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Report 2

On-Farm Food Safety and Environmental Farm Plans: A Conceptual Framework for Identifying and Classifying Benefits and Costs

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

Canada

On-Farm Food Safety and Environmental Farm Plans: A Conceptual Framework for Identifying and Classifying Benefits and Costs

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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 at the farm gate, producers are reassessing the way they do 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 the on-going work of stakeholders and government 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 second report in the series *"On-Farm Food Safety and Environmental Farm Plans: Identifying and Classifying Benefits and Costs"* provides a description of the conceptual framework. It identifies the different benefits and costs that may accrue at the various stages of the agri-food value chain. It discusses how these benefits and costs may vary according to the selected institutional delivery mechanism, the nature of the supply chain, the export dependency of the commodity and the overall market structure within which the sector operates. It also points out that benefits and costs would vary from farm to farm depending on physical and ecological characteristics of the site of production and on the farm size.

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

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.*

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

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 develops a conceptual framework for evaluating the potential benefits and costs associated with OFFS and EFP in Canadian agriculture. The economic basis for each of the benefit and cost entries of the conceptual framework is discussed.

Canadian food is regarded as being safe and the systems in place to ensure food safety are generally effective and perceived as operating at a high standard. However, no food safety regime can completely eliminate food safety risks. This means that improvements to the food safety system are always possible. It also means that any new initiatives to enhance food safety need to be assessed to determine if the benefits exceed the costs. The assessment of benefits and costs should encompass both the private benefits and costs to those that will be directly involved in implementing the proposed change, as well as the benefits and costs that affect other actors in the food supply chain, and those that affect the wider society. This is because food production takes place within complex interdependent supply chains and societal effects may not be strictly confined to private consumption – in other words there may be considerable externalities (non-market effects) both positive and negative, from initiatives to improve food safety. OFFS are one possible mechanism that could be used to improve the safety of Canadian food.

Consumers are not a single entity with homogenous preferences. The consumer market is increasingly segmented, with consumers focusing on both tangible and intangible aspects of quality. Some consumers are interested in the environmental practices under which their food is produced. They may also be willing to pay a premium for food produced to high environmental standards. While Canadian agricultural production takes place within a regulatory framework designed to protect the environment, there is no mechanism to signal to interested consumers the high level of environmental stewardship practised by most farmers. Further, given the heterogeneity of Canadian agricultural production and the site-specific nature of ecosystems, farmers may not realize that their individual practices may have undesirable effects on the environment. Individual EFP can act both as a signalling device and as a means to raise awareness of the effects of farming practices on the environment. They can also be a first step in improving the environmental sustainability of individual farm operations. As with OFFS, there may be externalities. In particular, the benefits arising from mitigating environmental costs are likely to accrue largely outside the farms where the costs associated with improved production practices are incurred. Thus a comprehensive benefit and cost analysis is required to judge the desirability of encouraging the widespread use of EFP.

The identification of benefits and costs of both OFFS and EFP is complex and depends on the context within which the initiative takes place (e.g. private or public, voluntary or mandatory, self assessment or compliance with regulatory standards, etc.) They also will vary depending on the complexity of the supply chain within which the farm operates, whether the product is exported and the physical and ecological characteristics of the site where production takes place. While the range of possible benefits is large, it is likely that only a subset of benefits will be applicable to any individual product. Similarly, the entire range of possible costs will not arise for all products or on all farms. How benefits are shared and costs borne across the supply chain will vary.

Summary tables 1 and 2 lay out the range of possible benefits and costs of OFFS and EFP respectively. While a common approach has been applied to both OFFS and EFP it is clear from a comparison of tables 1 and 2 that the range of benefits and costs varies considerably. The classification systems can be applied to individual products and supply chains as a check list for where benefits and costs can be expected to arise. This would lead to specific entries in various boxes, with some boxes likely blank in each case. Once the specific benefits and costs are identified in a particular case, quantitative estimates could then be made.

The conceptual framework identifies private demand-side and supply-side effects of introducing OFFS and EFP, as well as identifying potential public benefits and costs. Demand-side market benefits include reducing transaction costs for consumers, building consumer confidence, differentiating products on international markets, etc. Non-market benefits of OFFS include public benefits such as reductions in foodborne illness. Supply-side benefits include productivity and logistic improvements. Private supply-side costs include the management and compliance costs of implementing the programs as well as potential public sector monitoring costs. The distribution and size of the various benefits and costs will be influenced by the nature of the OFFS and EFP; i.e., whether it is a voluntary industry-wide system, a buyer specific program or a regulatory standard. Comparing different implementation methods indicates how different impacts can emerge relative to a 'no program' baseline.

Table S1: The benefits and costs of OFFS

	Voluntary industry-wide OFFS	Enforced industry-wide OFFS	Buyer specific OFFS	Regulatory standards
Benefits				
Private benefits				
Reduce transaction costs for consumers				
Build consumer confidence				
Convey additional information				
Provide differentiation on international markets				
Facilitate trade by reducing NTBs				
Reinforce and develop trade networks				
Improve productivity of inputs				
Improve efficiency in production				
Reduce logistic costs				
Reduce measurement costs: performance versus process standards				
Reduce monitoring and enforcement costs				
Reduce product liability costs				
Reduce ex-post cost following contamination				
Reduce free-rider impacts				

Table S1: The benefits and costs of OFFS (Continued)

	Voluntary industry-wide OFFS	Enforced industry-wide OFFS	Buyer specific OFFS	Regulatory standards
Public benefits				
Reduce incidence of foodborne illness				
Reduce information asymmetry				
Total benefits				
Costs				
Management costs				
fixed – establishing the HACCP plan				
variable – revising plan to reflect external changes				
Compliance costs				
fixed – capital costs				
variable				
Sunk investments				
Risk of hold-up				
Segregation costs				
fixed				
variable				
Monitoring and enforcement costs				
fixed				
variable				
Total costs				
TOTAL NET BENEFITS				

Table S2: The benefits and costs of EFP

	Voluntary EFP	New building EFP	Annual EFP	Annual enforced EFP	Emission standards	Land use regulations
Benefits						
Private benefits						
Reduce transaction costs for consumers						
Build consumer confidence						
Convey additional information						
Provide differentiation on international markets						
Facilitate trade by reducing NTBs						
Reinforce and develop trade networks						
Reduce monitoring and enforcement costs						
Reduce free-rider impacts						
Non-pecuniary benefit to farmers (feel-good factor)						

Table S2: The benefits and costs of EFP (Continued)

	Voluntary EFP	New building EFP	Annual EFP	Annual enforced EFP	Emission standards	Land use regulations
Public benefits						
Direct effects on human quality of life						
Reduce negative human health externalities (disease, toxic substances, etc.)						
Negative impact on value of assets (air quality, etc.)						
Nuisance (odours, etc.)						
Ecosystem effects (upland habitat, riparian/wetland habitat, water quality, greenhouse gases, soil resource quality, etc.)						
Total benefits						
Costs						
Planning costs						
fixed – establishing the framework						
variable – revising policy to reflect external changes						
Monitoring and enforcement costs						
fixed						
variable						
Compliance costs						
fixed – capital costs						
variable						
Segregation costs						
fixed						
variable						
Total costs						
TOTAL NET BENEFITS						



Chapter 1

Introduction

1.1 *Outline of the study*

Food safety, food quality and environmental concerns have become issues in the domestic and export markets for many Canadian agri-food products. A large number of industry-led, 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 Canada continues to be a world leader in the agri-food industry.

This is the second report in a series dealing with the assessment of potential benefits and costs associated with proposed OFFS and EFP initiatives for Canadian agriculture. The first report provides an overview of the whole study. The objective of this second report is to describe the conceptual framework that was developed. The remaining reports provide broad preliminary qualitative assessments for the pork, beef, grain and dairy sectors.

This second report is structured in six main chapters. The remainder of this chapter provides an introduction to the project. Chapter two outlines the nature of private and public benefits and costs. Chapter three describes the HACCP approach to food safety. Chapter four presents the classification system for identifying benefits and costs from on-farm food safety, with a discussion of measurement issues provided in Appendix A. A technical analysis of the potential effects of these benefits and costs under different scenarios is continued in Appendix B. Chapter five

classifies potential benefits and costs of EFP. Chapter six concludes the report. A glossary of key technical terms and a list of abbreviations can be found in Appendix C.

1.2 *The genesis of on-farm food safety programs and environmental farm plans*

Canadian food is generally regarded as safe. The Canadian agri-food sector has not experienced a widespread crisis of confidence in the safety of its food supply as has been the case in other countries, notably within the European Union. Food recalls and food safety incidents do occur, but by and large these have been minor. Environmental pressures, while present, have not been as dire as in competing countries with limited agricultural land bases and relatively dense populations (e.g. Taiwan, the Netherlands and Denmark).

Nevertheless, there is a need to be proactive, rather than reactive, in responding to potential food safety and environmental problems that could weaken Canadian consumer confidence in the domestic food supply and threaten access to export markets. This is probably the most important lesson learned from the UK's Bovine Spongiform Encephalopathy (BSE) or mad cow disease crisis. Initiatives to maintain or enhance on-farm food safety and environmental standards are part of a risk-reduction strategy, and could be likened to the need to have insurance. An additional motivation for focusing on on-farm food safety and environmental standards is to build on these aspects of the Canadian agri-food sector as a potential product differentiation strategy, particularly in export markets.

On-farm food safety and the environmental accountability of Canadian agriculture have become the focus of recent initiatives by industry organizations and at a policy level by Agriculture and Agri-Food Canada. Discussions among the Federal, Provincial and Territorial Ministers of Agriculture have resulted in the APF. Two of the five pillars of the APF are the environment and food safety and quality, ultimately aimed at increasing opportunities for Canadian products in international markets. OFFS and EFP have been proposed as core components of a Canadian 'brand' for agri-food products. This approach builds on the Canadian On-Farm Food Safety Program (COFFS), introduced in 1997 by the Federal government and the Canadian Federation of Agriculture. The COFFS facilitates the development of on-farm food safety and quality assurance initiatives by national commodity organizations. By March 2003, 19 Canadian commodity associations had launched or were developing national on-farm food safety and quality assurance programs[2]. Examples include the cattle industry's Quality Starts Here ✓ Verified Beef Production program, the pork industry's Canadian Quality Assurance program (CQA™), the Canadian Quality Milk program (CQM), and the Canadian Hatching Egg Quality program (CHEQ).

Figure 1 lists the national commodity association programs and their stage of development, using the process agreed to in April 2004. The industry begins by establishing a national strategy to adopt an on-farm food safety program. The program's technical review stage phase includes the development of a generic HACCP model, production of producer materials, running a pilot project, developing auditor and producer training materials and a program management system. This is followed by a technical review of the HACCP documentation and the management system by the Canadian Food Inspection Agency (CFIA). The implementation and third party audit stage involves staging producer awareness and training sessions, pre-audit service and contracting a CFIA accredited third party auditor to assess the on-farm program and management sys-

2. *Beef, hogs, dairy, chicken, turkey, bison, cervids, eggs, hatchery eggs, hatcheries, sheep, grains (including grains oilseeds & special crops), honey, herbs & spices, mushrooms, spouts, horticulture, veal and goats.*

tem. The final phase represents official recognition of the program through an implementation assessment by the CFIA of the review by the third party auditor. Several provincially-based OFFS (e.g. greenhouse vegetables) have been developed separately or in conjunction with national programs.

