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Report 3

A Qualitative Assessment of the Benefits and Costs of On-Farm Food Safety and Environmental Farm Plans in the Pork Sector

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On-Farm Food Safety and Environmental Farm Plans:
Identifying and Classifying Benefits and Costs

Canada

A Qualitative Assessment of the Benefits and Costs of On-Farm Food Safety and Environmental Farm Plans in the Pork Sector

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Foreword

As consumers become more sophisticated and discerning in their food purchases, Canadian agriculture and agri-food production is changing to meet the challenge. Supply chains have been formed that specifically address food safety, food quality, and environmental concerns. Even the farm gate is reassessing the way it does business. Industry initiatives are looking at the feasibility, and in many instances are already in the process, of implementing on-farm food safety programs (OFFS) and environmental farm plans (EFP). The Agricultural Policy Framework (APF) recognizes the importance of food safety and environmental concerns for the future growth of the agriculture and agri-food sector. For this purpose, Agriculture and Agri-Food Canada (AAFC) has commissioned a series of six reports to develop a conceptual framework to strengthen our understanding of the benefit and cost implications OFFS and EFP will have across the agri-food chain[1]. The conceptual framework provides a systematic approach for organizing and pulling together stakeholders and government ongoing work in determining how best to implement on-farm food safety and environmental planning. The reports also provide preliminary qualitative applications of the conceptual framework to the Canadian pork, beef, grain and dairy sectors.

This third report in the series "*On-Farm Food Safety and Environmental Farm Plans: Identifying and Classifying Benefits and Costs*" details the assessment for the Canadian pork sector. In particular, it focuses on the hog industries in Quebec, Ontario and Alberta.

The full list of reports in the series "On-Farm Food Safety and Environmental Farm Plans: Identifying and Classifying Benefits and Costs" is as follows:

Report 1: *Overview of the Development and Applications of a Conceptual Framework for Analyzing Benefits and Costs of On-Farm Food Safety and Environmental Farm Plans* by J.E. Hobbs, J-P. Gervais, R. Gray, W.A. Kerr, B. Larue and C. Wasylyniuk

Report 2: *On-Farm Food Safety and Environmental Farm Plans: A Conceptual Framework for Identifying and Classifying Benefits and Costs* by J.E. Hobbs, J-P. Gervais, R. Gray, W.A. Kerr and B. Larue

1. *The bulk of the analysis for this study was completed in March 2003, prior to the discovery of bovine spongiform encephalopathy (BSE) in a single beef cow in Alberta, and the subsequent closure of the U.S. and other countries' borders to all Canadian live ruminant and ruminant meat and meat product exports.*

Report 3: *A Qualitative Assessment of the Benefits and Costs of On-Farm Food Safety and Environmental Farm Plans in the Pork Sector* by B. Larue, J-P. Gervais, J.E. Hobbs, W.A. Kerr, and R. Gray

Report 4: *A Qualitative Assessment of the Benefits and Costs of On-Farm Food Safety and Environmental Farm Plans in the Beef Sector* by W.A. Kerr, C. Wasylyniuk, J.E. Hobbs, J-P. Gervais, R. Gray and B. Larue

Report 5: *A Qualitative Assessment of the Benefits and Costs of On-Farm Food Safety and Environmental Farm Plans in the Grain Sector* by R. Gray, M. Ferguson, B. Martin, J.E. Hobbs, W.A. Kerr, B. Larue and J-P. Gervais

Report 6: *A Qualitative Assessment of the Benefits and Costs of On-Farm Food Safety and Environmental Farm Plans in the Dairy Sector* by J-P. Gervais, B. Larue, J.E. Hobbs, W.A. Kerr and R. Gray

Executive summary

This report deals with the potential benefits and costs associated with OFFS and EFP in the Canadian pork sector. The OFFS in the pork sector is the Canadian Quality Assurance™ program (CQA). Introduced in April 1998, it is a national quality assurance program designed to minimize (or eliminate) all potential risks and to assure a high quality and safe pork supply for domestic and international consumption.

The national Environmental Management System (EMS) initiative in the Canadian pork industry establishes a voluntary national standard for hog production. The Canadian Pork Council (CPC) initiated development of the EMS standard in July 2000. The CPC mandated the Canadian Standards Association (CSA) to guide the industry through the process of developing the standard. The CSA has brought together pork producers, federal and provincial departments, universities, and environmental protection groups from across Canada to support a consensus-based standard for the Canadian pork industry.

This report provides an analysis of the main benefits and costs associated with OFFS and EFP for the Quebec, Ontario and Alberta pork industries. Differences in provincial hog marketing mechanisms, production and trade patterns are taken into account in the analysis. Enrolment in the CQA and validation of producers vary from one province to another. Yet it is already possible to identify some benefits and costs. Producers believe that OFFS in the form of the CQA are required to protect market shares in traditional markets (U.S. and Japan) and to penetrate new ones. However, the expectation is that completion of CQA certification is not likely to bring about price premiums. The CQA could become an instrument of market penetration in foreign markets if Canadian pork is competing against other foreign suppliers that have not established OFFS. Mandatory training sessions through the CQA can increase the overall productivity of hog producers and lower the average cost of production.

EFP in the hog industry have long been needed. Comprehensive environmental plans encouraging better practices must be implemented in conjunction with enforceable performance standards to prevent economic losses and environmental degradation. Similarly to the CQA, benefits of the EMS initiative are more in terms of not losing established market shares rather than in terms of price premiums. Producers have more to lose than any other group along the marketing chain from negative press about environmental problems as retailers and, to a lesser extent, processors can rely on substitution between products/inputs to mitigate losses.

Aggregate market impacts following the CQA and the EMS initiatives are likely to be modest. This is not to say that these programs do not have real impacts on the financial and economic variables affecting the bottom line of producers, processors and retailers. However, as the technical analysis in Appendix A illustrates, these programs have a multitude of offsetting effects that are not likely to impact much on market equilibria. At the producer level, a key factor will be the effect of the CQA and the EMS on the cost structure of hog farms. Will potential efficiency gains outweigh additional costs imposed by CQA and EMS validation? At this stage, it can be conjectured that there will be a modest economic gain to producers. The most important implication of the CQA and the EMS has to do with the protection and growth of market shares in pork. As such, these initiatives should contribute to the sustainable development of the pork industry across Canada.

Chapter 1

Introduction

Food safety, food quality and environmental concerns have become issues in the domestic market and in export markets for many Canadian agri-food products. A large number of industry-led and public sector initiatives are attempting to respond to these rising concerns. While these initiatives can be solely reactive, it is hoped that the changes being put in place can improve the competitive advantage of individual Canadian agri-food industries and the Canadian agri-food industry as a whole. Besides the positive effect on profitability, there may be other benefits that accrue to society from initiatives that enhance food safety and improve the environmental sustainability of agricultural production.

The APF, endorsed by the Government of Canada and most provincial governments, stresses food safety and environmental stewardship as among the top priorities for guaranteeing a strong future for Canadian agriculture. The APF considers the implementation of Hazard Analysis Critical Control Point (HACCP)-like OFFS and the implementation of EFP vital in ensuring that Canada continues to be a world leader in the agri-food industry.

This is the third report in a series dealing with the assessment of potential benefits and costs associated with proposed OFFS and EFP initiatives for Canadian agriculture. The objective of this third report is to provide a broad preliminary assessment for the Canadian pork sector. An analysis of regional differences in on-farm food safety and environmental initiatives is made. The analysis focuses on the Quebec, Ontario and Alberta hog industries.

This report is structured in five sections. The remainder of this section outlines the benefit-cost framework developed and used in this research project. Section 2 provides some background information on the OFFS initiatives in the pork sector, as well as on production and trade flows. Section 3 presents the analysis of OFFS in the pork sector. Section 4 discusses EFP. Conclusions are presented in Section 5. The technical material is consigned to Appendix A. A glossary of key technical terms and a list of abbreviations can be found in Appendix B.

1.1 The benefit-cost framework[2]

Any proposed change in the way a firm, or an industry, operates needs to be assessed before a decision can be made regarding its desirability. It does not matter if this change arises in response to an opportunity identified by the firm's management, from a change in market conditions (such as a recession) or a change in the regulatory environment within which the firm operates. If the proposed change is determined to be detrimental to a firm's profits, then alternatives can be explored or a decision made to exit from the industry. Assessments may be straightforward and as simple as "back of the envelope" calculations. In many cases, however, there may be a large number of factors that enter into the assessment of a proposed change and a more formal structure is needed to organize those factors to ensure completeness and to allow positive and negative factors to be weighed. Often the interaction among factors is complex, making it impossible to arrive at a correct assessment through informal means. One of the most long-standing and thoroughly developed aids to formal decision-making is benefit-cost analysis, and it has been employed in this study.

The benefit-cost approach has a number of advantages for decision-making in complex situations. It can be undertaken with differing degrees of sophistication and rigour. Typically, the use of the benefit-cost framework starts with a relatively simple exercise that catalogues the various expected outcomes that may arise from a proposed change in the way firms or industries operate. Outcomes are sorted into benefits and costs. This catalogue is typically very broad and not all of the listed outcomes may be applicable to each firm or industry. This broad approach is undertaken to ensure completeness.

Once the catalogue is complete, the next stage surveys those who work in the firm(s) to assess the importance of each possible outcome. This allows the important benefits and costs to be identified so that further efforts can be concentrated on the key decision variables. In many cases, once this stage is reached no further analysis is required because the broad outlines of the decision are obvious.

If the result is not clear, the use of the framework can be deepened to increase the transparency of the decision. If necessary, monetary values of key benefits and costs can be obtained. This is often expensive requiring sophisticated estimation techniques and specialised professionals. There is a clear research resources question regarding the value of improving the information pertaining to decision-making relative to the costs of obtaining the information. The important point, however, is that the consistent framework is capable of organizing increasingly sophisticated pieces of information.

Since many of the changes in the way firms or industries operate will have outcomes that span considerable periods of time, and costs may incur at different times than benefits are received, more formal benefit-cost procedures can incorporate discounting techniques. If the investment is made to obtain complete quantification of key outcomes, the discounting techniques allow comparison of the monetary benefits and costs over time, and hence determination of the dollar value of the net benefit. As many assumptions are typically needed to calculate the quantitative benefit and cost estimates, the decision-maker can also measure the sensitivity of his/her net benefit calculation to these assumptions.

2. *The Conceptual framework presented in this section is a summary of Report # 2. It is presented here for the convenience of the reader. For additional information on the conceptual model, the reader is referred to the report "On-Farm Food Safety and Environmental Farm Plans: A Conceptual Framework for Identifying and Classifying Benefits and Costs" (Hobbs et al., 2003).*

This report used a benefit-cost framework to assess OFFS and EFP. The catalogue of benefits and costs was first developed. Next, the experience of industry with already existing on farm quality control and environmental enhancement systems was used to identify the key benefits and costs. No attempt was made to deepen the analysis through the acquisition or development of quantitative measures, as this would have required far greater resources than were available. The framework provides a template upon which a formal quantitative analysis can be based. Considerable insights, however, can be gleaned from the qualitative analysis presented.

Benefit-cost analysis has one additional advantage as an aid to decision making. Private and societal benefits and costs often diverge (i.e. the costs imposed on society from water polluted by agricultural production do not show up on the financial balance sheet of the farm causing the pollution; nor do the benefits urban dwellers receive from farmers undertaking soil conservation practices that reduce dust storms). Thus, a proposed change in the way firms operate may lead to differences in the desirability of the outcome depending upon whether the private or public view is taken. Benefit-cost analysis allows both private and public benefits and costs to be incorporated into the decision-making framework in a consistent fashion. Through a comparison of the two decisions it is possible to assess the desirability of public sector intervention to encourage or dissuade private sector decisions.

