and mutton exports are to the US.

Livestock Exports

Livestock exports have dramatically increased over the last several years, particularly the pork sector. As indicated in Table A.10, between 2000 and 2001, live hogs exported increased by approximately one million head to 5.3 million. Live cattle exports increased substantially in 2001 from 2000, after four years of decline.

Most of the livestock exports are to the US. Canada exports most of the live hogs from Manitoba and secondly from Ontario for finishing and slaughter in the US (Table A.11).

In the cattle industry, Alberta is the major exporter of live animals, followed by Manitoba and Ontario to the US. Cattle exports to the US, represent over 90% of all livestock exports.

Table A.10
Total Hog and Cattle Slaughter and Farm Production, Canada, 1996 – 2001

Year	Total			*Farm Prod.
	Slaughter (A)	Exported Live (B)	Imported Live (C)	
<i>'000 head</i>				
Hog				
1996	15177.9	2780.5	2.2	17,956.2
1997	15384.6	3180.5	3.3	18,561.8
1998	16922.5	4122.7	9.4	21,035.8
1999	18952	4137.3	8.1	23,081.2
2000	19691.1	4364.1	7.9	24,047.3
2001	20677.9	5344.5	4.4	26,018.0
Cattle				
1996	3143.2	1481.1	46.8	4,577.5
1997	3257.7	1331.8	34.7	4,554.8
1998	3405.8	1288.7	62.4	4,632.1
1999	3588.7	957.5	182	4,364.2
2000	3498.7	938.1	260.3	4,176.5
2001	3433.9	1280.3	196.3	4,517.9

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

*Farm Production = (A+B-C)



Table A.11
Livestock Exports to the United States by Province (2000)

	BC	AB	SASK	MAN	ONT	QUE	MAR	Canada
Slaughter Cattle and Calves	46,247	373,248	21,724	196,663	161,459	0	64	799,405
Feeder Cattle and Calves	25,607	44,827	1,014	9,116	3,996	7	156	84,723
Total Cattle and Calves	71,854	418,075	22,738	205,779	165,455	7	220	884,128
Sheep and Lambs	701	21,903	2,609	24,005	749	0	499	50,466
Hogs	28,614	552,330	245,490	2,209,456	1,173,235	1,642	1,376	4,212,143

Livestock and Meat Imports

Canada is a significant importer of meat products, and to a lesser extent, livestock. Table A.12 below provides a snapshot of meat product imports by country in 2000. A significant source of Canadian meat imports are from the US and Australia, followed by other countries.

Canada imported some 312,00 head of cattle in 2000, mostly feeder cattle and calves (Table A.13). Very few hogs are imported into Canada. The numbers range from 5,000 to 10,000 head annually.

Table A.12
Dressed Meat Imports 2000 (tonnes)

	US	AUST	NZ	DMK	Other	Total
Beef	80,984	28,332	17,591	0	46,347	173,254
Veal	851	1,189	0	0	0	2,040
Pork	43,728	0	0	1,786	273	45,787
Lamb and Mutton	176	0	0	3,822	6,169	10,167
Edible Animal Fat	9,927	0	0	0	0	9,927

Source: AAFC Red Meat Market Information Website (<http://www.agr.gc.ca/redmeat>)

Table A.13
Livestock Imported From the United States by Province (2000)

	BC	AB	SASK	MAN	ONT	QUE	MAR	Canada
Slaughter Cattle and Calves	0	0	0	0	30039	11664	0	41,703
Feeder Cattle and Calves	15,854	179,064	25,598	2,443	24,461	22,934	0	270,354
Total Cattle and Calves	15,854	179,064	25,598	2,443	54,500	34,598	0	312,057
Sheep and Lambs	83	0	0	0	822	683	2	1,590

Supply and Demand Balance for Beef and Veal and Pork Products

The critical input for the economic analysis is the determination of the balance between supply and demand for both beef and pork products. Table A.14 and Figure A.5 provide a comparison of production,

consumption, and imports and exports for beef and pork between 1997 and 2002.

It is important to note the increase in the volume of trade. Beef and veal exports have increased from 382,000 to 580,000 tonnes over the 1997 to 2002 period (52%). Net exports, after considering imports, increased by 88%.