Figure 1: Canadian on-farm food safety programs

	STAGES OF DEVELOPMENT*		
Commodity	Technical review	Implementation and third party	Implementation assessment
Pork	✓ (Aug. 2004)	IP	
Beef	✓ (Dec. 2004)	IP	
Dairy	✓ (Dec. 2003)	IP	
Grains, oilseeds/specialty crops	IP		
Chicken	✓ (Aug. 2002)	IP	
Eggs	✓ (Feb. 2004)	IP	
Hatching eggs	✓ (Dec. 2004)		
Hatcheries	✓ IP		
Turkey	IP		
Bison	✓ IP		
Cervids	✓ IP		
Sheep	✓ IP		
Veal	IP		
Goats			
Mushrooms	✓ IP		
Horticulture	✓ IP		
Sprouts	IP		
Honey	IP		
Herbs and spices	IP		

✓ = Complete (whole phase or components)
IP = Components in-progress
O = Components operational
R = Components under revision
** = Stages are under development/review and subject to revision*

Source: Adapted from Grajcyzk (2002) *On-Farm Food Safety Programs in Canada*, Saskatchewan Agriculture, Food and Rural Revitalization, presentation at University of Saskatchewan, November. Additional information provided by Chambers (2003) and CFIA (2004).

In summary, there is a lot of interest in on-farm food safety and environmental practices at both the industry and policy levels. Yet many questions remained unanswered. A series of public consultations about the proposed APF generated many questions about the scope of OFFS and EFP, the cost of implementing these programs, their effectiveness and scepticism over their potential benefits. An assessment of the potential benefits and costs of OFFS and EFP is therefore timely. This project is the first step in that assessment.

This report begins by outlining the economic basis for identifying private and public benefits and costs. As OFFS and EFP differ somewhat in their objectives, scope and impact, the analysis will first focus on OFFS before focusing on EFP. Potential complementarities between OFFS and

EFP are identified. A wide-range of generic private and public benefits and costs resulting from OFFS are identified and their potential distributional effects outlined. The potential public and private benefits of EFP and a categorization of potential implementation costs follows.

Chapter 2

Benefits, costs and externalities

The conceptual framework in this report identifies the potential private benefits and costs and the public benefits and costs from OFFS and EFP. The discussion in this chapter outlines the economic foundation for the benefits and costs discussed. Some of these are non-market externalities (also known as spillover effects), which are the benefits and costs that flow between economic agents with incomplete compensation or remuneration from the marketplace. When there are externalities, market failure can occur, and the market will not, except through chance, allocate resources effectively or efficiently. Market failure can occur in the presence of information asymmetry if the quality (or safety) of food is a credence characteristic that consumers cannot detect without further information, and if there is an insufficient incentive for the private sector to provide that information.

Benefit-cost analysis has long been part of the economist's toolkit. Project evaluation usually requires comparing benefits and costs that occur in different time periods. From the point of view of a private firm, the computation of benefits and costs is relatively straightforward if these are measurable. The benefits from a project are the discounted expected revenues while the costs are the firm's discounted payments for inputs and services. Benefits and costs are measured at market prices. The evaluation is more complicated for the government because public benefits and costs may not be reflected in market prices. In a properly functioning competitive economy, the price of a good simultaneously reflects marginal social costs of its production and its marginal value to consumers. Agri-food markets, like many others, are plagued with many real-world imperfections such as externalities, incomplete information, uncertainty, and politically motivated interventions ranging from trade taxes to domestic subsidies. Furthermore, the benefits and costs of food safety and environmental programs and initiatives are harder to estimate because of the problems stemming from the valuation of intangibles, which boils down to inferring a value for benefits from goods for which no market exists.

2.1 *Private versus public benefits and costs*

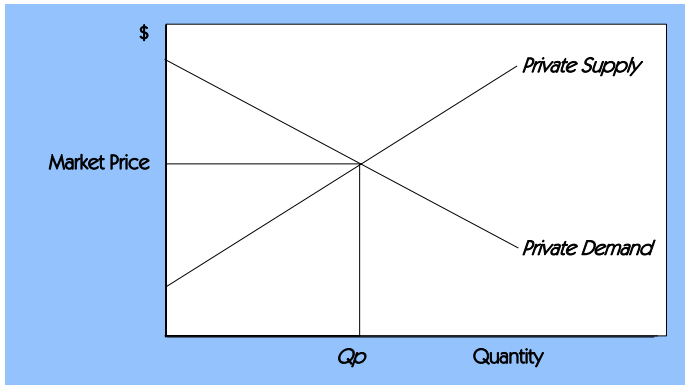
Non-market effects, or externalities, are benefits or costs that flow between economic agents with incomplete compensation or remuneration[3]. Most goods and services are bought and sold in the marketplace. The individuals or firms producing a good are paid by those who benefit from purchasing the good. A positive externality exists where a good generates benefits that are not being fully paid for in the market place. These are often third party benefits or costs that flow to those not involved in the sale or purchase of the good. For example, a farmer may pay to have trees planted as a wind break for his farm residence which also adds to the aesthetic value of the local community, yet he is not paid for creating this benefit. A negative externality exists when some cost is imposed on other members of society without compensation. For example, a hog barn may generate undesirable odours that drift onto a neighbour's property reducing their quality of life. If neighbours who are negatively affected are not adequately compensated by the hog operation, the hogs are creating a negative externality.

Indirect market impacts such as changes in prices or levels of employment, are sometimes referred to as pecuniary externalities (spillovers). For instance, a new flax variety might expand flax acreage and reduce the supply of canola. The resulting higher price and consumer surplus loss to canola consumers would be a pecuniary externality. These indirect market impacts are internal to the market place and do not affect the efficient functioning of the market place. As is the common practice in the economics literature, this paper will use the term externalities to refer to only non-market externalities.

Externalities are closely associated with the concept of market failure. When markets are perfectly competitive, such that individuals have to pay for the costs that they impose on others and get paid for the benefits they create, it is well known that markets will maximize the benefits to society[4]. When there are externalities the market will not, except through chance, allocate resources effectively or efficiently resulting in distortions.

The concept of how externalities affect decisions and overall economic welfare can be illustrated in a simple graph. The market demand for a good represents the relationship between the private willingness to pay, and the quantity available for sale. The market supply for a good represents the marginal cost of producing various quantities of the good. The market equilibrium occurs at a price where the private quantity supplied is just equal to the private quantity demanded. The market equilibrium is illustrated in Figure 2. If the private market demand reflects the aggregation of marginal individual benefits of the good and the supply curve is constructed by aggregating the marginal costs of individual producers, then at the market equilibrium total net benefits from

Figure 2:
Private supply and demand for a good

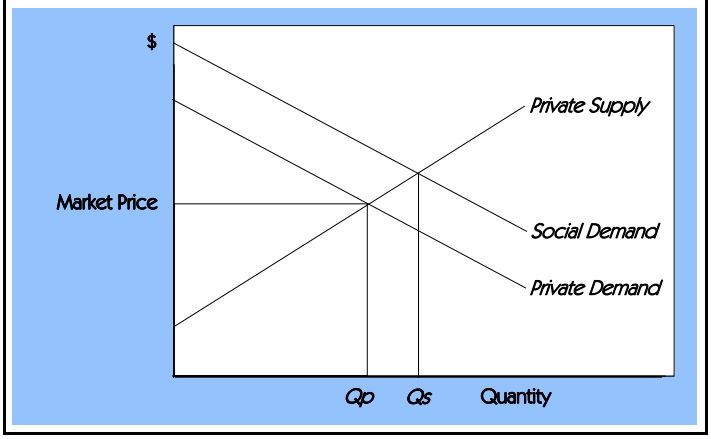


3. *This definition is consistent with the more extensive definition provided by Baumol and Oates (1988).*
4. *This notion was central to Adam Smith's "invisible hand" of the marketplace. The notion that competitive markets are Pareto optimal is one of the fundamental theorems of welfare economics.*

production and consumption are maximized. At quantities less than *Qp* the benefit from consuming another unit of the good exceeds the cost of producing the unit and at quantities greater than *Qp* the cost of producing an additional unit exceeds its benefits. Thus, in the absence of externalities the market acts like an invisible hand to produce the socially desirable quantity of the good. This relationship only holds when both the benefits and costs of a good provision are fully reflected in the private demand and supply curves and when the transaction costs are zero.

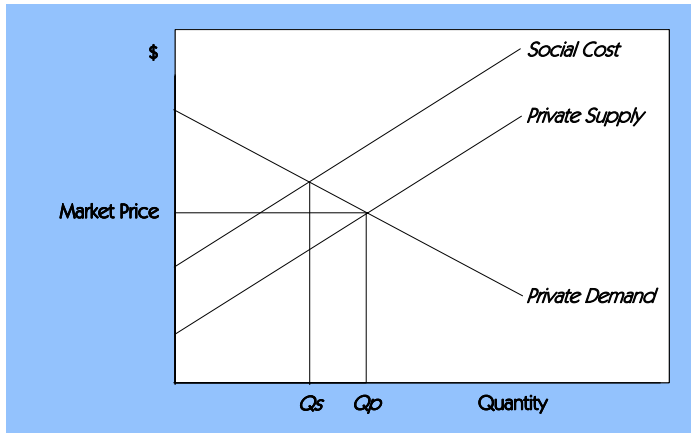
Markets fail to bring about an optimal allocation when externalities exist. The existence of an externality means that there is some benefit or cost to the provision of a good that is not reflected in the private demand and supply curves. When the production of a good creates a benefit that is not reflected in the private demand for the good, then the social or total marginal benefits exceed those reflected in the private demand curve. In this case a positive externality is said to exist and the market will under supply these goods. This is illustrated in Figure 3 where the social demand curve lies above the private demand curve. In this case the optimal production of the good is *Qs*, whereas the market, which only reflects private demand, would undervalue the good and supply quantity *Qp*.

Figure 3:
Private versus social optimum for a good with a positive externality



When the production of a good imposes some costs on others that are not reflected in the marketplace, a negative externality exists. The social or total marginal costs exceed those reflected in the private supply curve. As illustrated in Figure 4, the social supply curve lies above the private supply curve. The market tends to understate the costs of production and the good is over supplied at level *Qp* rather than at the social optimum level of *Qs*. Externalities result in market failure by driving a wedge between the private demand or supply and between the social demand or supply.

Figure 4:
Private versus social optimum for a good with a negative externality



The total loss to the economic system arising from the failure of markets to provide socially optimal levels of production is referred to as the deadweight loss of the market failure. The dollar amount of a deadweight loss is generally measured as the difference in total economic surplus between the optimal allocation as compared to the market allocation. In the calculation of total economic surplus, consumer surplus plus producer surplus minus any cost to taxpayers is considered. In reality there are costs to carrying out transactions that are not fully reflected in the demand and supply curves illustrated above. Thus, the transaction costs (such as the increased

costs of gathering and processing information or of monitoring and enforcing an exchange relationship) must also be considered explicitly in the calculation.

2.2 *The nature of consumer choice*

To understand the conditions under which market failure can occur, it is first necessary to outline some key economic concepts regarding consumer choice and relate these to the case of the environment and food safety.

Imperfect information and segregation costs

Consumers are not homogenous in their preferences towards the environment, food quality and food safety. Market failure can occur when the traditional neoclassical assumption of fully rational individuals operating in an environment of complete and certain information is relaxed. Information asymmetry is a form of incomplete information that arises when there is an unequal distribution of information between transacting parties. For example, there might be unequal information about the attributes of the product or about the characteristics of the buyer or seller.