Some of the costs of OFFS are obvious. There will be start-up (fixed) management costs associated with developing a plan and putting it into operation, including one-time costs associated with changes to facilities (fixed capital costs associated with compliance). There will also be ongoing (variable) management and compliance costs associated with operating the system, extra wage costs or possibly additional personnel, on-going staff training, computer equipment, updates of record keeping software, etc. Other costs may not be so obvious. If systems are not mandatory, there may be costs associated with segregating products that are produced under OFFS from those that are not, so that consumers can be assured of the quality of the products they are consuming. Whether products have been produced under OFFS protocols cannot be discerned when food is purchased or even after consumption. As a result, there must be ways of verifying that the products have been produced to this standard. Thus, there will be costs associated with monitoring production processes. There will also be costs associated with dealing with those who cheat or lack the skills to live up to their commitments.

A wide range of potential benefits have also been incorporated into the framework to evaluate OFFS. These benefits tend to be less obvious than the costs; and better illustrate the importance of using a formal framework. For example, in times of rising international concerns regarding food safety, having an OFFS in place may enhance access to foreign markets. It may also allow Canadian products to be differentiated from other products in foreign markets and allow Canadian producers to obtain a premium for their product. It may also enhance the reputation of Canadian food internationally, assisting in building a loyal base of international customers.

An OFFS can benefit consumers by reducing the costs they must incur to learn about the safety of the food they purchase. It may also benefit producers by reducing the expenditures they must make to build consumer confidence in their products, or in production through improvements in the use of inputs or an increased output (e.g. through the reduction in product condemnations or recalls). Benefits may also accrue along the supply chain, such as lower losses during transportation and less post-farm monitoring.

One of the major benefits may be the reduced liability cost arising from the ability to trace products through the supply chain when there is a break down in the food safety system. Being able to identify the farm(s) of origin may reduce the number of farms whose products must be

recalled and may also increase the speed with which an animal health problem or crop contamination problem can be dealt with. There may also be benefits that arise from isolating any firms currently free-riding on the food safety system (e.g. a farmer who feels he/she doesn't have to reduce his/her pesticide use because all the other farmers will, and no one will notice his/her high pesticide levels if everything is mixed at the grain elevator).

Many of these benefit and cost scenarios can be couched in an insurance framework whereby incurring the costs associated with OFFS acts not to eliminate a future occurrence but rather to reduce the probability that a future occurrence takes place. As some food safety problems can greatly reduce the income of a large number of farmers (e.g. a foot-and-mouth outbreak), each farmer's contribution to increased food safety acts as an insurance premium to reduce the probability of a high cost future event that affects a large number of farmers.

The benefit-cost framework for EFP is similar to that for OFFS. On the cost side there are both fixed and variable costs associated with establishing and implementing a plan. There are also monitoring and enforcement costs in terms of ensuring that plans are actually being followed and to discipline those who breach their commitments.

If the farm plan indicates that there are unacceptable environmental practices taking place in the farming operation, there may be mitigation costs associated with remedying the problem. These may be capital costs such as the installation of more sophisticated manure handling systems or variable costs such as changes to feed rations to reduce phosphorous in faecal material. As with OFFS, there may be costs associated with segregating products produced under EFP from products not produced under such plans.

Benefits from EFP arise from lowering information costs relating to the environmental friendliness of the processes used to produce food and simultaneously increasing consumer confidence in the food system. There may be benefits from being able to brand Canadian products as environmentally friendly and from reducing the costs of meeting the market access requirements of importing countries. Farmers may benefit from enhanced self-worth and community status from increasing their environmental stewardship. Putting production on an environmentally sustainable basis will increase the quality of life for Canadians and may result in reduced human health impacts from toxic spills, etc. Externalities and liabilities pertaining to air quality and odour (nuisance) problems may be reduced. There could also be positive ecosystem effects such as enhanced wildlife habitat and green house gas reductions.

Again, some of the benefit and cost scenarios can be couched in insurance terms – as cost premiums to reduce the probability of infrequent and catastrophic events. The framework can also be adapted to deal with the long-time horizons that characterize some environmental benefits.

In addition to cataloguing the benefits and costs of HACCP-based OFFS and EFP, the distributional effects of the changes to various actors along the supply chain have been examined. For example, to reap a private sector benefit from the HACCP-based OFFS will require changes to how agricultural products are monitored along the supply chain to the final consumer. The firms that participate in the supply chain will have to incur costs in ensuring that the high food standards are maintained through the supply chain and that consumers are ultimately informed of the benefits they receive. Supply chain participants may also have a chance to share in any increase in revenues that arise from the change. Where appropriate, the factors that influence how these benefits and costs are shared among supply chain participants are identified.

Individual sectors will have differences in benefits and costs depending upon factors such as

whether the industry is heavily involved in exporting and whether their products are currently branded. Where appropriate, these differences are pointed out and their effect on the efficacy of food safety and EFP initiatives are indicated.

Chapter 2

On-farm food safety initiatives in the pork sector

2.1 Introduction

At the outset, it is important to provide a brief history of how food safety initiatives in the Canadian pork sector began. The Canadian On-Farm Food Safety program (COFFS) began in 1997. It is administered by the Canadian Federation of Agriculture and is being implemented according to the following phases:

1. *Establishment of a national strategy to adopt an OFFS;*
2. *Development of a generic HACCP model, production of producer materials, running pilot projects, developing auditor training materials;*
3. *Implementation of the program through producer awareness and training sessions, auditor training, on-farm audits, development of certification system;*
4. *Official recognition of the program by the Canadian Food Inspection Agency (CFIA), a third party audit and an administrative assessment.*

The OFFS initiative of the pork industry is the Canadian Quality Assurance™ program (CQA). It was introduced in April 1998. It's main objective is to monitor and control biological contamination risks (e.g. salmonella, and E. coli bacteria); chemical risks (e.g. antibiotics, hormones and pesticides) and physical risks (e.g., foreign material in meat, such as needles) to assure a high quality and safe pork supply for domestic and international consumption. The CQA gained federal recognition in July 2004.

The CQA is based on the principles of producer education and awareness. Its development followed three major steps:

1. *Identification of potential risk areas on hog farms that could affect food safety, quality and integrity;*

2. *Identification of actions aimed at minimizing or eliminating risks;*
3. *Development of a risk-reduction plan for producers, which consists of set of documented standardized practices known as "Good Production Practices".*

The implementation steps of the CQA for a hog producer, for example, in Quebec are as follows:

1. *The producer must register with the CQA through his/her regional union office;*
2. *The CQA is explained to the producer in training sessions;*
3. *Producers must follow good production practices and keep the proper records;*
4. *A program validator checks the records kept by the producer. If problems are detected, the producer must agree to make the appropriate adjustments;*
5. *The validator visits the farm.*

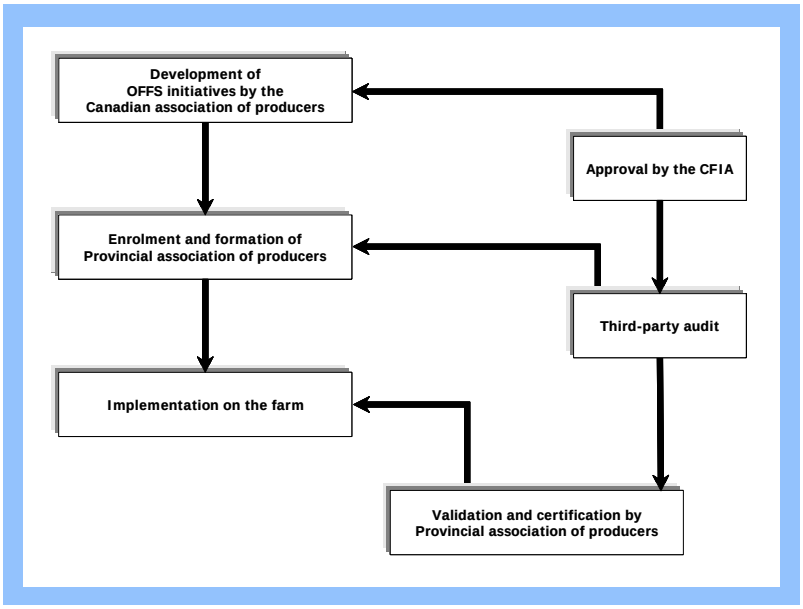
Validators are responsible for ensuring that producers are following the required production protocols and meeting the standards. The validator's role includes:

1. *reviewing the documentation of producers;*
2. *visiting the farm facilities;*
3. *making an annual partial validation through a review of the previous year's records;*
4. *making recommendations;*
5. *issuing documents attesting certification. Producers are recertified every three years.*

A certain percentage of validators are audited to verify the accuracy and consistency of the validation process and of the implementation of the whole program.

The certification mechanism of the CQA and the role of all participating parties is summarized in Figure 1. Figure 1 is adapted from a document of the Union des Producteurs Agricoles (UPA) in Quebec and illustrates the interactions between all parties involved in the implementation of on-farm food safety initiatives in Canada.

Figure 1:
On-farm food safety steps



The CQA is a voluntary program. The *Fédération des Producteurs de Porc du Québec* (FPPQ), Ontario Pork and Alberta Pork fully endorse the CQA. Alberta Quality Pork is the delivery agency for the CQA within the province of Alberta. It is responsible for training and certifying validators and for keeping producers and validators informed of any change in the program. Although enrollment in the CQA is voluntary, several processors require

farms shipping hogs to their plants to be enrolled in the program. In Ontario, two large processors (Maple Leaf Burlington and Quality Meats) require producers' validation for purchases. In Alberta, Olymel and Trochu have contract requirements related to on-farm food safety procedures. In Quebec, a monetary premium ($1/hog), effective January 1st, 2002, is paid from the total pool revenues to validated producers.

Table 1 describes the chronology of the implementation of the CQA by province. A total of 2,647 producers in Quebec are enrolled. Their herds make up 98% of all market hogs in Quebec. Although a larger number of producers are enrolled in Ontario, their herds represent only 57% of the province's production. This statistic also highlights the differences in the structure of hog farming operations in each province. It can be inferred from Table 1 that Quebec hog farms are, on average, larger than Ontario hog farms. The evidence presented in Table 1 is inconclusive with respect to comparisons involving Alberta hog farms. Hogs produced on validated enrolment in 2002 (i.e., producers who have been validated by an external audit), in Quebec, Alberta and Ontario make up 70%, 52% and 47% of the total supply in these provinces. In 2004, 80% of market hogs were enrolled in the program while 63% of Canadian hogs were raised by producers who obtained recognition within the CQA program.

2.2 *The pork industry*

Before presenting the benefits and costs of the CQA, production and trade patterns in Quebec, Ontario and Alberta are briefly described. It is important to understand the differences in production and trade patterns between these three provinces as this can effect the impact of the OFFS in each province.

Figure 2 illustrates annual hog production in Quebec, Ontario and Alberta from 1990 to 2001. Hog production has steadily increased in all three provinces during the last decade. The increase in production is more noticeable in Quebec and Ontario than in Alberta during the second half of the decade.