With respect to pork products, exports have grown even more, from 420,000 to 750,000 tonnes, or 79%. Net exports of pork, after deduction of imports have grown from 361,000 to 660,000 tonnes, or by 83%.

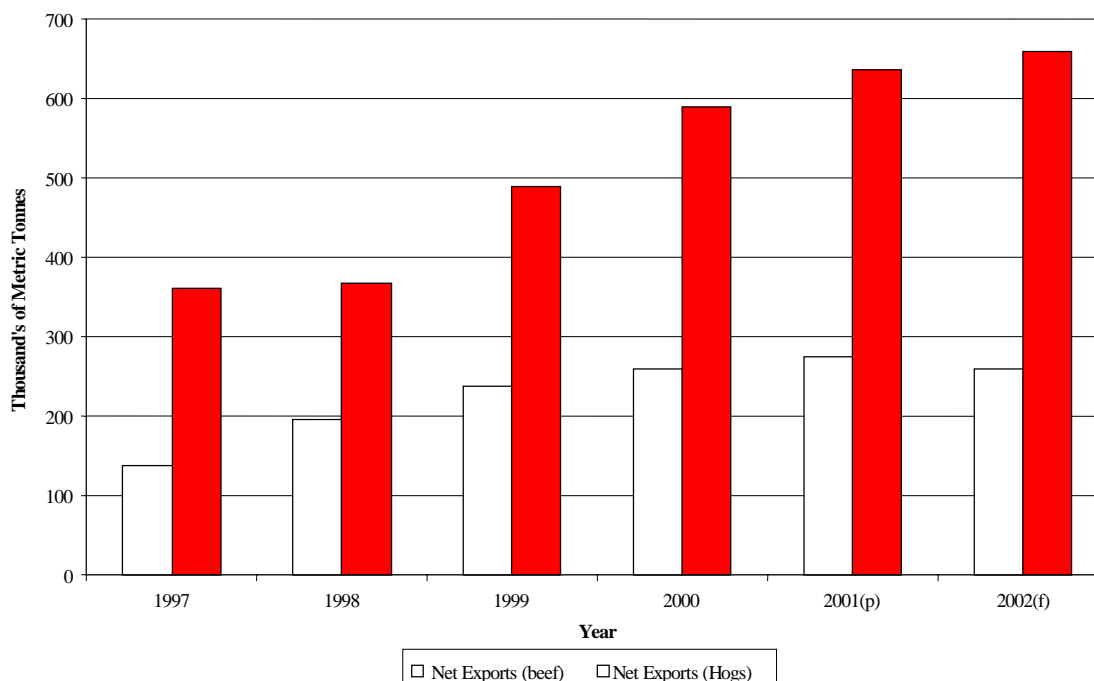
From these statistics, it is apparent that the hog industry is more exposed to the risk of a FMD outbreak, and its disruption on its export markets.

Table A.14
Canadian Beef and Veal and Hog Production, and Trade.

	1997	1998	1999	2000	2001(p)	2002(f)
Beef and Veal, (1000's tonnes)						
Production	1,075	1,150	1,238	1,246	1,235	1,214
Consumption	937	951	994	992	961	955
Exports	382	428	492	523	574	580
Imports	244	232	254	263	299	320
Net Exports (Beef)	138	196	238	260	275	260
Pork (1000's tonnes)						
Production	1,257	1,337	1,550	1,638	1,720	1,800
Consumption	889	955	1,063	1,047	1,082	1,140
Exports	420	432	554	658	727	750
Imports	59	64	65	68	91	90
Net Exports (Hogs)	361	368	489	590	636	660

Source: Statistics Canada - Cat. no. 23-603-XIE

Figure A.5
Comparative Net Exports of Beef and Veal, Pork, (1000's tonnes)



APPENDIX B

ECONOMIC MODEL MECHANICS AND LIMITATIONS

MECHANICS OF THE ECONOMIC MODEL AND ANALYSIS

This section provides an understanding of the mechanics of the logic of the economic models and the manner in which the economic impacts are developed. The mechanics of the sequence of activities with respect to the small-scale outbreak base case scenario are used as an example for this purpose.