Adverse selection is the result of incomplete information. In this situation, information is hidden from one party prior to a transaction. For example, the seller may have more information about the actual environmental conditions under which a good is produced than the buyer. In Akerlof's classic discussion of the market for used cars (Akerlof, 1970) the sellers offer only *lemons* for sale. The poor quality products (lemons) drive high quality products from the market[5]. Consumers with strong preferences for foods produced in an environmentally friendly production system will consider foods produced using less environmentally friendly practices to be lemons. Similarly, foods produced to lower food safety standards would be lemons. Under information asymmetry, consumers cannot distinguish between the products that were not produced in an environmentally friendly production system or in accordance with an on-farm food safety program from those products that followed food safety or environmental guidelines. Without more information, consumers cannot tell which products are the lemons. They would therefore assume that all relevant foods are produced using practices that are not environmentally friendly and discount these foods accordingly. There is a welfare loss for consumers wishing to consume foods produced using environmentally friendly production methods. Following the lemons case, foods produced in an environmentally unfriendly manner (or not in accordance with OFFS) could force their environmentally friendly counterparts (OFFS counterparts) from the market (Plunkett and Gaisford, 2000).

The information problem arises as a direct result of the credence nature of safer (supersafe) food or environmentally friendly food. Unlike search attributes, which can be detected by consumers before they purchase a product (e.g. the volume of milk in a carton) or experience attributes, which can be detected after consumption (e.g. the crispness of an apple), the quality of credence attributes cannot be determined accurately even after consumption. This may be because the consumer lacks expert knowledge or information. Examples are the services of a doctor or whether a beef product contains growth hormones. The environmental conditions under which a food is produced and whether an OFFS was followed are credence attributes. Due to information

5. *Consumers know that there is a probability that the used car they want to purchase might be a lemon, therefore they are not willing to pay as much as when the probability of getting a lemon was zero. It could be unprofitable to sell high-quality cars at that price for many dealers who must pay more for high-quality cars than for lemons. Consumers anticipate this and reason that if a car is offered it is likely to be a lemon. This brings about reductions in price and eventually no high-quality cars are offered for sale in the used car market.*

asymmetry, even after having consumed the food, the consumer does not know whether the product was produced in an environmentally friendly production system or following an OFFS. The lemons problem of adverse selection will be worse when goods are characterised by credence attributes unless there is a method to signal the presence of the environmentally friendly (on-farm food safety) credence attribute to consumers. Labelling foods produced in an environmentally friendly system or in accordance with an OFFS is one such method. Production under the guidance of an EFP can be used to signal environmentally friendly production through product labels (similarly for food safety programs). Labelling is relatively cheap, and to be credible it is essential that the firms benefiting from the labels have invested in a reputation.

Two other concepts are important in understanding the consumer information problem. *Bounded rationality* recognizes that individuals have limited cognitive abilities; although they intend to act rationally, their ability to accurately evaluate all possible alternatives is physically limited (Simon, 1961). *Opportunism* is "self interest seeking with guile" (Williamson, 1979). Individually, this may not be a problem. If someone knows that a person is going to act opportunistically, then they won't do business with that individual. However, once it is recognized that individuals are boundedly rational, and market participants have asymmetric information, it becomes impossible to determine with certainty whether opportunism will occur and who will act opportunistically.

One solution to information asymmetry in the market for environmentally friendly food is for companies to voluntarily label their food as environmentally friendly. The extent to which this is effective depends on the incentive to label accurately. If the price of food that does not conform to an environmentally friendly standard is discounted in the market, there is an incentive to cheat by mislabelling these products as environmentally friendly. Given bounded rationality and information asymmetry, it is not possible for consumers to determine which firms will act opportunistically to misrepresent their products. Market failure results. The existence of EFP along with independent certification that the plan is being implemented can assist in eliminating this form of market failure.

It can therefore be concluded that the properties of a market equilibrium under incomplete information depend on the characteristics of the product, the cost of communicating information among consumers and on the ability of consumers to use information (Stiglitz, 1989). The uncertainty about food quality (and safety) could be generalized or one-sided which results in information asymmetry between producers, processors and consumers. Incomplete information is now recognized as a ubiquitous problem and this is why there is a rapidly growing literature on mechanism design related to quality signalling, reputation effects, mandatory versus voluntary labelling, etc. All these mechanisms offer ways to circumvent the asymmetry of information problem, including that pertaining to food safety. Hence, there may exist a role for government intervention to correct market failures[6]. For example, Holloway (1999) points out that asymmetric information in food markets and the inability to trace back and trace forward along the chain creates distortions in the food supply which in turn engender free-riding problems. He argues that credible threats of penalty and efficient testing and sampling confer enough power to regulators to coerce market participants toward efficient market outcomes.

Another approach is to implement food safety measures at the farm level to reduce the impact of distortions due to information asymmetry. This is the approach being taken with the OFFS examined for this project.

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6. Government should opt to ignore a market failure if correcting it entails costs in excess of the benefits.

Government policy may encourage the use of EFP for the purpose of improving the environment or mitigating the adverse effect of farming on the environment. Similarly it may encourage the use of OFFS to improve or assure food safety. These programs can be created for private and/or public motives. There are many potential types of EFP and OFFS with a variety of options for ensuring that farmers comply with their farm plans or with industry-established standards of production. Farm plans are institutional arrangements that can address some types of externalities. The benefits and costs of EFP and OFFS have to be measured relative to some other institutional arrangement or policy instrument. All benefits and costs, private and public, should be considered. The following section outlines the approach on which OFFS in Canada are based.

Chapter 3

The HACCP approach

The OFFS envisioned by the APF and the COFFS are HACCP-based. The HACCP system has been applied to downstream food processing in a number of countries, and its application to the farm sector is relatively new. HACCP has been mandatory in U.S. meat, poultry and seafood processing plants for several years. The CFIA has strongly encouraged federally inspected food processing plants in Canada to adopt the HACCP standard. The program will be mandatory for federally registered meat processing plants by 2004, with a phase-in period of one year.

In food processing plants, the HACCP system involves identifying potential biological, chemical and physical hazards and identifying the critical control points at which these hazards can be eliminated, reduced or controlled. Procedures are developed for ensuring that critical control points are met. Documentation is central to a credible HACCP plan, wherein a firm documents the critical control points for each identified hazard and monitors compliance with the procedures designed to target each critical control point.

If a HACCP system is working effectively, the need to monitor the safety of final outputs (e.g. through microbiological testing) is reduced as the procedures are in place to reduce the risk of contamination in the first place. HACCP is a process standard rather than a performance standard. In this regard, it is only as effective as the processes that are established for each plant. A poorly designed HACCP plan, with an inappropriate assessment of hazards and weak critical control points will not establish procedures that reduce the risk of food safety problems arising. Third party monitoring and accreditation of HACCP systems is therefore important in establishing a credible HACCP plan.

The OFFS, developed and under-development, are based on an HACCP philosophy; they are said to be HACCP-based rather than full-fledged HACCP systems. This recognizes that the per farm cost of implementing a full HACCP approach would be impractical. The production environment on a farm is subject to a number of hazards that may be difficult or prohibitively expensive to control, unlike within the relatively closed environment of a food processing plant. For example, it may be difficult for a feedlot to prevent birds from coming into contact with cattle feed, even though this could be identified as a potential biological hazard.

The HACCP-based approach is recognized by CODEX as a legitimate application of HACCP principles to on-farm quality assurance systems. In Canada, HACCP-based is officially recognized as a process by which generic hazard analysis can be conducted across all producers in a given commodity sector. The generic hazard analysis is used to generate a list of commonly accepted hazards and related controls. These are then translated into good production practices for application at the farm level (e.g. standard withdrawal times for anti-biotic use in cattle).

Although a similar sector-wide approach could be applied to EFP, it may be more appropriate for individual farms to develop customized farm plans based on HACCP principles and industry guidelines. Ultimately, whether they are fully-fledged HACCP plans or HACCP-based plans, the objective is the same: to minimize risks through improved management practices. HACCP-based systems are only one of a range of potential institutional mechanisms for delivering enhanced food safety and environmental sustainability. In analysing the benefits and costs of HACCP-based OFFS and EFP, it is useful to benchmark the potential benefits and costs against those from other institutional arrangements.

Chapter 4

On-farm food safety programs – identifying and classifying benefits and costs

The discussion in Chapter 2 reveals that market imperfections exist and that asymmetric information in markets for food may create a role for labelling to inform consumers or for government intervention in the face of persistent market failure. Another approach is to implement food safety measures at the farm level to reduce the effect of distortions due to any uncertainty about food quality and safety. The implementation of such measures generates benefits and involves costs for producers, processors, retailers and consumers. The purpose of this chapter is to identify and classify these benefits and costs from various perspectives (e.g. according to distributional implications and market characteristics) and to identify the factors impacting on the size of the benefits and costs. Appendix A provides suggestions about empirically measuring the benefits and costs across the supply chain. The benefits and costs identified in this study are categorized into two broad groups:

- Market-driven benefits and costs
  - Demand-side effects
  - Supply-side effects
- Public benefits and costs

4.1 Market-driven benefits and costs

Market-driven benefits and costs accrue directly to private firms or individuals. They are captured by shifts in the private market demand and supply curves for a product.

4.1.1 Demand-side effects

Reduce transaction costs for consumers

The benefits of HACCP-based programs for consumers can be modelled after four potential consumer responses to food safety and are summarized in Van Ravenswaay and Hoehn (1996): i) product avoidance; ii) brand switching; iii) averting behaviour; and iv) mitigation. The first two responses entail passing up the opportunity to buy a commodity. Averting behaviour refers to actions taken to reduce contaminants in food (e.g. cleaning and cooking). Mitigation involves the treatment of illness from food contaminants. These consumer responses tend to exert ambiguous effects on the demand for farm products. For example, if a consumer is uncertain about the safety of consuming a raw apple because of potential chemical residues, he/she could switch to small packs of processed apple sauce, in which case demand for raw apple could increase; or else he/she could switch to a chocolate snack, in which case the demand for apples would decrease. Food safety processes such as HACCP can eliminate or reduce avoidance and averting actions by consumers. Hence, HACCP-type processes at the farm level can significantly reduce the costs for consumers to undertake actions to increase food safety. This is likely to bring about benefits, but as suggested by the example, these benefits will probably not be uniformly distributed across farmers, processors, retailers and consumers. A noteworthy producer-to-producer effect of a food contaminant follows from product avoidance, that is the substitution of one farm product for another (e.g. a piece of cheese replacing an apple). Improvements in food safety can change consumer behaviour over time. For example, if the E.Coli incidence drops low enough, consumers may reduce their averting behaviour, taking fewer precautions in the storage and cooking of meat.

Build and maintain consumer confidence

Food safety programs can be important in maintaining consumer confidence in the food industry and in the safety of Canadian food. Generally, Canadian consumers exhibit confidence in food safety. Most people expect their food to be safe. The food inspection system and industry programs to maintain high standards of food safety are important not only in ensuring that food safety problems are minimized but also in maintaining consumer confidence.