Figure 2:
Annual hog production in Quebec, Ontario and Alberta

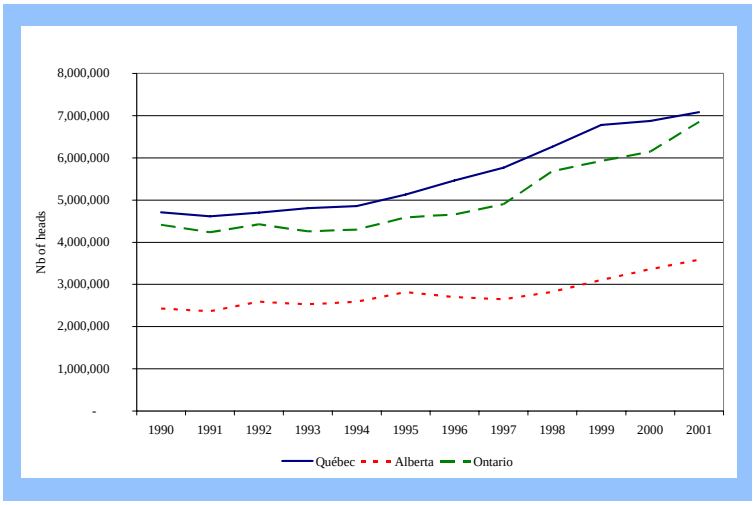


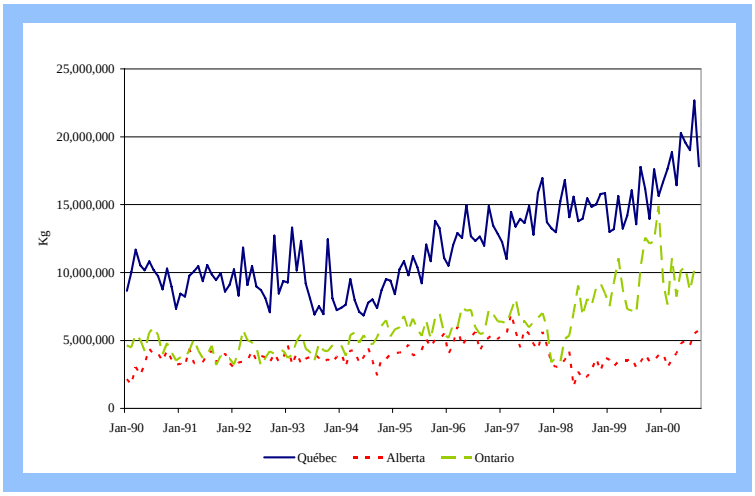
Table 1: Implementation progress in Canada of the CQA™

	CQA enrolment				Validated enrolment				
Province	Producers	Sows	Market hogs	% market hogs	Producers	Sows	Market hogs	% market hogs	Evaluators trained
British Columbia	25	-	199,802	67.7	6	-	56,000	19.0	1
Alberta	571	150,469	2,823,186	80.1	302	94,139	1,822,223	51.7	31
Saskatchewan	692	499,048	1,247,591	72.8	248	38,400	960,000	56.0	31
Manitoba	1,528	-	3,000,000	51.0	605	-	750,000	12.7	42
Ontario	3,650	-	3,900,000	57.3	2,153	-	3,219,986	47.3	68
Quebec	2,647	359,015	6,944,883	98.1	1,593	213,427	4,951,880	69.9	47
New Brunswick	96	-	176,063	74.5	55	-	109,368	46.3	9
Nova Scotia	119	-	358,652	92.7	101	-	342,914	88.6	3
Prince Edward Island	102	13,269	200,345	94.2	37	5,960	102,579	48.2	7
Newfoundland	-	-	-	-	-	-	-	-	-
CANADA	9,430	1,021,801	18,850,522	72.5	5,100	351,926	12,314,950	47.4	239

Note: Alberta and Quebec statistics are reported as of the end of the second quarter of 2002. Manitoba statistics are reported as of the end of the first quarter of 2001.

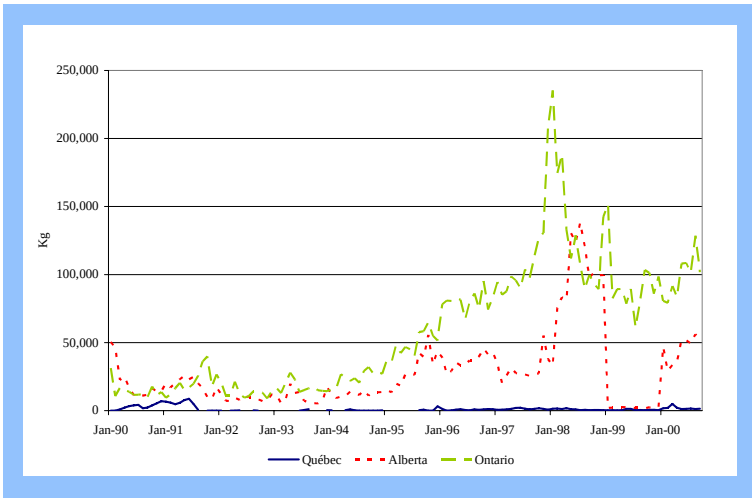
Figure 3 illustrates monthly pork exports from January 1990 to September 2000. Beginning in 1994, monthly pork exports from Quebec have increased at an average monthly rate of 2%. Exports from Ontario have increased at a slower rate. Pork exports from Alberta reached a peak in March 1997, quickly decreased to an all-time low in May 1998, and increased slowly thereafter. This latter period coincides with a surge in exports of live hogs from Alberta as depicted in Figure 4. Ontario and Alberta have exported significant volumes of live hogs in recent years, mainly to the U.S.[3]

Figure 3:
Monthly pork exports in Quebec, Ontario and Alberta



Historically, exports of live hogs from Quebec have been very low. The differences in trade patterns in Quebec can be explained by several factors. One of the three marketing mechanisms used in Quebec – the pre-attribution mechanism through which 55% of the hogs are marketed – guarantees the U.S. price to hog producers while the other two mechanisms, the daily electronic auction and the so-called English contract (i.e. the auctioning of monthly supplies which began in April 2000) have generated prices in excess of the U.S. price more often than not.[4] Figure 5 illustrates the prices generated by the three mechanisms between 1996 and 2002. Because Quebec hog producers participate in a revenue insurance program, the price they receive is at times above the average of the three prices plotted in Figure 5. Under these circumstances, Quebec hog producers have little incentive to export live hogs. Finally, Quebec hog producers are far away from the large processing facilities of the U.S. Midwest and as such they are confronted with a stiffer natural trade barrier than western Canadian hog producers.

Figure 4:
Monthly hog exports in Quebec, Ontario and Alberta



3. According to Ontario Pork, U.S. processors have indicated that they will require Ontario transporters delivering hogs to their slaughtering plants to become certified by the Trucker Quality Assurance program (TQA). The TQA was created by the National Pork Board to educate truckers on the importance of proper handling loading and transportation of hogs with attention to bio-security and animal welfare. Along with TQA and HACCP-certification for millers and processing plants, the whole supply chain for the pork sector will have developed food safety initiatives with the completion of the CQA.

4. The interested reader is referred to Larue et al. (2000) for a review of the Quebec hog/pork industry and its marketing mechanisms.

Finally, it is interesting to look at the evolution of pork export unit values in the three provinces. Unit values of pork exports are calculated by dividing the total value of exports by the quantities of pork exported. Figure 6 shows that unit values of pork exports from Quebec have been consistently below the unit value of pork exports from Ontario and Alberta. Quebec's unit values are also less volatile than in the other two provinces. These differences are directly linked to each province's volume of live hog exports. The large spikes in Ontario and Alberta's unit values correspond to periods of low/high exports of pork/live hogs. With fewer hogs being domestically processed, cheaper cuts remained in Canada while relatively more expensive cuts were exported. When the volume of hogs domestically processed is larger, it becomes profitable to increase the share of cheaper cuts in the export bundle.

Figure 5:
Weekly prices generated by Quebec's three marketing mechanisms between 1996 and 2002

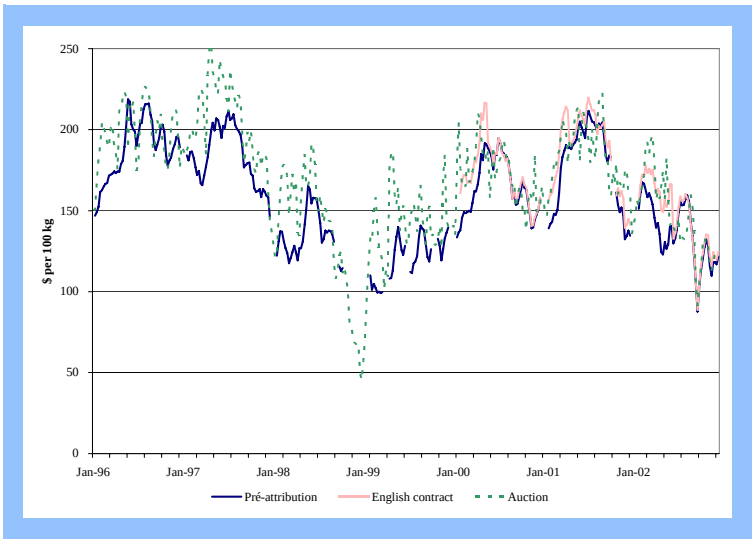
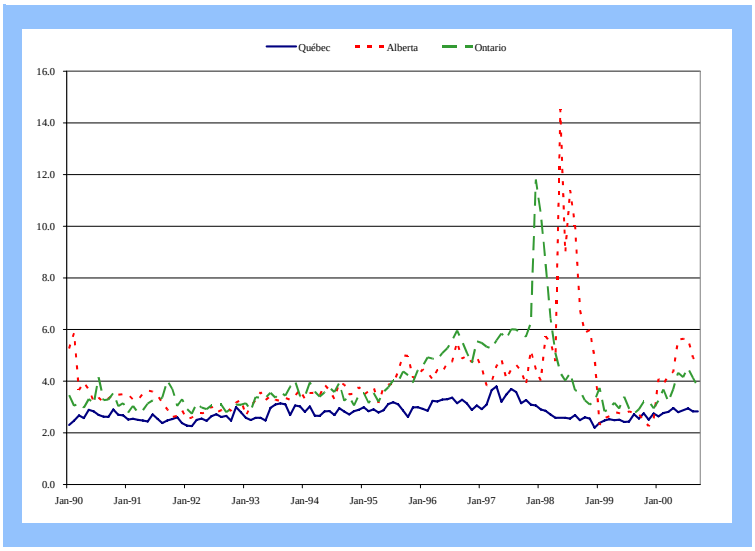


Figure 6:
Export unit values for Quebec, Ontario and Alberta



Chapter 3

Identifying the benefits and costs of on-farm food safety

Industry stakeholders were interviewed to determine the relative importance of the benefits and costs identified in the conceptual framework developed for this project. Table 2 summarizes the potential private benefits of implementing the CQA. In particular, it shows the benefits associated with demand-side effects (i.e. benefits originating from variations in the decision variables of end-users – both domestic and foreign consumers, and processors). Table 3 identifies the supply-side benefits of implementing the CQA; (i.e. the benefits associated with variations in the production decisions of producers).

Table 2: Potential demand-side benefits of on-farm food safety in hog production

DEMAND-SIDE BENEFITS	DESCRIPTION
Domestic market:	
Reduce transaction costs for consumers	Reduce substitution effects between farm products. Will tend to increase demand for pork products if consumers' perceptions are that pork meat is safer than other meat products
Build consumer confidence	Premiums may not be easily collected from consumers. However, if food safety initiatives increase demand, it could lead to higher prices at the retail, wholesale and/or farm level
	Currently, a premium of $1 per hog is being paid to certified Quebec producers. The premium is paid from the pool so it constitutes a cross subsidy from uncertified to certified producers. The premium is likely to disappear as the proportion of certified producers keeps rising. In other provinces, hogs from uncertified producers are discounted by as much as $3. Marketing mechanisms seem to have an important impact (i.e. pool in Quebec versus private contracts in Ontario and Alberta)

Table 2: Potential demand-side benefits of on-farm food safety in hog production (Continued)

DEMAND-SIDE BENEFITS	DESCRIPTION
International markets:	
Provide differentiation on the international market	Producers believe HACCP is an instrument to protect market shares in traditional markets (U.S. and Japan) and to penetrate new markets. No premiums can be obtained for certification, but it could be a *sine qua non* condition to get a sale
Reinforce and develop trade networks	Potential increases in market penetration in foreign markets if Canadian pork is competing against other foreign suppliers that have not established OFFS. However, foreign customers are not likely to pay more
Facilitate trade by reducing non-tariff barriers	Reduce marketing costs to communicate the nature of quality management systems and after-sale service. However, it is ambiguous where the reduction in costs will go. It can be translated either into lower prices for consumers and/or higher profits along the supply chain (retailers, processors and/or producers)

Table 3: Potential supply-side benefits of on-farm food safety in hog production

SUPPLY-SIDE BENEFITS	DESCRIPTION
Efficiency gains at the farm level:	
Improve the productivity of inputs	The mandatory training session at the beginning of the CQA program and the three months of training after which the producer is audited is believed to increase the over-all productivity of hog producers and lower the average cost of production. CQA forces producers to use inputs more efficiently and should lower the costs of production
Efficiency gains in business relationships between producers, processors and retailers:	
Reduce logistics costs	Reduce the costs of processing contaminated (or otherwise problematic) animals and contribute to improving the overall efficiency of the supply chain
Ex-post cost reduction following detection of contaminant in food	Reduce the costs associated with product recalls
Reduce measurement costs: performance versus process standards	Reduce expected losses in the event of a serious (contamination) incident and reduce the probability of a serious incident. Best practices do not eliminate all risks
Reduce monitoring and enforcement costs	
Reduce product liability costs	

Table 4 identifies the private costs of implementing the CQA.