Control and Disposal Costs

The small-scale outbreak is limited to an outbreak duration of six weeks, within which 50 livestock herds are found to be infected within one region in central Alberta. The control costs include the labour and travel costs for detection and surveillance, movement control costs, overhead and administration, as well as materials and supplies. Most of these costs are incurred in the six week outbreak period, but an additional six weeks of administration and overhead deemed practical. The additional control costs are directly related to the costs of the disposal of infected herds. In this example, all the animals of the 50 infected beef, dairy, hog and sheep herds are disposed of, together with feed supplies. The costs of cleaning and disinfecting the premises are also included in the control costs but these are not compensated under the *Health of Animals Act*. The number of animals disposed of is based on the average herd sizes for the beef, dairy, hog, and sheep herds respectively in this region of Alberta.

Trade Embargo and Recovery Period

The most critical economic assumption determining the extent of the economic and trade impacts of a FMD outbreak, are: 1) how long Canada remains excluded from trading with its export partners; and, 2) how long will it take after this period has ended to recover trade to the level enjoyed prior to the outbreak.

As a minimum, exports markets remain closed for the duration of the outbreak period, plus an additional three months (minimum OIE requirement for countries FMD-free without vaccination following stamping out). For the small-scale outbreak, the period in which Canada is fully excluded from its export markets is 4.5 month, given an outbreak period of six weeks

Once the trade embargo period is officially over, trade will recover at a gradual rate, relative to both technical and political market factors in each of Canada's major export markets. For the small-scale outbreak, this recovery factor has been set at an annual compound rate of 36%, implying that trade could be recovered in less than three years after the lifting of the embargos by individual importing countries.

Based on both the duration of the embargo period, and the subsequent rate of trade recovery, an estimate of the effective portion of a year out of the export markets within the first year is estimated. This provides the basis for estimating the impact on annual export sales of the FMD outbreak. For example, in the small-scale outbreak, the effective annualized loss in livestock and livestock product exports (from current export sales levels), is estimated at 56%, based on being out of the export market for an effective period of 6.75 months. This value is important in the estimation of the degree to which the production and processing sectors must scale-back in the event of a FMD outbreak.

FMD Sector Adjustment Factor

Underpinning the economic and trade impacts of a FMD outbreak, is the establishment of a "sector adjustment factor" which is an objective representation of the adjustment that the production and the processing sector must make to accommodate the reduced demand for livestock and meat products.

This factor is the net result of the supply and demand factors and assumptions imposed on the model in each outbreak scale. The Canadian livestock sector is assumed, in advance of a FMD outbreak, to be in

equilibrium. Supply of livestock and meat products (primarily domestic production and imports) are in balance with domestic and export demand.

The scenario assumptions with respect to export demand, domestic demand, and imports interact to determine the net annualized adjustment the sector must accommodate given the relative scale of the outbreak. A reduction in domestic demand, due to consumers shifting away from red meat consumption, compounds the impact of a FMD outbreak. A reduction in imports potentially reduces the supply of meat, and serves to help balance domestic demand and supply. Most importantly, the reduction in export demand directly creates an imbalance between supply and demand, due to the high dependence on exports for Canadian beef and hog products.

This FMD sector adjustment factor is then used as a driving factor for required adjustments needed in the processing and production sectors respectively. The larger the scale of the outbreak and the duration out of the export markets, the higher probability that this sector adjustment factor becomes a permanent reflection of the scale of the industry.

In the small-scale outbreak, in which imports are not significantly changed, the sector adjustment factors for the beef and hog sub-sectors were determined to be 20% and 18% respectively.

Primary Sector Economic Impacts

The primary sector's direct and indirect impacts are based on an evaluation of the adjustments which the beef, dairy and hog sectors must make, based on the FMD sector adjustment factors. These sectors must, in some way, reduce their current supply and production capacity relative to the calculated adjustment factors. From the current inventory of Canadian livestock breeding and market animals, a proportion of these must be disposed of. It is assumed that the full sector adjustment factor is applied to the market animals, and one-half of this factor applied to a reduction in the breeding livestock.

The disposal of these animals, or welfare slaughter, is the basis of the direct primary sector impacts. The direct primary sector economic impacts are the sum of:

- the cost of disposal of the animals;
- the cost of surplus feed and inputs; and,
- the loss of the economic value of the disposed animals.