A related role of food safety programs can be to build a 'brand image' based on food safety, that is to use food safety as a marketing tool and thus potentially allow farms and firms along the supply chain to extract premiums in the absence of adverse selection problems. As explained in Chapter 2.2, adverse selection is said to occur when an informed agent's trading decisions depend on unobservable characteristics in a manner that adversely affects the uninformed agents in the market. In this case, the informed agents are the firms that know the safety profile of the product they sell[7]. Food safety is unobservable from the consumers' perspective as consumers will not knowingly purchase/consume visibly unsafe products (e.g., with moulds or undesirable lumps, etc.). As a result, consumers form expectations about the average safety of products on the market and their willingness to pay is a function of the average quality. If there are no mechanisms to credibly convey information about the food safety of a product, the safest foods will be driven out of the market; negating any premium firms require to invest in food safety. However, if mechanisms exist to prevent adverse selection problems, firms producing safer foods can collect premiums from intermediate or final consumers that most value food

7. *It could be argued that firms are also "in the dark" regarding the safety of a particular item because it is prohibitively costly to test the quality of every item produced. However, because of quality control programs, they would have a far more precise assessment of the risks than consumers.*

safety attributes. It is unlikely that all consumers would be willing to pay more for food marketed as 'safer' if most consumers currently perceive their food to be safe. However, the consumer market is highly segmented and therefore some consumers may be willing to pay a premium for an extra assurance of food safety. The allocation of these premiums (if any) across the supply chain depends on a number of factors like demand conditions, technology, and the nature and intensity of the competition among firms.

Convey additional information

Labelling can be an important tool to differentiate "safer" foods from "other" foods. Beyond health cost reductions, labels signalling food safety can reduce the information costs for consumers. However, labelling imposes additional costs on firms and it may not be effective in securing a premium from consumers if a large proportion of them do not pay attention to labels or question the validity of the labels (see for example Noussair, 2002 and West et al., 2002).

Identity preservation, when integrated with HACCP-based processes, allows for the sharing of information unrelated to the final characteristics of the product. In the case of organic foods for example, identity preservation can contribute to the truthfulness of label information. It can protect the integrity of the certification of the product and, in the eventuality of falsely labelled conventional products, can facilitate the identification of the point in the chain responsible for the problem. But, identity preservation concerns are not restricted to the organic industry. These issues reinforce the ultimate *raison d'être* of HACCP-based and traceability programs which is to act as insurance against unmanageable confidence crises. Once a certain threshold of scepticism is reached, whether it is about the safety of certain foods or about the integrity of an identity preservation system, consumer demand could quickly and dramatically fall. In spite of actions aimed at reassuring consumers, it can take years to recover from such disasters. HACCP-based programs can lower the risk of contamination while traceability can help appease public concerns by quickly identifying a culprit. Traceability also reduces the cost of product recalls. It reduces risk for firms with good food safety practices by making it more difficult for firms with poor food safety handling practices to *free-ride*. The value of this sort of insurance depends on the risk attitudes of agents all along the marketing chain.

Provide differentiation on the international market

Food safety programs can serve as product differentiation mechanisms in international markets (e.g., New Zealand and Australia's quality assurance certification of beef production [Lawrence, 2002]). The fact that exporters get rewarded for efficient marketing practices, including quality controls, is nothing new. Larue (1991) showed that Canadian wheat was getting a premium on international markets that could not be explained by quality/product characteristics differences. There is also evidence that third-party quality control certification could become a minimum requirement for access to export markets[8].

Reinforce and develop trade networks

Communication of HACCP system elements to customers or communication of HACCP system requirements to suppliers can also reduce the marketing/sales and after-sale service costs of supply firms. The certification mechanism lowers search costs for purchasing materials and services as well as lowering marketing/sales costs in communicating the nature of the quality management systems in place. Hence, it can reinforce trade networks and facilitate trade

8. *Anecdotal evidence provided by a pork producer.*

(domestically and internationally). Demand-side effects emanate from all purchasers throughout the marketing chain. As such, even if final consumers were to expect the highest level of quality control and traceability (and hence would not want to pay more), retailers and processors would value HACCP-like programs by producers because it would lower the frequency of product recalls, re-negotiations of prices when deliveries do not meet specified standards, etc.

Facilitate trade by reducing non-tariff barriers

Although an important goal of HACCP-type processes at the farm level is to improve food safety, it can meet the objectives of facilitating trade by establishing internationally recognized food standards. Tariffs and other barriers to trade have steadily declined in the last decade although they remain high relative to the ones applied to industrial goods. Trade agreements also include sanitary and phytosanitary regulations that insist that national regulations be based on appropriate science and risk assessment processes. These regulations must be applied evenly to domestic and imported products. The potential for HACCP to become an international trade standard will depend on the degree to which regulatory convergence between countries is going to take place. This implies a role for government and international institutions like CODEX Alimentarius Commission, the FAO and others. It is worth noting, that this will likely create additional challenges and costs for producers in less developed countries as these countries struggle to meet international HACCP-based standards with poor supply chain infrastructure and scarce resources.

4.1.2 Supply-side effects

Improve productivity of input and efficiency in production

HACCP-based processes at the farm level might improve the productivity of inputs such as labour, capital, materials and energy, while enhancing food safety. HACCP forces managers to reconsider the way they are doing business because they have to carefully identify critical control points. A well-documented HACCP plan can improve communication among management and employees within large farm enterprises, leading to potential efficiency gains. HACCP may also lead to the overall computerization of farm operations and thus improve overall productivity indirectly. An important distinction must be made between voluntary and compulsory HACCP systems. Firms make production decisions to maximize private profits. If OFFS lower production costs and improve overall efficiency such that the expected monetary and non-monetary benefits that farmers receive exceed private costs, producers will voluntary set up these OFFS. Whenever the private costs of adopting specific HACCP based procedures at the farm level exceed the private benefits, farmers will not voluntarily agree to engage in OFFS without outside incentives being provided. Hence, one could argue that efficiency considerations will automatically lead producers to adopt HACCP procedures that will increase food safety up to the point where the net benefits of doing so are exhausted.

At the processing level, HACCP measures can either favour or disadvantage single over multi-species slaughtering facilities, high-volume over low-volume plants and single over multi-process plants. If the development and implementation of sanitation standards and operating procedures differ for different species, economies of scope for processing plants may be reduced following the implementation of HACCP. This line of reasoning can potentially be applied at the farm level as well. In particular, a HACCP-type system may confer higher per unit costs on smaller farm enterprises. Farms producing several commodities may also have to comply with several OFFS requiring several sets of records be kept. Thus, the costs of complying with on-farm food safety requirements can be expected to be higher than for single commodity farms. A miti-

gating factor, however, is the common approach to implementing OFFS being taken across commodities under the COFFS. Also synergies in producer awareness and training and potential synergies in auditing may help reduce the impact of these costs.

Reduce logistics costs

Mazzocco (1996) stresses the importance of HACCP as part of a global business management strategy. For example, HACCP systems may be important in inbound and outbound logistics. Suppliers and buyers of raw materials that have special post-harvest physical degradation concerns (e.g., vegetables, milk) have come to appreciate quality control in logistics. Lack of control over the process of delivering materials to intermediate or final customers may undo the benefits of HACCP systems focussing too narrowly on operations.

Reduce measurement costs: performance vs process standard

HACCP is a process standard and not a performance standard. Economic theory states that it is more efficient to let firms achieve performance standards in heterogeneous ways than to impose a mandatory process standard such as HACCP. However, Macdonald and Crutchfield (1996) dispute this notion in the context of food safety by arguing that pure performance standards are plagued by information requirements that are very costly. It may be difficult and costly to detect all food safety problems after processing. HACCP may not be a perfect substitute for all performance standards, but it may allow firms to spend far less on standard-based quality control programs. Due to measurement problems, process standards may be easier to verify than performance standards. It should be noted that this varies by industry due to differences in product type and ease of quality verification. In grains, for example, the opposite seems to be the case[9].

Reduce supply chain monitoring and enforcement costs

OFFS reduce monitoring and enforcement costs at the retail level. This implies that there may be increasing returns to scale with respect to food safety processes at the industry level, thus constituting a positive externality. Food safety actions of farm producers reduce the costs of processors and retailers, but nothing guarantees that these cost reductions will be internalized by producers. The benefits from the positive externality are more likely to be shared among different segments of the industry.

Reduce product liability costs and ex-post cost reduction if contamination occurs

HACCP-based farm programs can be regarded as risk management tools for food safety, animal health and plant health. Originally, HACCP was developed as a management tool in food processing in response to product liability concerns that were more pressing than those in the production of unbranded raw products. Reducing the probability of product liability is a benefit of HACCP-based programs, especially if a traceability system capable of tracking products all the way back to the farm is implemented. If this is effective, it may also change the distribution of liability costs along the supply chain. Those firms (including farms) that have implemented good food safety practices are not liable for the poor practices of others. More effective assignment of product liability should create stronger incentives for each agent in the supply chain to maintain

9. *See grain sector report: Gray, R., M. Ferguson, B. Martin, J.E. Hobbs, W.A. Kerr, B. Larue and J-P Gervais. A Qualitative Assessment of the Costs and Benefits of On-Farm Food Safety and Environmental Farm Plans in the Grain Sector, Report prepared for Agriculture and Agri-Food Canada, March 2003.*

good food safety practices, thereby increasing the level of food safety – this is a public benefit. Furthermore, the combination of HACCP-based and traceability systems would also reduce the ex-post liability costs in the event of a discovery of food contaminants. However, care should be taken not to double-count these benefits and costs. Damages awarded to consumers are a cost to the firms involved but a benefit to consumers. Reduced liability will reduce the private cost of lawyers; it will also reduce the net cost to consumers.

Reduce free-rider impacts

An OFFS may reduce the vulnerability of adopting farms to free-riding by non-adopters. A crisis in consumer confidence arising from a food safety problem could be contained to the non-adopting farm sector if it is shown that the problem did not emanate from a farm (food supply chain) following an HACCP-type plan. Note however, that this is a double-edged sword. An HACCP/OFFS without third party verification or enforcement of standards would leave farms vulnerable to free-riding by other OFFS members. The OFFS would not be credible to consumers if avoidable food contamination problems arose despite its existence. It is worth noting in this context that commodity sectors participating in the COFFS will have certification and third party auditing. This is discussed in more detail in each sector's report.

Management and compliance costs

Implementing HACCP systems imposes costs on individual firms. Management costs include the fixed costs of establishing an HACCP program and the variable costs of adjusting this program if necessary. Compliance costs include fixed cost investments in capital equipment necessary to implement an HACCP plan, plus variable costs of record keeping, training, etc. Macdonald et al. (1996) studied the market structure of the meat industries and food safety regulation. They found that HACCP raises per unit costs for small firms. This important drawback for small firms must be weighted against the benefits stemming from HACCP regulations. HACCP implementation is likely to hurt small firms more than large ones because plant adjustments, pathogen testing, training and record keeping impose costs that vary little as output increases. Similarly, small farms will face higher per unit costs than large firms. Where on-farm HACCP systems are developed by industry associations, small industries (e.g. the bison industry) will incur higher per unit costs than relatively large industries (e.g. the beef industry). However, the full extent of the actual effects of the regulations on small firms will depend on: i) the size of any cost disadvantage faced by the firm in light of its capacity to expand production; and ii) the degree to which small firms can raise prices.

The COFFS divides management and compliance costs between national programs and individual farms. National program costs include the development and maintenance of the program, a generic hazard analysis, certification development and auditor training, internal and third party audits, etc. Individual farm costs include the costs of producer training (financial and opportunity cost), on-farm implementation, record keeping, on-farm audit costs, etc. The burden of compliance costs depends on the model adopted for third party auditing i.e. a single commodity versus multi-commodity approach and on the number of participating producers over which the fixed costs of the audit process are to be spread[10].