Table 4: Potential private costs of on-farm food safety in hog production

SUPPLY-SIDE COSTS	DESCRIPTION
Management and compliance costs	Variable costs are more important than fixed costs, but overall costs depend on the age and degree of decay of buildings and facilities. The most important variable cost is the opportunity cost of the time required for record keeping. Fixed costs may include modifications to the buildings or other fixed capital to comply with the CQA guidelines. Some producers may have to make more adjustments in terms of fixed costs than others producers with newer facilities. The measurement of cost differences would require surveying farms
Sunk investments	Suppliers are vulnerable to opportunistic behaviour by processors if buyer-specific HACCP sunk investments are made. Although CQA reduces the extent of sunk investments, it is believed it still exists. The extent to which some processors' (such as Ménard and Maple Leaf) own requirements that are added on to CQA reduces the ability of producers to switch between processors remains to be evaluated

Table 5 summarizes the potential benefits and costs of implementing the CQA according to four different types of OFFS approaches. The table is based on a qualitative assessment of benefits and costs from discussions with industry stakeholders.

Table 5: Benefits and costs of alternative OFFS for the pork industry

	Voluntary industry-wide OFFS	Enforced industry-wide OFFS	Buyer specific OFFS	Regulatory standards
Benefits				
Reduce transaction costs for consumers	Minimal	Minimal	Moderate	Minimal
Build consumer confidence	Moderate	Moderate	Moderate	Moderate
Convey additional information	Minimal	Minimal	Significant	Minimal
Provide differentiation on international markets	Moderate	Moderate	Moderate	Moderate
Facilitate trade by reducing NTBs	Moderate	Moderate	Moderate	Moderate
Reinforce and develop trade networks	Minimal	Minimal	Moderate	Minimal
Improve productivity of inputs	Moderate	Moderate	Minimal	Minimal
Improve efficiency in production	Minimal	Minimal	Minimal	Minimal
Reduce logistic costs	None	None	None	Minimal
Reduce measurement costs: performance vs process standards	None	None	None	Minimal
Reduce monitoring and enforcement costs	Minimal	Minimal	Minimal	Minimal
Reduce product liability costs	Minimal	Minimal	Minimal	Minimal
Reduce ex-post cost following contamination	Moderate	Moderate	Moderate	Minimal
Reduce free-rider impacts	Minimal	Minimal	Minimal	Minimal
Reduce incidence of foodborne illness	Minimal	Minimal	Moderate	Minimal
Reduce information asymmetry	Minimal	Moderate	Minimal	Minimal

Table 5: Benefits and costs of alternative OFFS for the pork industry (Continued)

	Voluntary industry-wide OFFS	Enforced industry-wide OFFS	Buyer specific OFFS	Regulatory standards
Total benefits	Moderate	Moderate	Moderate	Minimal
Costs				
Management costs				
fixed – establishing the HACCP plan	Significant	Significant	Significant	Significant
variable – revising plan to reflect external changes	Significant	Significant	Minimal	Moderate
Compliance costs				
fixed – capital costs	Moderate	Significant	Moderate	Moderate
variable	Very minimal	Minimal	Minimal	Minimal
Sunk investments				
Risk of hold-up	Minimal	Minimal	Significant	None
Monitoring and enforcement costs				
fixed	Minimal	Minimal	Minimal	Moderate
variable	Moderate	Significant	Moderate	Moderate
Total costs	Moderate	Moderate	Significant	Minimal
TOTAL NET BENEFITS	**Minimal benefit**	**None**	**Minimal cost**	**None**

3.1 Modeling the effects of OFFS

Appendix A of this document provides a technical analysis of the economic impacts of the CQA at various stages of the supply chain for pork products. It also includes a preliminary estimate of the quantitative impacts of implementing OFFS in the province of Quebec. A more detailed explanation of the technical model is presented in Appendix B of the conceptual framework document (Hobbs et al., 2003a).

The analysis is presented for different scenarios of the demand and supply-side benefits and costs listed in the previous section. The assumptions underlying this analysis are explained in Appendix A. Different outcomes for the Quebec, Ontario and Alberta hog industries are predicted based on their differences in production and export trends. Note that a similar type of graphical analysis, as is carried out when live hog exports are positive, is also applicable for the beef and grain sectors. Two principal issues are analyzed to determine how prices and quantities are impacted. First, the effects of implementing OFFS on the cost structure of producers is explored. As argued before, the net effect of the CQA on producers' costs can be either positive or negative. Second, the potential implications of on-farm food safety initiatives on the demand for farm and processed products is also explored.

A number of different scenarios are possible.

Scenario 1: First, suppose OFFS increases the marginal costs of producers. Given the assumption of free trade and the net export position of the province, the domestic price of live hogs is unchanged. However, the increase in producers' costs causes a decrease in production which results in a decrease in live hog exports proportional to the decrease in hog production. Other variables in the supply chain are unaffected. The assumed negative impact of the OFFS is not transmitted downstream to processors and consumers. Naturally, any benefits stemming from implementing the OFFS would also be captured exclusively by producers.

Scenario 2: The situation would potentially be different if no exports of live hogs existed before implementing HACCP at the farm level. Assume that the domestic price for hogs is higher than the world price (adjusted for transportation costs). This represents the pork sector in Quebec. The initial impact of the increase in producers' costs due to the OFFS implementation is to increase the farm price and thus reduce the supply of pork products by domestic processors because their input costs have increased. With free trade in pork products, the domestic price of pork would remain constant. The farm price of live hogs increases, but both processors and producers are worse off due to the decrease in hog production and pork exports.

Scenario 3: Implementing HACCP at the farm and processing levels can also have positive implications. More specifically, suppose HACCP-induced efficiency gains decrease both producers' and processors' costs. There will be an increase in hog production but it does not affect the farm price if there is free trade. Quantities processed by domestic processors increase. The increase in domestically processed pork is all exported. The economic surpluses[5] of producers and processors increase following the implementation of HACCP.

Scenario 4: It is also important to consider the impact of HACCP on foreign markets. As previously discussed, food safety initiatives at the farm level can bring about a differentiation of Canadian pork products although these potential benefits are likely to be small if positive at all. Assume that the CQA increases the demand for Canadian pork and hogs. This increases hog and pork domestic prices because of free trade. The final effects are increases in live hog and pork exports, and in hog production. But domestic pork consumption decreases due to higher prices. These effects unambiguously decrease consumers' benefits (consumer surplus) and increase producers' benefits (producer surplus). The impact on processors is ambiguous because of the effect on the domestic price of live animals. Processors sales increase but purchases of their necessary inputs cost more than before the implementation of the OFFS.

Scenario 5: Finally, assume that implementing food safety initiatives at the farm level increases domestic consumers' demand. Under the assumptions explained in Appendix A (free-trade and the small country assumption), the domestic price of pork products does not change as Canadian provinces remain net exporters of pork products. Hence, given the constant domestic price, domestic consumption of pork products increases and exports decrease. Producers and processors do not benefit from this positive demand-side effect of food safety initiatives since prices remain constant at all market levels. Hog production also remains constant.

3.1.1 Numerical Simulation

A numerical simulation serves to highlight the potential magnitude of some of the demand and supply side changes discussed above. Full details of the simulation are provided in Appendix A. A model of the Quebec pork sector is constructed in the appendix that accounts for the revenue-insurance program, Assurance Stabilisation du Revenu Agricole (ASRA). First, a benchmark equilibrium is defined, which is then used to assess the relative impacts of simulated food safety shocks. Two different scenarios and a risk analysis are presented. The first scenario assumes a boost in consumer confidence at home and abroad that translates into a higher world price and an enlarged domestic market. The second scenario assumes that the implementation of on-farm

5. *Economic surplus is a measure used by economists to evaluate the gross benefits associated with a particular market equilibrium. Changes in economic surpluses are used to compute the net benefits (positive or negative) accruing to a particular segment of the economy following a policy change or changes in the decision variables of a particular set of agents. The interested reader can refer to Varian (2002) for further details on the concepts of consumer surplus and producer surplus.*

food safety measures induces an increase in efficiency on the part of hog producers. The third scenario is a simulation of a crisis that brings about major reductions in domestic demand and in the world price of Canadian pork.

The optimistic scenario of demand-side benefits, which features positive shifts in domestic and foreign pork demands due to greater consumer confidence in pork, brings a higher hog price, but the increase is not sufficient to provoke a change in supply because of ASRA. Consumer surplus increases in spite of the higher pork price and export sales decrease. Processors benefit from the higher pork price. Given that ASRA costs are being financed by the provincial and federal governments (66.7%) and hog producers (33.3%), hog producers and taxpayers also gain under the optimistic scenario. The net welfare gain relative to the benchmark case is $12.2 million; which represents an increase of 5.8% over the benchmark welfare level.

The second scenario showcases the effect of efficiency gains in hog production. Total welfare decreases by $22 million because it makes ASRA more expensive through enlargement of the subsidy base and the subsidy margin although there is a productivity improvement. Gains accruing to hog producers and pork processors are too small to make up for the loss to taxpayers, hence the $22 million welfare loss.

The crisis scenario is one in which Quebec would have to export its pork at a much lower price to get rid of its ASRA-determined supply under a depressed domestic market. Under such a scenario, the adjustment on the domestic hog price would be brutal. The lower domestic demand for pork would bring about lower consumer surplus in spite of the drastic reduction in the price of pork. Producer surplus would fall due to the reduction in the price of pork in spite of the positive effect of the much lower hog price. Having to export in a context of depressed domestic demand, the gains from trade are very large, but the overall welfare is low due to the astronomical ASRA cost. The welfare loss relative to the benchmark slightly exceeds $584 million. A scenario with a completely closed border would have a similar qualitative effect. Hog production would remain high as long as ASRA remains unchanged. However, the market price for hogs would fall further and some hogs might have to be destroyed. This would inflate further the cost of the ASRA program.

Assume that the probability of a crisis is 1%. This is most likely too high, but it will illustrate an aspect of the so-called insurance motive for OFFS. To properly isolate the insurance value, it is assumed that the only benefit generated from OFFS is to cut in half the probability of a serious food safety problem. It is assumed that with or without OFFS, a crisis lasts two years when it happens. The change in probability due to OFFS is worth $5.72 million. Consider another aspect of the insurance motive for OFFS by assuming that the probability of a major problem is the same with or without OFFS, but that the duration of the problem is shortened by a year in the presence of OFFS. Given the probability of a crisis, the value of OFFS is $5.59 million. Naturally, the value of OFFS could be even higher if it reduced both the probability of a crisis and the length of potential crises. Interested readers can find greater details about the simulation in the technical appendix.