In the small-scale outbreak, the number of "surplus" animals which would need to be disposed of range from 3.0 to 4.5 million. The model makes no statement as to the physical and social implications of slaughtering these large numbers of livestock. In the UK experience, the number of welfare animals slaughtered was determined to be 2.6 million, and the number of infected animals slaughtered was 4.1 million.¹¹ It is fully expected the proportion of welfare disposal in Canada would be significantly higher than the infected animal slaughter, given the high dependence of Canada on exports relative to the UK.

The indirect primary sector impacts are related to the impacts in the industries and communities which supply the primary agricultural sector. To determine these impacts, indirect primary sector multipliers were calculated from simulations performed by the Statistics Canada National Input-Output Model. The indirect multiplier applied to the primary sector was .87. This implies that for each \$1.00 of direct primary sector impact, there is an additional \$0.87 impact on the sectors directly affected by and supplying this primary sector.

Processing Sector Impacts

The processing sector economic impacts are first based on the calculated FMD sector adjustment factor, similarly as applied to the primary sector. In the event of an outbreak, the processing sector will be required to immediately curtail processing capacity within the plants, and export shipments in transit are arrested, returned, and otherwise disposed of. The direct economic impact is calculated, based on the economic value of the processed beef and pork products which are deemed excess to market demand. For example, in 2001, the approximate value of processed pork products was \$6.3 billion. In the small-scale outbreak situation, the FMD sector adjustment factor for the hog industry is 18%, which implies a value of excess capacity of \$1.13 billion for that sector. This forms the basis for the direct impacts to the pork processing sector, and similar estimates are made for the beef sector.

Other direct costs within the processing sector relate to the disposal costs of surplus meat. This is estimated based on assumptions of the portion of the annual supply which needs to be disposed of which is

¹¹ Productivity Commission, Research Report, and DCMS Study, 2002.



surplus both to export and domestic market needs. In the model, this is estimated as the export proportion of one month's processing capacity.

Other costs of plant closures, such as layoffs, are included in the indirect processing sector costs. The indirect costs are estimated based on the indirect multipliers extracted from the Statistics Canada National Input-Output Model. In addition, the employment impacts, both for the processing and primary sectors have been estimated, using the employment multipliers from the input-output simulations.

Tourism Impacts

The potential tourism industry impacts are based on an assessment of the total value of this industry (\$54 billion in 2001) and the degree of this value which is derived from US travelers. For example, 78% of international tourism dollars in Canada are from US visitors. International tourism represents about 30% of total tourism. In the event of an outbreak, US tourism is anticipated to be most affected and with much lesser impacts on domestic tourism activity. In the small-scale outbreak, the net tourism impact is assumed to decline by 5%, 12% in the medium-scale outbreak, and 20% in a large-scale outbreak. The duration of the reduction in tourism is projected to be for two months in the small-scale scale outbreak, four months for a medium-scale outbreak, and five months for the large-scale outbreak. The net annual impact, adjusting for the duration of reduced tourism is 0.83%, 4%, and 8.33% of the small- to large-scale outbreaks, respectively.

This results in a tourism sector impact of between \$450 million for a small-scale outbreak, to \$4.5 billion in the event of a large-scale outbreak.

These values differ considerably from those reported in recent studies of the UK outbreak and an assessment of an outbreak in Australia. These differences relate to fundamental differences between Canada's tourism industry, and its heavy reliance upon the US market, and the tourism industry in either the UK or Australia.

Other Economic Impacts

Other economic impacts have been estimated using multipliers from the Statistics Canada National Input-Output Model. These other impacts relate to the

induced impacts which the direct and indirect impacts within the primary and secondary agricultural economy create. As these sectors contract, there is an induced impact on income, employment and investment in other sectors of the economy.

Consumer Gains

In the event of a FMD outbreak there are potential gains for consumers, retailers, and other sectors which can supply close food substitutes. For example, as prices of domestic meat prices fall, consumers can be better off, as their purchasing power increases. Retailers have the opportunity to capture added margins given differential rates at which retail prices fall relative to wholesale prices. Consumers will change their preferences for different meats and other foods in response to changes in relative prices and due to perception of food safety issues.