10. *Preliminary industry estimates of audit costs by the COFFS Working Group range from $450 to $1600 per audit depending on the industry and on the approach taken e.g. single commodity versus multi-commodity approach, and depending on the number of participating farms. These preliminary estimates do not include additional costs to the producer such as training time, record keeping, preparing for the audit and any increased capital or insurance costs (Chambers, 2003).*

Sunk investments

If large purchasers (for e.g. processors or retailers) force their producers/suppliers to adopt their own HACCP-like system that involves substantial sunk costs, the producers/suppliers might be partially held up since these investments are only valuable if the trading relationship with the purchaser continues. This situation might deter individual producers/suppliers from investing in the food safety program.

Alternatively, once producers/suppliers have committed to implement a buyer-specific food safety program, they can become captive. If all major purchasers force their own HACCP-like system on their producers/suppliers and sunk costs are high, producers/suppliers tied to these systems will not have an incentive to switch to another purchaser. In this instance, benefits from the implementation of HACCP-like systems could have negative implications in terms of market power. The industry-wide OFFS approach being adopted in Canada should avoid these problems as the investments in on-farm food safety practices are not relationship-specific, with respect to a downstream buyer but are intended to be implemented on an industry-wide basis. Although a purchaser may still require the producer/supplier to comply with the OFFS, this investment does not tie the producer/supplier to a specific purchaser.

4.2 On-farm food safety programs: summary tables of private benefits and costs

This chapter presents summary tables outlining major private benefits and costs of OFFS according to distributional implications, market characteristics, and factors affecting their size and direction. A more technical economic framework for evaluating the various potential effects of on-farm HACCP-type processes is provided in Appendix B.

4.3 Public benefits and costs

As explained in Chapter 2.1, externalities exist when a good generates benefits that are not fully paid for in the market place (positive externality) or a cost is imposed on other members of society without compensation (negative externality). These are public benefits and costs.

Reduce the public cost of foodborne illness

If OFFS are effective in reducing the incidence of foodborne illness, public benefits arise in the form of (i) reduced medical costs for society, (ii) reduced productivity losses as a result of absences from work due to illness and (iii) reduced illness-related deaths and permanent disabilities resulting from food contaminants. The Economic Research Service of the U.S. Department of Agriculture has developed a cost-of-illness method to estimate the annual resource expenditures for illnesses caused by foodborne pathogens. According to some computations reported in Buzby et al. (1996), total benefits from reducing foodborne illness in the U.S. can be decomposed in the following way i) $US 5.25 billion due to the reduction in premature deaths, ii) $US 3.15 billion due to the reduction in work-loss, and iii) $US 4.92 billion due to the reduction in medical expenses directly related to foodborne illnesses.

Table 1: Impact-based classification system of potential private benefits and costs of on-farm food safety programs according to their distributional implications in the supply chain

Private benefits and costs	Input supplier-to-producer	Producer-to-producer	Producer-to-processor	Processor-to-retailer	Retailer-to-consumer
Demand-side effects					
Reduce transaction costs for consumers		Reduce substitution effects between farm products			Reduce product avoidance, brand switching, mitigation and averting actions
Build consumer confidence			Domestic marketing mechanisms can allow premiums to be distributed to producers	Domestic marketing mechanisms can allow premiums to be distributed to processors	Extract premiums from consumers for foods with safety assurances
Convey additional information (when used with identity preservation systems)		Reduces the incentive to free-ride	Protect the integrity of the product	Protect the integrity of the product	Protect the certification mechanism for consumers
Provide differentiation on the international market	Domestic marketing mechanisms can allow premiums to be distributed to suppliers		Domestic marketing mechanisms can allow premiums to be distributed to producers	Domestic marketing mechanisms can allow premiums to be distributed to processors	Collect premiums for quality and product characteristics
Facilitate trade by reducing non-tariff barriers				Potentially increase market penetration in foreign markets	
Reinforce and develop trade networks	Reduce marketing costs in communicating nature of quality management systems and after-sale service		Reduce marketing costs in communicating nature of quality management systems and after-sale service	Reduce marketing costs in communicating nature of quality management systems and after-sale service	
Private benefits and costs	**Input supplier-to-producer**	**Producer-to-producer**	**Producer-to-processor**	**Processor-to-retailer**	**Retailer-to-consumer**
Supply-side effects					
Benefits:					
Improve productivity of inputs	Increase demand for farm inputs		Reduce producers' average cost which leads to lower prices for farm products		
Improve efficiency in production	Inputs used more efficiently reduces costs of production		Reduce cost of raw inputs	Reduce cost of goods for the retailer	
Reduce logistics costs	Reduce in-bound and out-bound logistic costs		Reduce in-bound and out-bound logistic costs	Reduce in-bound and out-bound logistic costs	

Table 1: Impact-based classification system of potential private benefits and costs of on-farm food safety programs according to their distributional implications in the supply chain (Continued)

Private benefits and costs	Input supplier-to-producer	Producer-to-producer	Producer-to-processor	Processor-to-retailer	Retailer-to-consumer
Reduce measurement costs: performance versus process standards			Improve quality control mechanisms; reduce resources devoted to quality monitoring		
Reduce monitoring and enforcement costs	Applies to business relationships between producers and input suppliers		Applies to business relationships between producers and processors	Applies to business relationships between processors and retailers	
Reduce product liability costs	Potentially higher costs for those at fault. Lower for others	Potentially higher costs for those at fault. Lower for others	Reduce expected losses in the event of a serious incident	Reduce expected losses	Fewer consumers affected in the event of a serious incident
Reduce ex-post cost following detection of contaminant in food	Potentially higher costs for those at fault. Lower for others	Potentially higher costs for those at fault. Lower for others	Stabilize supply for processors	Stabilize supply for retailers	Reduces the potential for or degree of market disruption
Reduce free-rider impacts		Reduce vulnerability to food contamination in non-adopter sector	Reduce processor information costs		Consumer information costs reduced
Costs:					
Management and compliance costs		National programs spread *some* costs over all adopting producers	Small farms may be disadvantaged if OFFS implementation costs vary little with output. Marketing mechanisms and market structure at the processing level will determine the extent of damages		
Sunk investments		National programs reduce risk. Buyer-specific programs increase risk	Suppliers vulnerable to opportunistic behaviour by processors if buyer-specific OFFS sunk investments made	Processors vulnerable to opportunistic behaviour by retailers if buyer-specific OFFS sunk investments made	

Table 2: Impact-based classification system of potential private benefits and costs of on-farm food safety programs according to market characteristics in the supply chain

Private benefits and costs	Exported versus non-exported	Mandatory versus voluntary labelling	IP versus non-IP	Branded versus generic
Demand-side effects				
Reduce transaction costs for consumers		Labelling can reduce information costs for consumers. Not clear whether mandatory or voluntary labelling more effective		Reduce product avoidance of generic products. Reduce brand switching with branded products
Build consumer confidence		Consumer confidence can be built over a long-term horizon under voluntary labelling	Protect the integrity of the product	
Convey additional information (when used with identity preservation systems)			HACCP and traceability systems can protect the certification of certain identity preserved products (e.g. organic foods)	Protect the certification mechanism for consumers
Provide differentiation on the international market	Marketing instrument to capture and protect established market shares	Domestic marketing mechanisms can allow premiums to be distributed to processors	Help target specific niche markets for identity-preserved products	
Facilitate trade by reducing non-tariff barriers	Facilitate trade and potentially increase trade flows			Potentially increases market penetration in foreign markets
Reinforce and develop domestic and foreign trade networks	Reduce marketing costs in communicating nature of quality management systems and after-sale service to foreign customers			
Private benefits and costs	**Exported versus non-exported**	**Mandatory versus voluntary labelling**	**IP versus non-IP**	**Branded versus generic**
Supply-side effects				
Improve productivity of inputs	Increase competitiveness of domestic products in foreign markets. Potentially increase output in domestic markets			
Improve efficiency in production	Increase profits of producers			

Table 2: Impact-based classification system of potential private benefits and costs of on-farm food safety programs according to market characteristics in the supply chain (Continued)

Private benefits and costs	Exported versus non-exported	Mandatory versus voluntary labelling	IP versus non-IP	Branded versus generic
Reduce logistic costs	Increase competitiveness of domestic products in foreign markets. Potentially increase output in domestic markets			
Reduce measurement costs: performance versus process standards		More so if mandatory	Especially important for IP	Especially important for branded
Reduce monitoring and enforcement costs		More so if mandatory	Especially important for IP	Especially important for branded
Reduce product liability costs			Especially important for IP	Especially important for branded
Reduce ex-post cost following detection of contaminant in food		More so if mandatory	Especially important for IP	
Reduce free-rider impacts		More so if mandatory	Especially important for IP	Generic more vulnerable
Costs:				
Management and compliance costs				
Sunk investments				Branded more vulnerable

Table 3: Impact-based classification system of potential private benefits and costs of on-farm food safety programs and the factors affecting the size and direction of these benefits and costs

Private benefits and costs	Marketing structure	Consumer preferences	Technology
Demand-side effects			
Reduce transaction costs for consumers	The more direct is the link between consumers and producers, the higher the returns producers will receive from food safety initiatives if they reduce consumers' transaction costs. The number of intermediaries and concentration of downstream markets affect the extent producers can capture benefits	The more important it is for consumers to have food safety assurances, the higher will be the premiums for 'safer' food	
Build consumer confidence		Attitude toward risk is important. Risk averse consumers are harder to convince of the safety of food products	
Convey additional information (when used with identity preservation systems)		Information must reveal quality attributes important to consumers	Technology can facilitate identity preservation. More feasible in some industries due to technological capability for IP
Provide differentiation on the international market	Ability to price discriminate in the world market will be positively correlated with benefits	Exporters must face an excess demand that is not perfectly elastic; i.e. residual import demand of foreigners is downward-sloping	Overall level of competitiveness of exporters will determine if exporter can extract additional returns for food-safety initiatives at the farm level
Facilitate trade by reducing non-tariff barriers		If foreign standards are not in accordance with consumers' valuation of food safety initiatives but are imposed through worldwide harmonization; the ability to make profitable sales is hindered	Standards must be technologically feasible
Reinforce and develop domestic and foreign trade networks	Increased concentration at point in the supply chain can lead to stronger trade networks and thus increases the benefit of HACCP (likely to be a marginal effect however)		
Private benefits and costs	**Market structure**	**Consumer preferences**	**Technology**
Supply-side effects			
Benefits:			
Improve productivity of inputs			More so when the industry has undergone rapid technological changes

Table 3: Impact-based classification system of potential private benefits and costs of on-farm food safety programs and the factors affecting the size and direction of these benefits and costs (Continued)

Private benefits and costs	Marketing structure	Consumer preferences	Technology
Improve efficiency in production	More so in highly concentrated and protected sectors		More so if more producers can adopt the technology/procedures
Reduce logistic costs	Less so in highly protected sectors	Less so when preferences are less homogenous across countries	More so if more producers can adopt the technology/procedures
Reduce measurement costs: performance versus process standards		Less so when foreign buyers are very risk averse and insist on performance quality tests	More when quality tests are time consuming
Reduce monitoring and enforcement costs	More so when there are a large number of small suppliers/farms		
Reduce product liability costs	Particularly important for retailers and/or processors with large market shares		More so with technology for traceability
Reduce ex-post cost following detection of contaminant in food	More so when there are many farms and processors		More so with technology for traceability
Reduce free-rider impacts	More so when there are many farms and processors		
Costs:			
Management and compliance costs	More so for small farms		Technology improvements could alleviate this effect
Sunk costs	More so in concentrated sectors with few alternative buyers	More so if preferences are heterogeneous with respect to food safety and quality	More so if technology/procedures are buyer-specific

Reduce consumer information costs in the presence of information asymmetry

The presence of asymmetric information implies that consumers could be made better-off by improvements in food safety, but market incentives to offer safer foods may not be strong enough if consumers are not able to tell safe from unsafe food at the point of purchase. This is the "market for lemons" argument explained in Chapter 2.2. Typically, consumers assume that food is safe and they expect that their government will take the necessary action to ensure that it is. For this reason, the public sector has long had a role in developing and maintaining a regulatory framework governing food safety and food inspection (Law, 2001).