Chapter 4

Environmental farm plans

4.1 *Introduction*

The Environmental Management System (EMS) initiative establishes a voluntary national standard for hog production. The Canadian Pork Council (CPC) initiated development of the EMS standard in July 2000. The CPC mandated the Canadian Standards Association (CSA) to guide the industry through the process of developing the standard. The CSA has brought together pork producers, federal and provincial departments, universities and environmental protection groups from across Canada to support a consensus-based standard for the Canadian hog industry. The key development aspects of the standard are:

1. *It will be complementing regulation (not substituting for environmental policies, laws and regulations);*
2. *It will combine environmental management system and performance-based aspects while maintaining flexibility and innovation in meeting farm-based goals and objectives;*
3. *It will be designed such that it may be practically and economically implemented by hog farmers;*
4. *Conformity with the standard must be verifiable by independent third parties.*

Pilot projects were started in late 2004 to test the implementation tolls and audit abilities. Fifteen farms have been chosen to verify the accessibility and audit ability of the draft EMS standard for hog operations.

Initiatives at the provincial level are also being developed. For example, the agro-environmental plan of Quebec hog farmers initiated in 1997 has three main components:

1. *Establishing the environmental outlook of hog production in Quebec;*
2. *Providing technical support to hog producers;*
3. *Offering environmental certification.*

The first component of the Quebec initiative produced two environmental portraits of the industry (1996 and 1998) which were used to establish specific agro-environmental objectives for 2004. These technical objectives are described in a FPPQ document (2002). Broadly, these objectives will be achieved by:

1. *Improving technical knowledge of production practices to minimize the negative impacts on the environment;*
2. *Educating and training producers in implementing environmentally respectful production practices;*
3. *Encouraging environmental certification.*

The environmental problems (air and water pollution mostly) that accompanied the growth of the Quebec hog industry have attracted a lot of media attention and a moratorium has been imposed to appease the public.[6] The moratorium prevents hog production from expanding in regions that do not have environmental problems. But, it cannot erase the environmental damage that has already occurred (and continue to occur) in regions with excessive manure supply. As such, this temporary measure is not efficient, but it provides time to develop a proper response to the crisis. One might wonder why the environmental plan failed to prevent the crisis given that the FFPQ had enough foresight to initiate it in 1997. Like the European mad cow crises and dioxin contamination, the magnitude of the Quebec environmental problems and the reaction of the public toward these problems were underestimated for too long. Until recently, the main concern was to adequately contain stocks of manure, as demonstrated by the generous subsidization of manure-storage facilities. The environmental plan encouraged the adoption of environmentally-friendlier practices by hog producers, but it could not convey the sense of urgency to producers the way strict enforceable performance standards could to prevent soil saturation. The main lesson is that comprehensive environmental plans encouraging better practices must be implemented in conjunction with enforceable performance standards. In fact, the performance standards in the new regulations in Quebec will undoubtedly boost participation in so-called 'environmental-management clubs'.

The Alberta Pork Sustainable Environment Initiative also endorses the Alberta Environmentally Sustainable Agriculture program (AESA). The AESA is a voluntary, whole farm, self-assessment program that helps producers identify risk areas and provides an opportunity to them to document due diligence. The two pillars of the AESA initiative are to:

1. *Transfer new technology and information to farmers and processors to minimize environmental impacts;*
2. *Monitor soil and water quality to track the industry's effects on these resources.*

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6. *A first moratorium was enforced in over 200 municipalities as of June 2001. In May of 2002, a 6-week province-wide moratorium was instigated at the request of the UPA. In mid-June of 2002, new environmental regulations were adopted, but it was decided that no permits regarding expansion of existing facilities or the construction of new ones would be delivered for at least the next 18 months. Quebec's environment minister also requested that the Bureau d'audiences publiques sur l'environnement (BAPE) conduct a public inquiry to identify ways for the hog industry to grow without environmental degradation. BAPE's recommendations are to be released no later than September 2003.*

4.2 *Identifying benefits and costs of environmental farm plans*

The following tables identify the potential demand and supply-side benefits and costs of EFP in the pork sector. The categories are drawn from the conceptual framework outlined in report #2 of this series, (Hobbs et al. 2003a). Information was gathered through interviews with industry stakeholders.

Table 6: Potential private demand-side benefits of environmental farm plans in hog production

DEMAND-SIDE BENEFITS	DESCRIPTION
Domestic market:	
Build consumer confidence	How much does a moratorium cost to producers? EFP can perhaps prevent the sort of crisis afflicting the Quebec hog industry. Even though the moratorium has no direct cost to producers, it definitely costs money for producers in terms of lost market opportunities at the present time and in the future due to tougher regulations
Convey additional information (when used with identity preservation systems)	Similar to OFFS, benefits are more in terms of not losing established market shares than in terms of premiums. Environmental certification is geared toward environmental concerns. The negative press is not good for business. Retailers do not suffer as much as producers from the negative publicity because of substitution between farm products. Conversely, processors and producers are usually not diversified (although horizontal integration exists in processing activities)
International markets:	
Provide differentiation on the international market	Especially when integrated with product integrity (animal welfare, etc.) certification, there may be additional niche markets for Canadian pork. Price premiums for environmentally clean pork may not be large if they exist at all
Facilitate trade by reducing non-tariff barriers Reinforce and develop trade networks	Could environmental standards be treated as a trade issue by the WTO in a context of multifunctionality? In other words, can payments to producers be tied to environmental certification? Would this make it easier for government to circumvent domestic support commitments to maintain or increase support to producers?

Table 7: Potential supply-side private benefits of environmental farm plans in hog production

SUPPLY-SIDE BENEFITS	DESCRIPTION
Improve efficiency in production	Improve efficiencies through reduced resource use and waste Improve relations with neighbours through more efficient odour management strategies
Reduce monitoring and enforcement costs	Demonstrate compliance with applicable laws and regulations and thus may decrease monitoring costs for the industry Eliminate or minimize environmental incidents and in the process demonstrate due diligence in the event of prosecution or litigation. It could also lead to a reduction in the environmental risk assessed by insurance and lending institutions; leading to lower insurance premiums
Reduce free-rider impacts	Reduce vulnerability to environmental disaster in non-adopter sector

Table 8: Potential private costs of environmental farm plans in hog production

SUPPLY-SIDE COSTS	DESCRIPTION
Planning costs Management and mitigation costs	Producers believe that investments are larger for EFP than for implementing OFFS. Variable costs are also larger. Unlike food safety initiatives, this could have an impact on the structure of farms; especially in Ontario where hog farms are generally smaller than in Quebec

Table 9 summarizes the potential benefits and costs of implementing EFP in the pork industry according to two different institutional scenarios. The table is a qualitative assessment based on interviews with industry stakeholders.

Table 9: Institutional comparisons of the benefits and costs of EFP for the pork industry

	Voluntary EFP	Land use regulations
Benefits		
Reduce transaction costs for consumers	None	None
Build consumer confidence	Minimal	Significant
Convey additional information	Minimal	None
Provide differentiation on international markets	Moderate	None
Facilitate trade by reducing NTBs	None	None
Reinforce and develop trade networks	None	None
Reduce monitoring costs	Moderate	None
Reduce free-rider impacts	Minimal	Minimal
Provide non-pecuniary benefit to producers	Significant	None
Reduce negative human health	Moderate	Moderate
Reduce negative impact on farm assets	Moderate	Minimal
Improve local ecosystem effects	Moderate	Moderate
Total benefits	Moderate	Minimal
Costs		
Planning costs		
fixed – establishing the framework	Significant	Significant
variable – revising policy	None	Significant
Monitoring costs		
fixed	Minimal	Significant
variable	None	Significant
Mitigation costs		
fixed – capital costs	Minimal	Significant
variable	None	Significant
Total costs	Minimal	Significant
TOTAL NET BENEFITS	**Minimal to moderate benefit**	**Minimal to moderate to cost**

Chapter 5

Conclusions

The objective was to provide an analysis of the main benefits and costs associated with OFFS initiatives and EFP for the Quebec, Ontario and Alberta hog industries. Notwithstanding the specific considerations outlined in the text pertaining to differences in provincial hog marketing mechanisms, the conclusions can be extended to other provinces in Canada. The CQA is the voluntary food safety program implemented by hog industries across Canada. Enrolment in the CQA and validation of producers varies from one province to another. Yet, it is already possible to identify some benefits and costs. Producers believe that OFFS initiatives in the form of the CQA are required to protect market shares in traditional markets (U.S. and Japan) and to penetrate new ones. However, the expectation is that completion of CQA certification is not likely to bring about price premiums. The CQA could become an instrument of market penetration in foreign markets if Canadian pork is competing against other foreign suppliers that have not established OFFS. Mandatory training sessions through the CQA can increase the overall productivity of hog producers and lower the average cost of production.

The national EMS initiative is to establish a voluntary national standard for hog production. However, EFP in the hog industry have long been needed. Comprehensive environmental plans encouraging better practices should be implemented in conjunction with enforceable performance standards to prevent economic losses and environmental degradation. Similar to the CQA, benefits of the EMS initiative are more in terms of not losing established markets shares than in terms of gaining price premiums. Producers have more to lose than any other group along the marketing chain from negative press about environmental problems as retailers and, to a lesser extent, processors can rely on substitution between products/inputs to mitigate losses.

Industry stakeholders indicated that there are unlikely to be synergies between OFFS and EFP in the hog industry. Aggregate market impacts of the CQA and the EMS initiatives are likely to be modest. This is not to say that these programs do not have real impacts on the financial and economic variables affecting the bottom line of producers, processors and retailers, but as the technical appendix illustrates, these programs have a multitude of offsetting effects that are not likely to have much of an impact on market equilibria. At the producer level, a key factor will be the effect of the CQA and the EMS on the cost structure of hog farms. Will potential efficiency gains

outweigh additional costs imposed by CQA and EMS validation? At this stage, it is conjectured that the economic surplus of producers will modestly increase. The most important implication of the CQA and the EMS has to do with the protection and growth of market shares in pork meat markets. As such, these initiatives will contribute to the sustainable development of hog industries across Canada.

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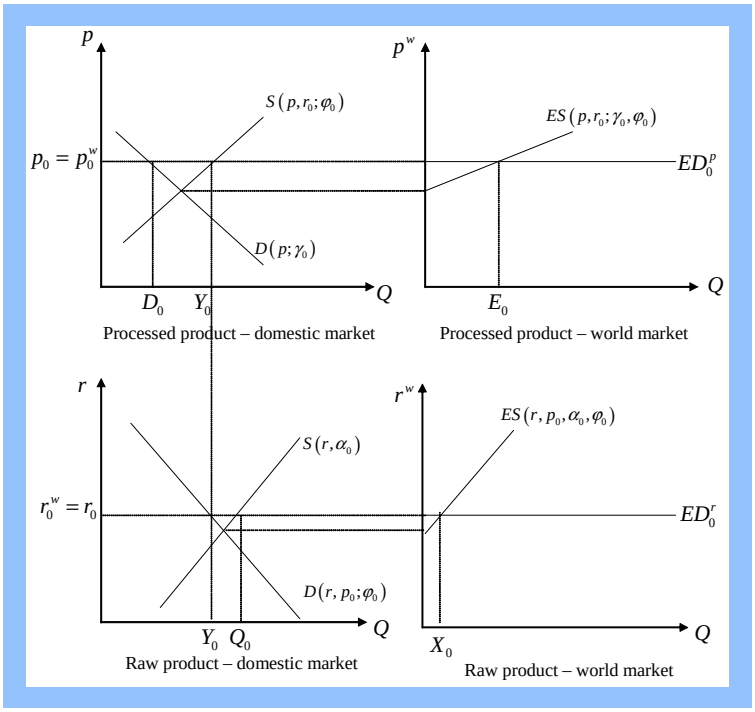
Technical appendix

APPENDIX A

This section presents a technical analysis of the economic impacts of the CQA at various stages of the supply chain for hog/pork products. A more detailed explanation of the technical model is presented in Appendix B of the conceptual framework document (Hobbs et al., 2003a). The analysis is presented for different scenarios of the demand and supply-side benefits and costs listed in the previous section. Different outcomes for the Quebec, Ontario and Alberta hog industries are predicted based on their differences in production and export trends. A numerical simulation of the analysis follows.