To capture the consumer and other food industry gains, a consumer gain, or surplus has been estimated. This consumer/food industry gain is based on the gain in nominal disposal income of consumers as relative meat prices are estimated to decline. As an example, if consumers were buying 100 units at \$1.00 per unit before an outbreak, and if prices declined after an outbreak by 50%, there is a consumer gain of \$50.

Trade Losses

Trade losses are defined as the future difference between the current level of exports, to the level of trade based on the recovery allowed in the model, calculated on a quarterly basis. For example, meat and livestock exports are currently at a level of approximately \$8.0 billion annually. If the level of trade in a future recovery year has been limited to \$6 billion, the trade loss is \$2.0 billion. It is important to realize, the trade losses begin in the second year after the outbreak has begun. The first year's loss of trade is already accounted for in the losses which the processing sectors will soften in the first year or part of the year in which adjustments are being made. The trade losses as calculated are considered an opportunity cost to the agriculture and agri-food sector, and to the whole Canadian economy.

These future trade losses are considered to be underestimated, as they do not make an assumption about trade growth over this future period. Livestock



and meat exports have been increasing dramatically over the past several years. A continued growth in these exports is not considered in the determination of trade losses.

Potential for Double-Counting of Impacts and Costs

Care has been taken to ensure that there is no, or very little double-counting between the primary, processing, and trade sector economic impacts. The Canadian livestock sector is assumed to be at, or near, capacity at the time of an outbreak. In this situation, the losses due to contraction at the primary sector are independent of the losses at the processing sector, as it contracts. Due to the swift and simultaneous nature of an outbreak, this is a strong assumption.

A simple example makes this point. Let us assume the case of the Canadian livestock and meat sector as being one farmer, with 100 head of cattle, and one processing plant with 1,000 tonnes under its control at the time of the outbreak. The outbreak occurs resulting in the need to scale-back the sector by 20% on an annualized basis, due to the closure of export markets and corresponding domestic consumption adjustments. The economic methodology determines the primary sector loss due to the scale-back (disposal) of 20 head of cattle at the primary sector, and 200 tonnes of meat must be disposed of or stored by the processing sector. These are independent and additive costs with respect to the economic impacts. The further trade losses, are determined for the subsequent years, after the immediate year of the outbreak, as the trade losses in the first year are in fact already included in the processing sector's adjustment costs.

APPROACH LIMITATIONS

As in any quantitative analysis, the modelling approach is based on a number of potential limitations in terms of its representation of operational reality. There are eight main areas where the model/approach is limited in its ability to represent reality in the event of a FMD outbreak. While it is very difficult to include these factors in modelling, they must be understood in the context of a FMD outbreak, as they are significant considerations and would need to be addressed. In

general, the model includes a sensitivity analysis of the economic impacts to some of the assumptions. A significant constraint is that epidemiological factors stated in the model (duration of outbreak, number of herds to slaughter, number of herds vaccinated etc.) less dependent upon the control measures applied, than they would be in a real outbreak. No action was taken to compensate for this shortcoming. Other limitations are addressed below, and actions taken in order to reduce, or at least measure the potential impact are identified.

Homogeneity of export products: The model does not estimate the value of lost production based on the sum of all of the value on a per cut basis, and the loss is assumed to be on a whole animal unit basis. In reality, it is very likely that certain cuts – likely the higher-value ones – would be more significantly impacted than other product categories by an outbreak.

Discussions with industry experts suggest that while some of the markets for specific cuts/processed products are likely to be as significantly impacted as others, it is essential that the processors can sell the whole carcass, not just parts of it. The loss of higher-value markets for even a small portion of the product could make the processing sector unprofitable, thus not willing/able to participate in a return to the market with Canadian products.

This limitation is not specifically addressed in the analysis, but it would have the same effect as being held out of the market for an extended period of time, unless much of the processing capacity was to leave the country indefinitely, in which case the organizational structure would change forever.

Uniform financial and economic characteristics of producers and processors: The model assumes that production and processing units are uniform in scale, financial structure, and market focus. It is obvious that this is not the case. Higher-leveraged, export-focused facilities/production units would be at a much greater risk under a FMD outbreak than would other entities.

In order to address this limitation, a micro-economic analysis was conducted (Chapter 4) to observe the current financial structure of the industry and to provide an estimate of how the impacts might be felt based on its actual demographic profile.