Environmental impacts

HACCP-based OFFS change the management of farms and thereby may directly or indirectly affect the environment. Thus there may be synergistic environmental effects.

Farm structure and rural development impacts

The introduction of OFFS could have a differential impact on farms of different size. The capital requirements and on-going compliance costs of these programs may tend to drive smaller farms out of the industry. This direct impact tends to be private in nature. However, the loss of smaller farms could change the aesthetic appeal of the countryside and create additional pressures for rural depopulation. This would be a negative externality.

Taxpayer funded monitoring and enforcement costs

Third party monitoring and enforcement costs may be incurred in establishing a credible OFFS across sectors. If monitoring and enforcement occurs on a cost recovery basis, these costs will be internalized, thereby becoming private market costs for the firms involved.

In the presence of positive externalities, government intervention can bring about a gain in social welfare by developing and implementing policies that will bring marginal social costs closer to marginal social benefits. Such actions could entail facilitating the implementation of food safety measures through a subsidy program. Government might also respond by adjusting its regulations related to food safety to lower its costs as a service provider and to lower the costs of compliance for processing firms and farms.

It is beyond the scope of this project to provide a quantitative assessment of the private and public benefits and costs of OFFS and EFP. Instead, important methodological issues and challenges in measuring benefits and costs are discussed in Appendix A.

Chapter 5

Environmental farm plans – identifying benefits and costs

EFP have been proposed as part of a broad-based initiative to reduce the possible negative effects of agricultural production on environmental amenities in the short run and environmental sustainability over the long run. Farm plans are inherently proactive rather than reactive in that their intent is to encourage farmers to explicitly consider the effects of their production, storage and waste disposal practices on the environment. Only if existing production and associated practices are found to be harmful to the environment, or potentially harmful to the environment, are alterations in practices suggested. In extreme cases EFP might indicate abandonment of a particular crop or livestock enterprise or the winding up of agricultural production altogether. This raises the question of what use is to be made of EFP.

At the most basic level, EFP can be seen as simply a mechanism to raise the awareness of farmers without any suggestion that they be compelled to act to fulfil the plan. EFP can also be seen as a means of determining what is required to achieve an externally imposed environmental standard for agricultural production and the incentives needed to induce farmers to voluntarily meet that standard. The plans can also be seen as a mechanism by which externally determined environmental standards can be imposed as a prerequisite for licensing production at the individual farm level. In this case the farm plan sets both the standard and provides an individual benchmark against which ongoing performance can be judged by an enforcement agency. The latter will require a considerable monitoring and enforcement effort to ensure compliance. In all three cases, it is important to understand the benefits and costs associated with the use of farm plans; otherwise, it is not possible to assess whether society's welfare is enhanced through this particular planning process.

If the public policy objective of encouraging farmers to use farm plans is to reduce existing or potential environmental costs, then in the first case where EFP are voluntary, there is an implicit assumption that the expected monetary and non-monetary benefits that farmers will receive from the farm plan exceed the expected costs. In other words, the expected private benefits must exceed the expected private costs. Otherwise, farmers will not voluntarily agree to engage in the

farm planning process without outside incentives. Certainly, farmers who suspect that they will have to incur large costs to improve the environmental performance of their operation and believe that they will receive little direct benefits will not voluntarily initiate EFP. But, these farmers may be the ones who contribute the most to environmental degradation.

On the other hand, farmers who believe that their operations are environmentally sound will not wish to incur the costs associated with the planning process because they believe they will receive no benefit. As a result, the awareness-raising objective of the planning process may be thwarted because those farmers who actually engage in environmentally unfriendly practices, but believe they do not, will fail to voluntarily engage in the planning process and, hence, not become aware. Governments will have to ensure that farmers understand the link between the insights gained from the planning process itself and the private benefits that can arise from reducing negative environmental impacts.

Raising awareness through the farm planning exercise, however, may succeed in reducing the environmental impact of agricultural production if: i) planning shows that altering farming practices can reduce net negative impacts on the environment, and ii) the private pecuniary benefits of altering agricultural practices exceeds the private costs, or if iii) the sum of the private pecuniary and non-pecuniary benefits of altering agricultural practices exceeds the private costs of undertaking the changes. Raising awareness will have no impact on improving the environment if condition (i) is not satisfied. If conditions (i) and (ii) are satisfied, then farmers will voluntarily agree to alter their farming practices to enhance the environment because it is financially profitable. If conditions (i) and (iii) are satisfied – but not (ii) – then farmers will again voluntarily act to improve their environmental practices but it will not simply be a business decision. Some farmers may receive considerable non-pecuniary benefits from improving their environmental record. In particular, farmers may receive psychological benefits from environmental stewardship, or being perceived by others as active in environmental stewardship. Awareness building will be most effective when the non-pecuniary benefits are large. Thus, even if only private benefits and costs are expected to provide the incentive to raise environmental standards, it will be important to understand how to measure non-pecuniary private benefits if the efficacy of farm plans is to be assessed.

If private benefits do not exceed private costs for a sufficient number of farmers to achieve the higher environmental standards desired by society, then incentives must be provided to induce additional farmers to voluntarily engage in environmental farm planning and the implementation of those plans. This would happen if policy makers believe that the public benefits arising from on-farm environmental planning and implementation diverge from the private benefits. Private and public benefits normally diverge because of the existence of externalities. As externalities are not captured by market mechanisms, there is a market failure that leads to underinvestment in the environment[11]. Government incentives such as subsidies and taxes can be used to correct market failures in society's interest. As a result, it is important to be able to identify and, if possible, measure all the benefits and costs associated with EFP.

If incentives are not provided to induce participation in EFP and instead they are made mandatory, then in addition to having information on the private and public benefits and costs associated with planning and implementation, a complete assessment will require information on the

11. See Chapter 2 for a more detailed discussion of externalities.

costs of monitoring and enforcing compliance. These costs will include validating the proposed plan as well as ensuring that the plan is being carried out. These transaction costs must be accounted for in any benefit-cost analysis.

Several public and private benefits and costs arise from EFP. Environmental standards are quite different from food safety standards in terms of their potential impact. Environmental standards may have benefits for consumers who have strong preferences for environmentally-friendly production processes. This benefit can be captured through market premiums for food that is identified as environmentally friendly. Many other benefits of environmental standards, however, are public benefits. They facilitate the reduction of negative externalities from environmental problems or they encourage the production of positive externalities from environmental improvements.

There are two major differences between the benefits provided by OFFS and EFP. In the case of OFFS consumers receive a direct consumption benefit from consuming products that are produced to a higher food safety standard – the likelihood of consuming a foodborne pathogen is reduced. In contrast there is no direct consumption benefit from ingesting food produced in an environmentally friendly way. There are, however, two other benefits. The first is the increase in utility, for consumers who value the environment, from food produced in an environmentally friendly production system. Ingesting the food in and of itself, however, does not produce any additional direct benefit. As well, there are direct benefits to the environment that arise from improved on-farm practices. These benefits do not show up in the markets where the products of agricultural activity are sold. These benefits accrue in markets for environmental amenities (e.g. wildlife habitat) or other directly consumed goods (e.g. clean water). There may be common or shared costs of producing these benefits, but this is not necessarily always the case.

Some of the private benefits and costs of EFP are similar to those identified for OFFS previously discussed and will be dealt with first. The benefits and costs associated with the mitigation of environmental effects – the public benefits and costs - will be dealt with later and will be identified as non-product market effects.

5.1 Market driven benefits and costs

The benefits to market participants from the implementation of EFP are discussed first, followed by the costs.

5.1.1 Benefits

Demand for undifferentiated agricultural products

Consumer willingness to pay for agricultural products may be reduced if there is uncertainty over the environmental impacts of agricultural production. Consumers cannot detect whether a product was produced using environmentally friendly or unfriendly practices – it is a credence attribute. Similarly, consumers may not be able to determine whether segregation or labelling of environmentally friendly products is accurate and credible. If the consumer is uncertain about the characteristics of an agricultural product, the demand for these products will fall (i.e. the poor quality environmentally unfriendly *lemons* chase the high quality environmentally friendly products from the market, see Chapter 2.2). The cost of this impact can be measured as the reduction in the consumer surplus of these products. EFP with credible segregation and identity preservation systems allow producers to internalize the benefit from environmentally friendly production.

The size of this benefit will be determined by the size of the market affected, the number of consumers that discount the value of products that may harm the environment, the extent to which they discount these products, and the perceived probability that contamination has taken place. The size of this effect is difficult to measure even after the fact. Separating changes in consumer demand due to these concerns from other demand factors is very difficult. The consumer research methodologies discussed in Appendix A are applicable to this question. In the case where the consumer pressure leads governments to impose an import ban on all products because environmental friendliness cannot be proven, EFP can assist in circumventing these bans. EFP could enable the certification of production as environmentally friendly and assist in lending credibility to certification. The impact of non-tariff barriers based on environmental attributes would be diminished. Thus, EFP can reduce information (transaction) costs for consumers, build consumer confidence, facilitate differentiation in international markets and help reduce non-tariff barriers.

Marketing/segregation effects

The existence of products produced in an environmentally unfriendly way may force those wishing to market environmentally friendly products to incur costs to segregate and distinguish their products. The credence nature of an environmentally friendly product requires a signalling mechanism such as segregation and labelling. These are externalities because the costs are not borne within the non-certified market. These additional marketing costs are reflected in lower producer prices and/or higher consumer prices for environmentally friendly products. EFP can reduce this effect when used with identity preservation systems to convey additional product information to consumers.

Key determinants of the magnitude of this effect include: (i) the products affected, (ii) the importance of these crops to the agri-food sector (number of producers, volume and value of sales) and (iii) the ability of the current supply chain infrastructure (grain handling and transportation facilities etc.) to segregate EFP from non-EFP products. The regulatory approaches in different markets (e.g. importing countries may insist that products must meet environmental standards to be eligible to enter their customs territory) and the value of market opportunities foregone will determine whether segregation is necessary. If EFP are compulsory and have to be complied with, the need for segregation disappears and monitoring and enforcement costs for downstream processors and retailers are reduced. Free-rider effects are reduced, making producers who comply with EFP less vulnerable to the repercussions of environmental problems caused by the non-adopter sector.

Reduce information costs

The credence nature of the environmental production attribute imposes higher information and search costs on consumers and downstream food processors and distributors. This occurs in two ways: first in determining whether products are environmentally friendly, and second (for consumers) in evaluating the potential environmental impact of consuming products produced using environmentally friendly methods. Consumers' information costs are exacerbated by the plethora of contradictory information from various sources about the environmental impacts of agricultural production. This raises the costs of determining the credibility of an information source.