Figure 7 represents the initial market equilibrium in the live hog and pork markets. The bottom left diagram depicts the domestic market for live hogs in a given province. The marginal cost curve of hog producers determines the supply of live hogs. Given the domestic demand of processors for live hogs, the export supply curve onto the world market is represented in the bottom right diagram. It is assumed that exporters of live hogs face constant terms-of trade (i.e., the small country assumption). Domestic production of live hogs is denoted by the quantity Q_0. Given free trade in live hogs, processors' purchases of live hogs are made at a price of r^w and are denoted by Y_0. This implies that a quantity X_0 of live animals is exported. Note that this market structure seems to represent markets in Ontario and Alberta based on their production and trade patterns.

Figure 7:
Initial market equilibrium in the pork sector



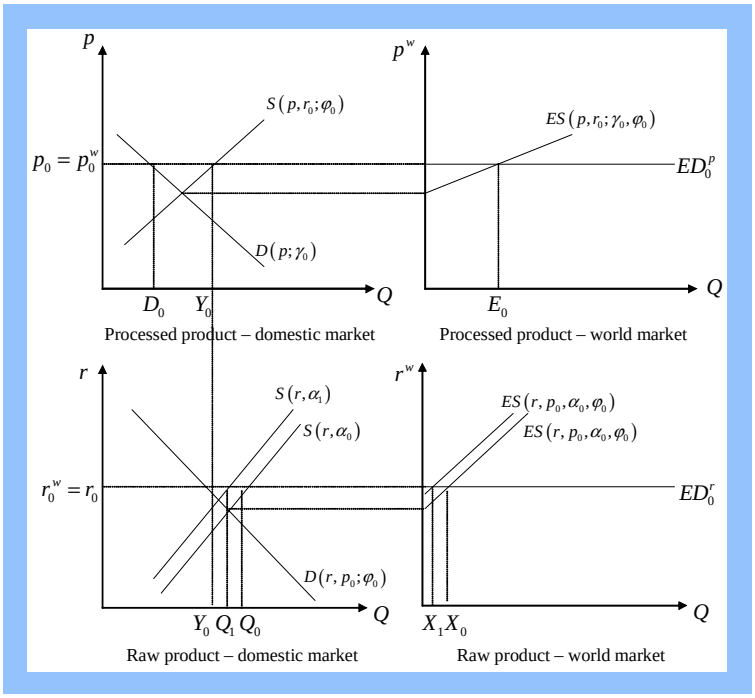
It is assumed that there exists a constant proportion technology when processing live hogs into pork meat. Hence, the top left diagram illustrates the domestic market for pork. It is also assumed that pork processors are exporters. Given the constant world price and free trade, the domestic pork price is $p_0 = p_0^w$. Domestic consumers purchase a quantity D_0 and pork exports

are denoted by E_0 on the top right diagram of Figure 7. As in the general conceptual model, shifters are included in the demand and supply schedules of producers, processors and consumers to represent changes in food safety measures at the farm level.

It is possible to illustrate how equilibrium quantities are impacted by changes in a number of different factors by using Figure 7 as a benchmark. Two principal issues were analyzed. First, the effects of implementing OFFS on the cost structure of producers was explored. As argued before, the net effect of the CQA on producers' costs can be either positive or negative. The second issue examines the implications of on-farm food safety initiatives on the demand for farm and processed products.

First, consider the situation in Figure 8, which posits that an OFFS increases the marginal costs of producers. There is an upward shift in the domestic supply of live hogs in the bottom left panel of Figure 8. Given free trade, the perfectly elastic foreign demand and the net export position of the province, the domestic price of live hogs is unchanged. However, the increase in producers' costs causes a decrease in production, while the domestic demand for live hogs remains constant. This results in a decrease in live hog exports proportional to the decrease in hog production.

Figure 8:
An increase in unit-cost of production on hog farms



The situation would potentially be different if no exports of live hogs existed before implementing OFFS. In Figure 8, the assumed negative impact of the OFFS is not transmitted downstream to processors and consumers. Naturally, any benefits stemming from implementing the OFFS would also be captured exclusively by producers. It should be noted that the result in Figure 8 does not imply that there will not be any effect in downstream markets. The strategy taken was to let only a single shifter vary at a time to gain a better understanding of the impact of each shifter at all stages of the supply chain. Figure 8 simply shows that when exports of live hogs occur, on-farm food safety induced changes in the producers' cost structure are not likely to impact downstream markets.

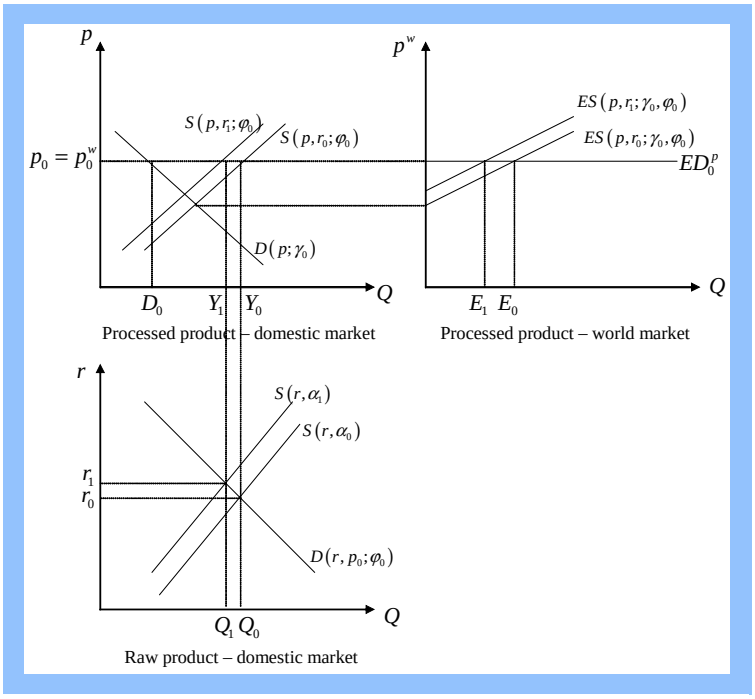
Now consider the situation in Figure 9. Assume that the domestic price for hogs is higher than the world price (adjusted for transportation costs) and thus, that no exports of live hogs occur in the initial equilibrium. This represents the pork sector in Quebec.

The initial impact of the increase in producers' costs due to the OFFS implementation in Figure 9 is to shift upward the domestic supply curve of producers. This increases the farm price and thus shifts upward the domestic supply of processors in the top left panel. Because there is free trade

in pork products, the domestic price of pork remains constant. The farm price of live hogs increases, but both processors and producers are worse off due to the decrease in hog production and pork exports.

Consider now the situation where the net effect of implementing HACCP at the farm and processing levels is positive. More specifically, suppose HACCP-induced efficiency gains decrease both producers' and processors' costs. Producer costs are reduced due to improved productivity, and processor costs are reduced due to improved logistics, lower product recalls, etc. The two effects are depicted in Figure 10: the cost savings for producers by an outward shift in their supply function, and the cost savings for processors by an outward shift both in their demand for live hogs and in their supply of pork. This optimistic scenario assumes that the movements in the demand and supply schedules leave the export supply curve for live hogs unchanged. Hence, the increase in hog production does not affect the farm price due to the arbitrage condition imposed by free trade, but it increases the quantities processed by domestic processors (from Y_0 to Y_1). The increase in domestically processed pork is all exported (from E_0 to E_1). The economic surpluses of producers and processors increase following HACCP implementation.

Figure 9:
An increase in unit-cost of production on hog farms when exports of live hogs are not profitable



It is also important to consider the impact of OFFS on foreign markets. As previously discussed, food safety initiatives at the farm level can bring about a differentiation of Canadian pork products although these potential benefits are likely to be small if positive at all. Nevertheless, it is assumed that the CQA increases the demand for Canadian live hogs and pork. Figure 11 illustrates the implications for hog and pork prices as well as on quantities produced and exported. Unlike Figures 7, 8 and 10, no supply-side effects are taken into consideration. This is equivalent to assuming that the net effect of OFFS on cost is insignificant because any OFFS-induced cost increases are offset by equivalent decreases in other costs.

Two excess demand schedules are represented on the right hand-side diagrams. These two excess demands are a function of the world price and a shifter representative of the quality of Canadian hogs and pork meat. The implementation of the OFFS is represented by changes in the shifters β_0 and λ_0. It is assumed that the program increases the demand for Canadian pork and hogs, shifting the two excess demands outward. This increases hog and pork domestic prices because of free trade. The movements in prices are accompanied by shifts in the processors demand for live hogs. While the higher domestic price for pork induces an upward shift in the demand for live hogs, the increase in the price of live hogs increases the processors' marginal

cost and shifts upward the supply of pork in the top right panel. The end result is that export supplies of live hogs and pork decrease in the right panels. The higher pork price encourages production but discourages domestic consumption, which falls from D_0 to D_1.

The final effects are increases in live hog and pork exports, and in hog production. But domestic pork consumption decreases due to higher prices. These effects unambiguously decrease consumers' surplus and increase producers' surplus. The impact on processors is ambiguous because of the effect on the domestic price of live animals. Processors' sales increase but purchases of their inputs cost more than before the implementation of the OFFS.

Finally, consider the situation depicted in Figure 12 in which the only significant net effect of implementing food safety initiatives at the farm level is through an increase in domestic consumers' demand. Due to free-trade and the small country assumption, the domestic price of pork products does not change as Canadian provinces remain net exporters of pork. Hence, given the constant domestic price, domestic consumption of pork products increases and exports decrease. Producers and processors do not benefit from this positive demand-side effect of food safety initiatives since prices remain constant at all market levels. Hog production also remains constant.

One important demand-side effect of food safety initiatives that is absent from the above graphical analysis are the positive effects related to their pro-active nature. An OFFS can protect established market shares both domestically and internationally that otherwise could be challenged by foreign competitors or other agri-food products, especially when a food contamination

Figure 10:
HACCP-induced decrease in production costs at the farm and processing levels