Assumption of a smooth recovery measurement:

The model assumes that the industry recovers at some pre-specified rate of recovery over a specific period of time. Economic impacts are estimated to be the present value of these costs over time. However, the very nature of the industry, both primary and processing, is not uniform in scale, and the 80/20 rule applies. As a result of this, and the other factors already discussed, the recovery from FMD is unlikely to be a smooth process. Some facilities/producers would simply shut down, never to return. Others would potentially buy some of this capacity at low prices and become major players. This could not be modeled, but must be considered in the discussion of results.

Independence of epidemiological factors: Many of the factors being evaluated in the analysis are dependent, in part, upon each other. Epidemiological factors such as duration of outbreak, number of herds to slaughter, number of herds vaccinated etc., are dependant in part upon control measures applied during the course of the outbreak and thus, are directly and indirectly linked to the economic factors. These epidemiological factors are also dependent however, upon factors other than control measures such as environmental conditions and wilful acts of terrorism. These relationships are not fully reflected in this model, in which the initial size of the outbreak was pre-set to a fixed size and duration for small medium and large outbreaks

The analysis does not consider the relationship amongst specific control actions and the ultimate course of the disease from an epidemiological perspective. How long Canadian products remain out of the market is contingent on the duration of the outbreak which in turn is dependent on effectiveness of control measures. It is important to recognize that credibility takes a significant amount of time to build, but is very quick to dissipate once a country is no longer considered to be FMD-free, regardless of the size of the outbreak. An efficient disease control response will assure trading partners of the efficacy of veterinary infrastructure, a critical factor in acceptance of zoning. However, a small outbreak, in a remote location, can still have a significant economic impact if Canada's trading partners choose to take a conservative view of Canada's credibility.

Consumer reactions to outbreak: Consumers in developed countries, both domestically and internationally, have become increasingly interested in their food sources. The model has assumed that

consumers would behave rationally, and increase consumption of red meats as the price lowers. However, there is a non-zero probability that an average consumer would not be able to differentiate between a FMD problem and a Bovine Spongiform Encephalopathy (BSE) outbreak, resulting in a more significant and permanent shift away from red meat consumption. In fact, there is a large majority of consumers that do not differentiate between red meat and poultry products and, therefore, poultry might also be impacted. The impact could result in total consumption pattern changes.

Consumer reaction to an outbreak is virtually impossible to model, as it is very reliant on the type and extent of the media coverage of the event. For example, the recent FMD outbreak in Korea was virtually overshadowed by the coverage of the World Cup of Soccer and other internal newsworthy factors. The previous outbreak had more significant coverage and had a much larger impact on consumption.

Canada as an isolated outbreak: The model has focused on an outbreak in Canada alone. While this is a potential scenario, given the significant amount of north/south trade in animal and animal products a North American outbreak is also a distinct possibility. This is not a significant factor in the analysis, as the purpose is to estimate the economic impact on Canada of an outbreak in Canada. However, there is reason to believe that trade with the US might be impacted differently should there be FMD south of the border as well.

Disposal issues: The model does not address the activities that are undertaken in order to address the operational constraints associated with the slaughter, storage and disposal of carcasses or products that result from the significant amount of welfare slaughter that would occur in the event of a FMD outbreak. This is considered a most significant implication of the analysis, and is not directly addressed in the model. Canada simply does not currently have the capacity to address the numbers of livestock that would be affected even under the small-scale outbreak.

The pipeline of animals to processed meat products is a continuous process, and animals do not stop eating or growing because of FMD. However, if the border is shut for a period of three months, the country has to find a place for all of the livestock and products that would have to stay in the country. This problem is compounded by the fact that Canada's freezer

capacity would be effectively full within seven to ten days of the border being shut.

Yet another issue is determining who exactly would slaughter the animals, as the processors and renderers contacted in this analysis suggested that they would not do this on a voluntary basis. Although the number of animals affected is estimated for each scenario, the costs calculated do not include additional costs associated with feeding, handling and managing the animals that would now be a financial burden on their owners.

Availability of resources: The model and analysis assumes unrealistically that there are adequate resources available to manage the detection and control of an animal disease outbreak. This includes that Canada will have available sufficient veterinarians, technical support personnel, and will have access to sufficient quantities and types of vaccine.