The magnitude of this cost depends on the amount of unbiased information provided and the consumers' beliefs about the credibility of each source. The more polarized is the available information, the greater the cost to consumers who must invest time and effort to make consumption

decisions. Measurement of this cost will require conducting survey(s) of consumers or, where available, using existing survey data. This will involve evaluating consumer perceptions of environmental practices on-farm and the information sources at their disposal. To what extent consumers have access to accurate sources of information and whether they regard these information sources as credible will be important factors. Conjoint analysis (which allows one to measure the relative importance of different product attributes in a consumer's purchase decision) may be a useful methodology to apply to this question. EFP can contribute to improved information by providing documentation regarding the practices under which food is produced.

5.1.2 Costs

Adoption of EFP will entail private sector costs in the form of planning costs in establishing a framework and revising plans to reflect external changes, management and compliance costs. These include fixed capital, variable and segregation costs. Segregation costs arise from keeping products from farms complying with EFP from non-EFP products in the agri-food supply chain. Monitoring and enforcement costs arise in monitoring compliance with EFP and, where appropriate, applying enforcement penalties to dissuade non-compliance. The distribution of these costs along the supply chain or between the public and private sector will depend on the type of EFP or environmental regulation being used. If an EFP is specific to a buyer and requires sunk and asset specific investments with little or no value in alternative uses, the producer can be vulnerable to opportunistic behaviour by the buyer once the sunk investment has been made. Industry-wide or generic farm plans reduce this risk.

5.2 Environmental farm plans: summary tables

The benefits and costs associated with the market-driven effects of EFPs are summarized in Tables 4 and 5.

5.3 Public benefits and costs concerning the environment

The environmental externalities arising from agricultural production are not likely to be consumed in farm output markets but rather in environmental amenity markets or in other products that use environmental amenities as inputs. The benefits arise from mitigating negative environmental effects of agricultural production. Some farmers participating in the farm planning process will not produce any of these additional benefits because their farm plans reveal no environmental externalities that need to be mitigated. They will incur planning costs but produce none of the public benefits. The environmental effects that can be mitigated are classified into two broad categories: (i) direct effects on human quality of life and (ii) ecosystem externalities.

5.3.1 Direct effects on human quality of life

This category includes possible adverse human health effects arising from poor environmental management (e.g. from consuming contaminated ground water), reductions in the commercial value of assets (e.g. contamination of a neighbour's field) and nuisance (e.g. reduced utility arising from odours emanating from a neighbouring hog barn). Benefits of EFP are reductions in these negative externalities.

Table 4: Impact-based classification system of potential private benefits and costs of environmental farm plans according to their distributional implications in the farm output supply chain

Private benefits and costs	Input supplier-to-producer	Producer-to-producer	Producer-to-processor	Processor-to-retailer	Retailer-to-consumer
Demand-side effects					
Reduce transaction costs for consumers		Reduce substitution effects between farm products			Reduce product avoidance, brand switching, mitigation and averting actions
Build consumer confidence	Domestic marketing mechanisms can allow premiums to be distributed to suppliers of environmentally friendly inputs		Domestic marketing mechanisms can allow premiums to be distributed to producers	Domestic marketing mechanisms can allow premiums to be distributed to processors	Extract premiums from consumers for environmentally friendly foods
Convey additional information (when used with identity preservation systems)		Reduce the incentive to free-ride	Protect the integrity of the product	Protect the integrity of the product	Protect the certification mechanism for consumers
Provide differentiation on the international market	Domestic marketing mechanisms can allow premiums to be distributed to suppliers of environmentally friendly inputs		Domestic marketing mechanisms can allow premiums to be distributed to producers	Domestic marketing mechanisms can allow premiums to be distributed to processors	Premiums collected for environmentally friendly production methods
Facilitate trade by reducing non-tariff barriers				Potentially increases market penetration (or maintains market share) in foreign markets	
Reinforce and develop trade networks			Reduce marketing costs in communicating nature of environmentally management systems	Reduce marketing costs in communicating nature of environmentally management systems	

Private benefits and costs	Input supplier-to-producer	Producer-to-producer	Producer-to-processor	Processor-to-retailer	Retailer-to-consumer
Supply-side effects					
Benefits:					
Reduce monitoring and enforcement costs	Applies to business relationships between producers and input suppliers		Applies to business relationships between producers and processors	Applies to business relationships between processors and retailers	
Reduce free-rider impacts		Reduce vulnerability to environmental disaster in non-adopter sector	Reduce processor information costs		Reduce consumer information costs

Table 4: Impact-based classification system of potential private benefits and costs of environmental farm plans according to their distributional implications in the farm output supply chain (Continued)

Private benefits and costs	Input supplier-to-producer	Producer-to-producer	Producer-to-processor	Processor-to-retailer	Retailer-to-consumer
Costs:					
Planning costs		Standard industry format for preparing farm plans may reduce planning costs for individuals			
Management and compliance costs			Small farms may be disadvantaged if environmental mitigation costs vary little with output. Marketing mechanisms and market structure at the processing level will determine the extent of damages		
Sunk investments			Producers vulnerable to opportunistic behaviour by processors if buyer-specific EFPs require sunk investments. National programs reduce this risk		

Table 5: Impact-based classification system of potential private benefits and costs of environmental farm plans according to market characteristics in the farm output supply chain

Private benefits and costs	Exported versus non-exported	Mandatory versus voluntary labelling	IP versus non-IP	Branded versus generic
Demand-side effects				
Reduce transaction costs for consumers		Labelling can reduce information costs for consumers. Not clear whether mandatory or voluntary labelling more effective		Reduce product avoidance of generic products. Brands can be used to identify environmentally friendly production
Build consumer confidence		Consumer confidence can be built over a long-term horizon under voluntary labelling	Protect the integrity of the product	
Convey additional information (when used with identity preservation systems)			EFP can protect the certification for certain identity preserved products (e.g. organic foods)	Protect the certification mechanism for consumers
Provide differentiation on the international market	Marketing instrument to capture and protect established market shares	Domestic marketing mechanisms can allow premiums to be distributed to processors	Help target specific niche markets for identity-preserved products	
Facilitate trade by reducing non-tariff barriers	Facilitate trade and potentially increase trade flows			Potentially increases market penetration in foreign markets
Reinforce and develop domestic and foreign trade networks	Reduce marketing costs in communicating nature of environmental management systems			
Private benefits and costs	**Exported versus non-exported**	**Mandatory versus voluntary labelling**	**IP versus non-IP**	**Branded versus generic**
Supply-side effects				
Reduce monitoring and enforcement costs		More so if mandatory	Especially important for IP	
Reduce free-rider impacts		More so if mandatory	Especially important for IP	Generic more vulnerable
Costs:				
Planning costs				
Management and compliance costs				
Sunk investments				Branded more vulnerable

Table 6: Impact-based classification system of potential private benefits and costs of environmental farm plans and factors affecting the size and direction of these benefits and costs in the farm output product market

Private benefits and costs	Market structure	Consumer preference	Technology
Demand-side effects			
Benefits:			
Reduce transaction costs for consumers	The more direct is the link between consumers and farmers, the higher the returns to environmentally friendly management initiatives if they reduce consumers' transaction costs. The number of intermediaries and concentration of downstream markets is important for producers to capture benefits	The more important it is for consumers to have environmental assurances, the higher will be the premiums for environmentally-friendly food	
Build consumer confidence			
Convey additional information (when used with identity preservation systems)		Information must reveal environmental attributes important to consumers	Technology will facilitate identity preservation. More feasible in some industries due to technological capability for IP
Provide differentiation on the international market	Ability to price discriminate in the world market will be positively correlated with benefits	Exporters must face an excess demand that is not perfectly elastic; i.e. residual import demand of foreigners is downward-sloping	Overall level of competitiveness of exporters will determine if exporter can extract additional returns for environmental initiatives at the farm level
Facilitate trade by reducing non-tariff barriers		If foreign standards are not in accordance with consumers' valuation of environmental amenities, but are imposed through worldwide harmonization; the ability to make profitable sales is hindered	Standards must be technologically feasible
Reinforce and develop domestic and foreign trade networks	Increased concentration at a point in the supply chain can lead to stronger trade networks and thus increase the benefit of EFP (however this is a marginal effect)		

Private benefits and costs	Market structure	Consumers' preferences	Technology
Supply-side effects			
Benefits:			
Reduce monitoring and enforcement costs	More so when there are a large number of small suppliers/farms		

Table 6: Impact-based classification system of potential private benefits and costs of environmental farm plans and factors affecting the size and direction of these benefits and costs in the farm output product market (Continued)

Private benefits and costs	Market structure	Consumer preference	Technology
Reduce free-rider impacts	More so when there are many farms and processors		
Costs:			
Planning costs	More so for small farms		Technology improvements could alleviate this effect
Management and mitigation costs	More so for small farms		Technology improvements could alleviate this effect
Sunk costs	More so in concentrated sectors with few alternative buyers	More so if preferences are heterogeneous with respect to environmental amenities	

Reduce negative human health externalities

There can be direct negative human health impacts on consumers if poor environmental practices on the farm lead to off-farm consumption of, or exposure to, substances that harm human health. These might include inhaling chemicals drifting off a farm, contact with a straying animal that is a vector for a human disease or drinking contaminated groundwater. (Note however, these are different from adverse health effects that arise directly from consuming unsafe food. The latter were dealt with in the chapter on food safety.) This is very much akin to the traditional notion of a negative externality and implies that a side effect of consuming the product causes the social marginal cost of producing products in an environmentally irresponsible manner to exceed consumers' private marginal cost. Assessment of the cost of human health effects is difficult because the health problem may have a long incubation period. The negative impact on health may be compounded by other factors such as lifestyle and reduced productivity or enjoyment of life, which are difficult to measure. EFP can lead to a reduction in these negative externalities by identifying production practices that could harm human health and forcing farmers to find a means to reduce them.

Reduce negative impacts on the value of assets

Asset ownership contributes to quality of life by producing income or providing security. If the value of an asset is reduced by the activity of others and there is no compensation, quality of life declines (e.g. air pollution). These are classic externality effects where the costs incurred by the polluter do not include the reduction in value of assets arising from the polluting activity – the public costs exceed the private costs. EFP can be used to identify these externalities and to find ways to reduce their emission.

Reduce nuisance

Nuisance reduces the quality of life. Nuisance is most often considered as non-pecuniary reductions to quality of life such as loud noises, obnoxious odours, time spent chasing off strays, etc. Non-pecuniary nuisances are difficult to measure. EFP can assist in identifying the causes of nuisances and in devising methods to reduce or eliminate them.

5.3.2 Ecosystem externalities

Ecosystem externalities include the impacts of poor on-farm environmental practices on the off-farm natural environment. Specifically these externalities result in changes in the value of the natural environment. They include changes in social use value such as recreation or hunting, and non-use values such as aesthetics or existence values. To avoid double counting, these externalities do not include the direct effects on human quality of life discussed above. Examples include on-farm changes to water courses that eliminate downstream waterfowl habitat, draining of pot holes that disrupt flight paths of migratory birds, fencing that disrupts movements of wild ungulates, predator control activities that create population imbalances in natural prey that in turn can have detrimental effects on the prey's food supplies. Green house gas emissions, soil resource quality and water quality are other examples of ecosystem impacts.