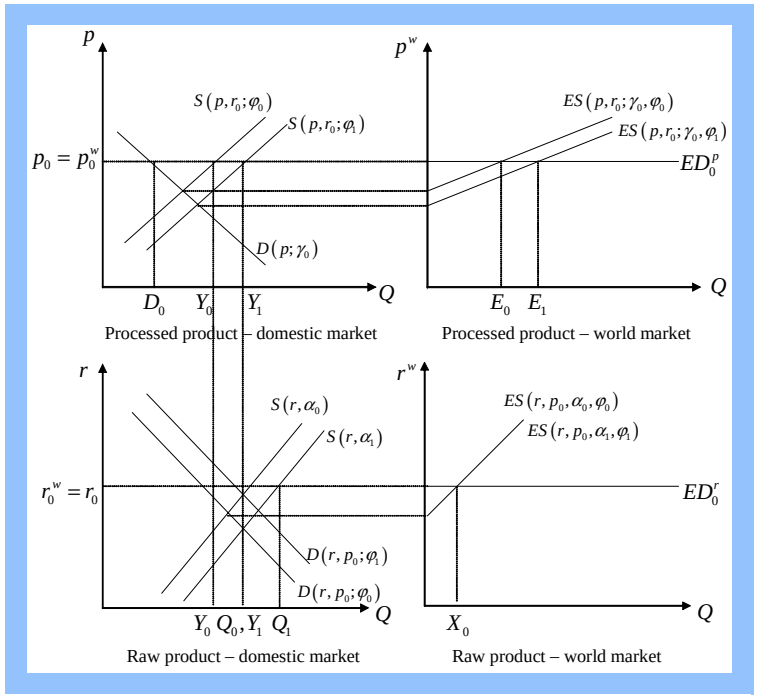
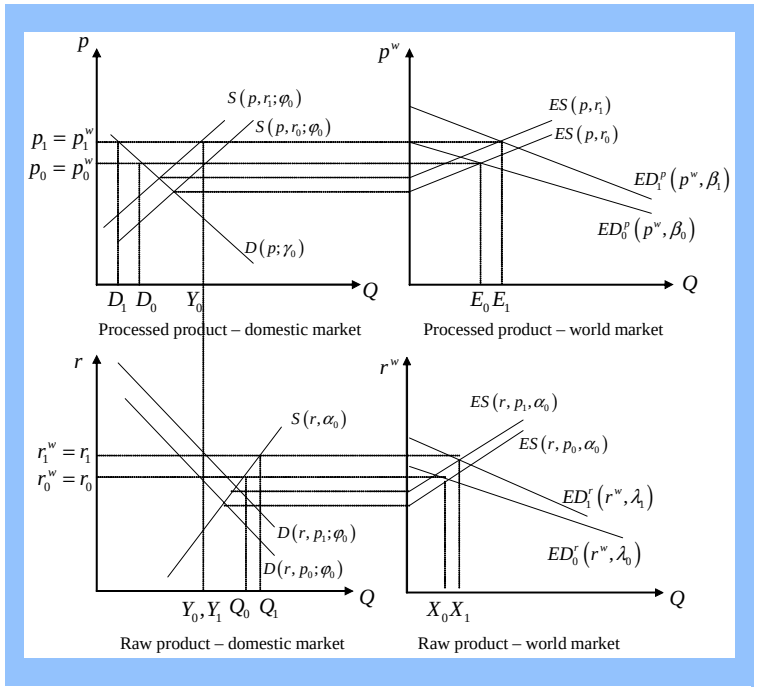


Figure 11:
HACCP-induced increase in the foreign demand for farm and processed products

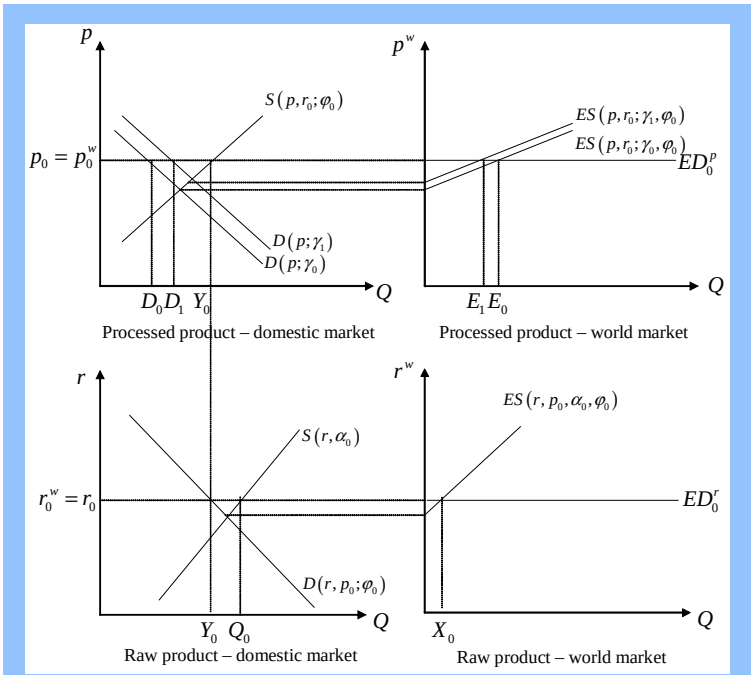


incident happens. The above analysis has studied the effects of implementing an OFFS, but has neglected to examine the effects of not implementing an OFFS. These effects can be equally as important as the ones previously identified.

Numerical simulations of food safety scenarios in the Quebec industry

A numerical simulation serves to highlight the potential magnitude of some of the demand and supply side changes discussed above. A simple partial-equilibrium model of the Quebec pork sector is constructed that accounts for the revenue-insurance program, Assurance Stabilisation du Revenu Agricole (ASRA). It is assumed there is zero substitution between live hogs and other inputs in the pork processing technology. First, a benchmark equilibrium is defined, which is then used to assess the relative impacts of simulated food safety shocks. Linear supply and demand curves are assumed and the small country assumption is made in order to derive the pricing of pork in the export market. After a discussion on how the parameters for the supply and demand functions were derived, the results for three different scenarios and a risk analysis are presented. The first scenario assumes a boost in consumer confidence at home and abroad that translates into a higher world price and an enlarged domestic market. The second scenario assumes that the implementation of on-farm food safety measures induces an increase in efficiency on the part of hog producers. Such a positive externality has been documented in case studies about the implementation of HACCP in meat processing plants. The third scenario assumes a substantial drop in demand at home and abroad brought about by a crisis. This scenario is used in the risk analysis which posits that on-farm food safety measures could decrease the probability of a crisis and/or reduce the length of such an unfortunate event. As previously demonstrated through the graphical analysis, the simulation results are strongly conditioned by the economic and policy environment in which the Quebec pork sector operates.

Figure 12:
OFFS-induced increase in consumers' demand for processed products



Aggregate annual data on pork consumption are not readily available by province. An estimate of pork meat consumption in Quebec is built using the following accounting formula:

$$D_t = Q_t + IM_t - EX_t - \left(STOR_{end} - STOR_{beg}\right)$$

where D_t represents consumption in year t, Q_t denotes quantities slaughtered in year t, IM_t and EX_t represents imports and exports (including inter-provincial transfers) in year t respectively, and $STOR_{end}$ and $STOR_{beg}$ represents the quantities of pork meat stored at the end and the beginning of year t respectively.

In 1998, total consumption of pork products was 4,821,897 100 kg carcass-equivalent. The average retail price in 1998 was $522.44 per 100 kg in Quebec. Based on elasticities reported in the literature, it is assumed that the own-price elasticity of pork demand is -0.75.[7] Given the assumption of a linear demand, $D^p = a - bp$, it must be that: $-0.75 = -b\frac{p}{D^p}$ which means, after plugging in the 1998 average price and quantity, that: $b = 6,922$. Substituting the estimate of b into the retail demand function and evaluating it at the 1998 price-quantity combination pair, it is found that: $a = 8,438,227$.

Attention is now turned to the supply of live hogs. The average hog price in 1998 was $123.82/100 kg, more than $30 below the support price of ASRA of $154.67/100 kg. Total hogs slaughtered in 1998 in Quebec amounted to 8,613,696 units of 100 kg. The combination of the support price and quantities slaughtered yields a point on the marginal cost curve of producers. Moschini and Meilke's (1992) long-run supply elasticity[8] of Canadian hog producers of 0.328 is used because it is believed to be a reasonable estimate for the supply elasticity for hog production in Quebec. Defining *r* as the price of live hogs, a linear relationship is assumed between supply and price (i.e., $S^h = \alpha + \beta r$). This implies that: $0.328 = \frac{\beta r}{S^h}$, a relationship that holds only if the slope parameter β equals 18,267. Substituting back this estimate into the supply function, the other parameter of the supply curve is derived: $\alpha = 5,788,339$. Given the parameters of the supply function, the producers' marginal costs can be expressed as: $MC^h = \frac{S^h - \alpha}{\beta} = -317 + 0.000054S^h$.

This parameterization takes into account that Quebec hog producers do not export. Likewise, there are no imports of live hogs. Hence, total processed hogs amount to 8,613,696 units of 100 kg. To parameterize the processors' demand for live hogs and their supply of pork meat, Moschini and Meilke's (1992) estimate of 0.495 for the pork supply elasticity is used. It is assumed that there exists a constant proportion technology in processing live hogs. This implies that the demand and supply of pork meat will be a function of the marketing margin of processors. In other words, the difference between the retail and the farm price will condition the supply and demand of processors.[9] The processors' supply of pork is depicted by: $S^p = c + d(p - r)$. The average retail and farm prices being $522.44 and $123.82 respectively, for $0.495 = d\frac{r}{S^p}$ and the linear supply relation to hold, it must be that: $d = 8,161$ and $c = 5,360,558$. Fixing *p* at a specific level, namely the U.S. pork price, the processors' supply equation can be interpreted as a hog demand equation: $S^p \equiv D^h(r; p^{US}) = (c + d\,p^{US}) - (d\,r)$. Finally, it is assumed that the average export price is equal to the domestic retail price under free trade, i.e. $p^{US} = 522.44$. Because of lack of data, the retail sector was not explicitly modeled in the analysis. Table 5 provides a summary of the calibrated equations used in the numerical simulations.

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7. *The concept of own-price elasticity of demand refers to the responsiveness of the quantity demanded of a good to a change in its price, other things remaining the same.*

8. *The elasticity of supply measures the responsiveness of the quantity supplied of a good to a change in its price, other things remaining the same.*

9. *The theoretical basis for this assumption is the following. Hog producers sell their output q to downstream processing firms. Processing of the primary commodity involves J other inputs. The processing technology is represented by the production function* $y = F(q, \mathbf{L})$*; where* $\mathbf{L}$ *is an input vector of dimension J ¥ 1, and all inputs in* $\mathbf{L}$ *are supplied competitively at prices wj. The profit equation of a representative processor is:* $\pi^p = py - rq - \sum_j w_j l_j$*; where p and r represent the prices of the final processed product and the raw input respectively. Assuming that one unit of output (pork meat) requires one unit of primary input (hogs), the technology used by processors can be depicted by:* $y = F(q, \mathbf{L}) = Min\{q, f(\mathbf{L})\}$*. No additional structure is imposed on the sub-production function* $(f(\mathbf{L}))$*, except for the assumption that it is a twice-differentiable, continuous and quasi-concave function. The cost function dual to this technology is:* $C(y, r, \mathbf{w}) = ry + \phi(y, \mathbf{w})$*. The profit function of processors is:* $\pi^p = (p - r)y - \phi(y, \mathbf{w})$*. The first order condition yields:* $\partial\pi^p / \partial y = (p - r) - \phi_y(y, \mathbf{w}) = 0$*. This equation determines the supply function of processors which is also equal to the demand for hogs given the specified constant proportion technology.*

Given the market characteristics specified in Table 10, the impact of on-farm food safety measures can be simulated. First, assume that on-farm food safety measures boost consumer confidence at home and abroad. This positive development specifically translates into a parallel shift of the domestic demand function for pork (i.e. parameter a in the consumer demand function increases by 2%) and into a 1% increase in the world price for Canadian pork. The second simulation assumes that any increase in variable costs due to on-farm food safety measures is more than offset by an efficiency gain. The net result is a 1% downward shift of the hog supply curve. The third scenario is a simulation of a crisis that brings about major reductions in domestic demand and in the world price of Canadian pork. Key variables are compared across scenarios, such as quantities exported, domestic sales, hog price, consumer and producer surpluses, gains from trade and ASRA costs. Finally, the risk reduction effects of on-farm food safety measures are considered. To isolate the risk effect, it is assumed that the only benefit of on-farm food safety measures is to decrease the probability of two year long crisis (in the first case) or to leave the probability of a crisis unchanged, while reducing the length of a crisis from two to one year when such an event occurs (in the second case).

Table 10: Potential supply-side private benefits of environmental farm plans in hog production

EQUATION	FUNCTIONAL FORM	ESTIMATES
Consumers' demand	$D^p = a - bp$	$D^p = 8,438,227 - 6,922\,p$
Processors' pork supply/demand for hogs	$S^p = c + d\,(p - r)$	$S^p = 5,360,558 + 8,161p$
Processors' marginal cost	$MC^p = (S^p - c)/d$	$MC^p = -657 + 0.00012S^p$
Producers' supply	$S^h = \alpha + \beta r$	$S^h = 5,788,339 + 18,267r$
Producers' marginal cost	$MC^h = (S^h - \alpha)/\beta$	$MC^h = -317 + 0.000054S^h$

Table 11 summarizes the results for the benchmark case, the OFFS scenario with a positive demand shock, the OFFS scenario with lower production costs for hog producers and the food safety crisis scenario. The numbers between parentheses indicate the percentage change in the variable under a given scenario with respect to the benchmark case.

At the outset, it should be noted that the results in Table 11 are meant to provide an order of magnitude about food safety effects rather than absolute measures. Different results would have been derived under different assumptions regarding the size and nature of the shocks and/or if the model had been calibrated using a different year. Nevertheless, the simulations are instructive because they show how adjustments would take place given the specific regulatory context of the Quebec hog/pork industry. ASRA sets the supply of hogs as long as the market price remains below the guaranteed price. Consequently, an increase in the market price for live hogs does not affect hog supply as long as the increase in the market price is not large enough to change the ranking between the guaranteed price and the market price. It follows that an increase in the hog market price that does not change the hog supply will not affect the pork supply given that all hogs domestically produced are domestically processed under the marketing agreement negotiated between hog producers and pork processors. The relatively low hog prices that prevailed throughout 1998 contributed directly to the high cost of ASRA. The benchmark case provides an estimate of $266 million. The optimistic scenario of demand-side benefits,

which features positive shifts in domestic and foreign pork demands due to greater consumer confidence in pork, brings a higher hog price, but the increase is not sufficient to provoke a change in supply. Consumer surplus increases in spite of the higher pork price and export sales decrease. Processors benefit from the higher pork price. Given that ASRA costs are being financed by the provincial and federal governments (66.7%) and hog producers (33.3%), hog producers and taxpayers also gain under the optimistic scenario. The net welfare gain relative to the benchmark case is $12.2 million; which represents an increase of 5.8% over the benchmark welfare level.

Table 11: Summary of the simulation results[a]

VARIABLE	BENCHMARK	OPTIMISTIC (demand shock)	OPTIMISTIC (supply shock)	CRISIS (demand shock)
Price of pork	522.44	527.66 (1.0)	522.44 (0.0)	417.95 (-20.0)
Price of hogs	123.82	129.04 (4.2)	120.60 (-2.6)	19.33 (-84.4)
Domestic sales	4.8219×10^6	4.9545×10^6 (2.7)	4.8219×10^6 (0.0)	3.85752×10^6 (-20.0)
Export sales	3.7918×10^6	3.6592×10^6 (-3.5)	3.81811×10^6 (0.6)	4.75618×10^6 (25.4)
Consumer surplus	1.67948×10^9	1.77312×10^9 (5.6)	1.67948×10^9 (0.0)	1.07487×10^9 (-36.0)
Producer surplus[b]	3.38635×10^9	3.39769×10^9 (0.3)	3.40014×10^9 (0.4)	2.88731×10^9 (-14,7)
ASRA cost	2.65733×10^8	2.20731×10^8 (-16.9)	2.94397×10^8 (10.8)	11.6576×10^8 (338.7)
Gains from trade	4.76612×10^8	4.43868×10^8 (6.9)	4.83257×10^8 (1.39)	7.49892×10^8 (57.3)
Net welfare gain relative to benchmark	–	1.22489×10^7	-2.220279×10^7	-62.6757×10^7

a. The numbers in parentheses are percentage changes from the benchmark case.

b. The producer surplus was calculated from the processors' supply curve. Because pork and hog productions are competitive industries, the producer surplus reflects increases in input costs at all levels as industry output expands.

The second scenario showcases the effect of efficiency gains in hog production (i.e. the hog supply curve shifts down by 1% from the benchmark ASRA price). The reported outcome might seem peculiar at first because a productivity improvement usually triggers an increase in production which ends up increasing welfare. The reason why the increase in production is not welfare enhancing is because it makes ASRA more expensive through enlargement of the subsidy base and the subsidy margin. Gains accruing to hog producers and pork processors are too small to make up for the loss to taxpayers, hence the $22 million welfare loss. This example clearly demonstrates the importance of accounting for the policy-induced distortions in the modeling of the hog market. It is worth noting that if the insurable volume under ASRA was fixed for years (as were acreages in the old U.S. commodity programs), the efficiency increase in hog production would not have had any effect on production, price and trade.

The crisis scenario is one in which Quebec would have to export its pork at a much lower price to

get rid of its ASRA-determined supply under a depressed domestic market. Under such a scenario, the adjustment on the domestic hog price would be brutal. The lower domestic demand for pork would bring about lower consumer surplus in spite of the drastic reduction in the price of pork. Producer surplus would fall due to the reduction in the price of pork in spite of the positive effect of the much lower hog price. Having to export in a context of depressed domestic demand, the gains from trade are very large, but the overall welfare is low due to the astronomical ASRA cost. The welfare loss relative to the benchmark slightly exceeds $584 million. A scenario with a completely closed border would have a similar qualitative effect. Hog production would remain high as long as ASRA remains unchanged. However, the market price for hogs would fall further and some hogs might have to be destroyed. This would inflate further the cost of the ASRA program.

Assume that without the OFFS, the probability of a benchmark scenario is 0.99. In other words, the probability of a crisis is 1%. This is most likely too high, but it will illustrate an aspect of the so-called insurance motive for OFFS. To properly isolate the insurance value, it is assumed that the only benefit generated from OFFS is to cut in half the probability of a serious food safety problem. Define π_t^b and π_t^c to be the monetized welfare gains generated by the hog/pork industry under the benchmark and crisis cases at time t. Without OFFS, the discounted contribution of the hog/pork industry is measured as:

$$B^{w/oOFFS} = 0.99\left(\pi_t^b + \frac{\pi_{t+1}^b}{1+r} + \ldots + \frac{\pi_{t+n}^b}{(1+r)^n}\right) + 0.01\left(\pi_t^c + \frac{\pi_{t+1}^c}{1+r} + \frac{\pi_{t+2}^b}{(1+r)^2} + \ldots + \frac{\pi_{t+n}^b}{(1+r)^n}\right),$$

while with OFFS, it is assumed to be:

$$B^{OFFS} = 0.995\left(\pi_t^b + \frac{\pi_{t+1}^b}{1+r} + \ldots + \frac{\pi_{t+n}^b}{(1+r)^n}\right) + 0.005\left(\pi_t^c + \frac{\pi_{t+1}^c}{1+r} + \frac{\pi_{t+2}^b}{(1+r)^2} + \ldots + \frac{\pi_{t+n}^b}{(1+r)^n}\right).$$

With or without OFFS, a crisis lasts two years when it happens. Given the assumption of stationary/constant monetized welfare gains through time, a 5% discount rate *r* and an infinitely-lived hog/pork industry, the change in probability is worth $5.72 million. Consider another aspect of the insurance motive for OFFS by assuming that the probability of a major problem is the same with or without OFFS, but that the duration of the problem is shortened by a year in the presence of OFFS. In this instance, the discounted benefits from the hog/pork industry are computed as:

$$B^{OFFS} = 0.99\left(\pi_t^b + \frac{\pi_{t+1}^b}{1+r} + \ldots + \frac{\pi_{t+n}^b}{(1+r)^n}\right) + 0.01\left(\pi_t^c + \frac{\pi_{t+1}^b}{1+r} + \ldots + \frac{\pi_{t+n}^b}{(1+r)^n}\right).$$

Given the probability of a crisis, the value of OFFS is $5.59 million. The previous computations did not account for risk aversion in the agents' preferences. Allowing for risk aversion would inflate the measured OFFS benefits. Similarly, an extended crisis duration without OFFS would inflate the previously computed benefits.

The objective of the numerical simulation was to provide ballpark estimates of potential OFFS benefits for the Quebec hog/pork industry by taking into account the revenue-insurance program and some aspects of the marketing agreement between hog producers and processors. An optimistic scenario posits that OFFS can boost consumer confidence at home and abroad or reduce production costs for producers and processors. The increased demand for pork would generate net gains of $12 million/year over the benchmark case which precludes OFFS. The second scenario simulated is one in which OFFS bring about small efficiency gains in hog produc-

tion. Because the hog market price is below the guaranteed price of the ASRA in the benchmark case, the increase in output and the decrease in the market price for hogs that follow an increase in hog production efficiency end up reducing welfare as the loss to taxpayers more than offset the gains accruing to hog producers and pork processors. The net effect on welfare is an annual loss of $22 million.

A crisis scenario, which brought about drastic reductions in the pork price, was also simulated. OFFS could potentially reduce the probability of such crises and/or shorten the length of these crises when they occur. To isolate the risk/insurance benefits, it was assumed that OFFS has no impact on consumer and processor demands and producers' cost of production. The benefits of OFFS were measured by comparing the discounted value of the industry welfare gains with and without OFFS. In one case, the probability of having a two-year crisis was reduced from 1% to 0.5%. In another case, the probability of a crisis was held constant at 1%, but the duration of the crisis was shorted to a year under OFFS. In both cases, the OFFS benefits are worth in excess of $5 million. These estimates give an order of magnitude about the benefits and costs of OFFS. Many more scenarios could be simulated. But given the limited amount of information available, it is fair to say that without a pilot study, OFFS benefits and costs will be difficult to measure accurately.

Glossary of terms and list of abbreviations

APPENDIX B

Glossary

TERMS	DEFINITIONS
Consumer surplus	A measure of the benefits to consumers (buyers) of a market outcome, i.e. the excess of marginal benefit over price.
Demand-side effect	A benefit or costs that manifests itself by increasing or decreasing the demand for a product
Economic surplus	The sum of consumer and producer surplus. A measure of the total value to society of a market outcome
Externality	Costs or benefits that flow between economic agents but that are not paid for in the market place
Free-ride	The ability to benefit from something without incurring the costs
Information asymmetry	When one party to a transaction (e.g. the seller) has more information than the other (e.g. the buyer)
Marginal benefit	The additional benefit from producing one more unit of output
Marginal cost	The additional cost of producing one more unit of output
Market benefit/cost	See Private benefit/cost
Market failure	When distortions prevent prices from accurately reflecting the true benefit or cost of a good, leading to a misallocation of resources (see externalities)
Non-market benefit/cost	See Public benefit/cost
Opportunism	Self-interest seeking with guile
Own price elasticity	A measure of the responsiveness of quantity demanded for a product to a change in its price, everything else remaining equal
Perfectly elastic	When own-price elasticity is infinity. A firm can sell all it wants at the going market price but will sell nothing at all other prices.
Private benefit/cost	Benefits and costs for products that bought and sold in the marketplace
Producer surplus	A measure of the total benefits to producers of a market outcome, i.e. the excess of price over marginal cost

TERMS	DEFINITIONS
Public benefit/cost	Benefits and costs that flow between economic agents but that are not paid for in the market place (see externality)
Social benefit/cost	See Public benefit/cost
Social welfare	See economic surplus
Supply-side effect	A benefit of cost that manifests itself by increasing or decreasing the supply of a product
Sunk costs/investments	Costs that cannot be recovered
Transaction cost	The cost of carrying out an exchange, including search costs of gathering information, the costs of negotiating the transaction costs, the costs of monitoring product quality or actions of trading partners and the costs of enforcing the terms of the transaction

Abbreviations

AESA	Alberta Environmentally Sustainable Agriculture Program
APF	Agricultural Policy Framework
ASRA	Assurance Stabilisation du Revenu Agricole
BAPE	Bureau d'audiences publiques sur l'environnement
CFIA	Canadian Food Inspection Agency
CFIA	Canadian Food Inspection Agency
COFFS	Canadian On-Farm Food Safety program
CPC	Canadian Pork Council
CQA	Canadian Quality Assurance™ Program
CSA	Canadian Standards Association
EFP	Environmental Farm Plan programs
EMS	Environmental Management System
FPPQ	Fédération des Producteurs de Porc du Québec
HACCP	Hazard Analysis, Critical Control Points
OFFS	On-Farm Food Safety programs
TQA	Trucker Quality Assurance Program
UPA	Union des Producteurs Agricoles