The complex nature of ecosystems makes these effects difficult to quantify. For example, there has been controversy over the potential impact of genetically modified (GM) corn on the monarch butterfly, with contradictory scientific studies seeming to prove or disprove the hypothesis that the GM crop could harm this species. The magnitude of this type of externality depends on the scientific assessment of the probability of a negative impact, society's level of risk aversion

and the value society places on potentially threatened environmental amenities/species. Similarly, it may be hard to establish the potential impact of farming practices on green house gas emissions. Accepted methods of valuing non-market goods, such as contingent valuation, have a role to play in this regard.[12]

The costs associated with mitigating environmental effects will be specific to the individual problem and to the particular situation of the individual farm. Hence, little can be said about the mitigation costs. Their magnitude will depend on the size of the problem and the technology available for mitigation.

12. *Adam and Khler, 1996; Clark, 1999; Cook et al., 1996; De Leij et al., 1998; Hauser et al., 1998; Heap, 1999; Holt and LeBaron, 1990; Kappeli and Auberson, 1997; Mooney and Klein, 1999; Nickson and McKee, 1999; Nielson et al., 1999; Rissler and Mellon, 1996; Saat, 1996; Tabashnik, 1994.*

Chapter 6

Summary and conclusions

Ultimately, the key question is whether the total private and public benefits of an EFP or an OFFS outweigh the costs of implementation. The first step in this assessment is identifying classes of benefits and costs. The incidence of benefits and costs, their distribution, and the influence of external factors on their magnitude will depend, to some extent, on the institutional delivery mechanism for these programs. Voluntary sector-wide programs, mandatory sector-wide programs, enforced regulatory standards and individual (branded) supply chain initiatives are examples of alternative institutional delivery mechanisms for OFFS and EFP. In assessing the benefits and costs of any individual system, it is necessary to ask whether there are private alternatives or policy alternatives that will create larger net benefits. Tables 7 and 8 summarize the benefits and costs identified in this report for OFFS and EFP. The tables provide a framework for comparing benefits and costs across alternative institutional delivery mechanisms for on-farm food safety and environmental sustainability. For on-farm food safety, Table 7 indicates that the comparison could be made between voluntary industry OFFS, mandatory industry OFFS, buyer (supply chain) specific OFFS and regulatory standards (pesticide residues). For environmental sustainability, Table 8 suggests that the appropriate institutional comparison might be between voluntary EFP, EFP required for putting up new buildings, annually reviewed EFP, annually reviewed EFP that are monitored and enforced and regulatory standards such as emission standards and land-use regulations.

In the Canadian agri-food sector, a number of commodity associations are implementing OFFS that are voluntary industry-wide systems, backed by regulatory oversight by the CFIA. EFP are in their infancy. Ontario has a provincial environmental farm plan initiative. The hog industry has an industry-based EFP. An institutional comparison of alternative approaches to EFP is therefore timely. The sector analyses for this project assess the roles, and potential benefits and costs of OFFS and EFP specific to the beef, dairy, hogs and grain sectors. The extent to which there may be synergies between OFFS and EFP are also assessed in the sector analyses. These synergies may arise if the mitigation of environmental hazards also reduces food safety hazards. However, where substantial synergies are absent, there is the risk that farm operators will be faced with additional compliance and management costs from both a commodity-specific OFFS and a whole-farm EFP.

Table 7: The benefits and costs of OFFS

	Voluntary industry-wide OFFS	Enforced industry-wide OFFS	Buyer specific OFFS	Regulatory standards
Private benefits				
Reduce transaction costs for consumers				
Build consumer confidence				
Convey additional information				
Provide differentiation on international markets				
Facilitate trade by reducing NTBs				
Reinforce and develop trade networks				
Improve productivity of inputs				
Improve efficiency in production				
Reduce logistic costs				
Reduce measurement costs: performance versus process standards				
Reduce monitoring and enforcement costs				
Reduce product liability costs				
Reduce ex-post cost following contamination				
Reduce free-rider impacts				
Public benefits				
Reduce incidence of foodborne illness				
Reduce information asymmetry				
Total benefits				
Costs				
Management costs				
fixed – establishing the HACCP plan				
variable – revising plan to reflect external changes				
Compliance costs				
fixed – capital costs				
variable				
Sunk investments				
risk of hold-up				
Segregation costs				
fixed				
variable				
Monitoring and enforcement costs				
fixed				
variable				
Total costs				
TOTAL NET BENEFITS				

Table 8: The benefits and costs of EFP

	Voluntary EFP	New building EFP	Annual EFP	Annual enforced EFP	Emission standards	Land use regulations
Private benefits						
Reduce transaction costs for consumers						
Build consumer confidence						
Convey additional information						
Provide differentiation on international markets						
Facilitate trade by reducing NTBs						
Reinforce and develop trade networks						
Reduce monitoring and enforcement costs						
Reduce free-rider impacts						
Non-pecuniary benefit to farmers (feel-good factor)						
Public benefits						
Direct effects on human quality of life						
Reduce negative human health externalities (disease, toxic substances, etc.)						
Negative impact on value of assets (air quality, etc.)						
Nuisance (odours, etc.)						
Ecosystem effects (upland habitat, riparian/wetland habitat, water quality, greenhouse gases, soil resource quality, etc.)						
Total benefits						
Costs						
Planning costs						
fixed – establishing the framework						
variable – revising policy to reflect external changes						
Monitoring and enforcement costs						
fixed						
variable						
Compliance costs						
fixed – capital costs						
variable						
Segregation costs						
fixed						
variable						
Total costs						
TOTAL NET BENEFITS						

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Measuring private and public benefits and costs

APPENDIX A

The ability to collect premiums for a food safety assurance (due to adoption of HACCP processes and/or identity preservation systems) can be measured with different techniques. First, contingent valuation methods can estimate the consumers' average willingness to pay for "supersafe" foods using survey data and econometric tools. A second method to estimate potential premiums that can be extracted from a food safety assurance is to rely on experimental economic techniques such as auctions. In this framework, potential consumers are given money (and/or something tradeable) to bid for products with different attributes like colour, freshness date or a food safety certification. Finally, another possibility is to conduct experiments directly in supermarkets or to use scanner data along with the consumer characteristics. Travel and acquisition cost methods can be used to infer the value consumers attach to foods with safety attributes (i.e. measuring the extra effort/distance consumers might go to obtain products with additional food safety assurances). Similar techniques could be used to elicit importers' preferences towards products that guarantee certain attributes with respect to food safety. This would provide an estimate of the ability of Canadian exporters to extract premiums or equivalently provide combinations of attributes (one of which being food safety) that maximizes the probability of buyers importing the domestic product.

Buzby, Skees and Ready (1995) provide an interesting survey of contingent valuation techniques aimed at estimating the valuation consumers place on reducing particular food risks. In particular, they review bias-reducing techniques in designing surveys. Their application analyzes data obtained from phone and mail surveys of U.S. grapefruit consumers. They estimated consumer willingness to pay (WTP) for a grapefruit treated with a safer pesticide than the traditional post-harvest pesticide. This new pesticide was said to provide a 99% risk reduction. According to the various designs of their analysis, consumers were ready to pay on average between 10 cents and 22 cents per grapefruit. Given that the initial price of the fruit was 50 cents, this represents a premium between 20% and 44%. Golan and Kuchler (1999) review critical issues pertaining to designing contingent valuation studies related to food safety.

Shrogen et al. (1999) compare three methodologies to evaluate consumers' valuation of irradiation techniques to control salmonella in fresh poultry. They compare retail market choices, experimental auction markets and a hypothetical market survey. Interestingly, the percentage of consumers preferring irradiated meat when there is a 20% price premium is about the same in all three experiments. The hypothetical survey yields a lower percentage of consumers choosing the irradiated meat than traditional chicken meat relative to the other two methods.

Flake and Patterson (1999) estimated a food demand system that includes a food safety indicator and a health information measure to model the impact of food safety concerns on the demand for meat in the U.S. They used the number of press articles filed on E. Coli and salmonellosis contamination in beef as a proxy for food safety concerns of consumers. They found that food safety

information has a small negative impact on beef demand. Although their analysis provides an interesting starting point to model the impact of food safety information on food demands, their methodology is clearly restrictive since price responses of food demand are assumed to be insensitive to food safety information[13].

As suggested earlier, it could be that consumers expect food safety and they are not willing to pay more for higher levels of it. Still, processors and retailers might want to pay more for an assurance of safer and/or traceable farm products if they perceive this will give them a competitive edge or reduce their risk. Stated-choice experiments where respondents are asked to choose between different hypothetical products with and without any additional food safety assurance, or experimental auctions could be conducted to ascertain their willingness to pay. Henson and Holt (2000) surveyed UK processors to explore the incentives to adopt food safety controls such as HACCP. Not surprisingly, the most important factor influencing the decision to adopt HACCP processes is to meet legal requirements. The other important factors are all related to demand-side effects, such as to meet the need of major customers, attract new customers, improve product quality, etc. The only exception is to improve control of production processes, which may be classified as a supply-side effect. The extent to which Canadian processors and retailers are willing to pay for food safety or traceability assurance will depend on whether they can pass this cost on to their downstream markets and the extent to which it yields supply side production benefits.

Donovan et al. (2001) examined the impacts of foreign requirements that processors adopt HACCP systems on the level of safety offered in the domestic market by Brazilian processors of fishery products. They showed that the adoption of HACCP systems has been concentrated on the export sector, with only small impacts on domestic standards and food safety levels. This suggests that export sectors of the domestic agri-food industry are likely to benefit most from food safety initiatives when the pressure to adopt new standards comes from external markets. However, this conclusion is dependent upon the sector-specific and country-specific characteristics of the food safety program.

With respect to measuring the impact of food standards on trade, an interesting reference is Beghin and Bureau (2002). They provide a detailed literature review of the various methodologies to model the impacts of standards and other technical barriers on agri-food trade. A promising strategy to measure the impact of OFFS on export sales would be to combine economic models that measure the interactions between the demand for different agricultural commodities with models that measure international trade impacts under different assumptions[14]. This way, the probability of exporting could be predicted as well as the level of exports. The effects of having HACCP certification on both the probability and the level of exports could be measured provided that data from the CFIA and Statistics Canada could be combined.

The studies that examine or measure private benefits and costs stemming from the supply-side are relatively rare. Nganje et al. (1999) estimated the benefits and costs of implementing mandatory HACCP regulations for small meat processors and packers. They used survey data collected from meat packers and processors in the U.S. The data included HACCP-related expenses, output price before and after HACCP implementation, and input prices and quantities. They show that output price did not increase significantly to compensate for HACCP expenses. However, small firms were more profitable after HACCP implementation due to cost savings from reduced

13. *In other words, the own-price and cross-price elasticities of demand could depend upon food safety information.*

14. *For example combining powerful micro-econometric tools like double-hurdle demand with gravity-like trade models.*

product rework[15]. The impacts of HACCP regulation on small firms are especially important because they can be a determinant to a firm's survival and market concentration. To the authors' knowledge, there are no studies in the literature attempting to measure the benefits and costs of HACCP-based processes at the farm level. Surveys could be conducted to characterize farmers' perceptions towards food safety initiatives at the farm level.

Another technique to estimate supply-side benefits and costs involves measuring the efficiency effects of HACCP adoption[16]. This could be done using a sample of firms certified to use HACCP-type processes and firms that do not implement specific food safety procedures. This would reveal the extent to which producers become more efficient after implementing HACCP-based programs.

Finally, public benefits from society's perspective could be measured using a model that measures economy-wide effects and inter-sector interactions resulting from OFFS[17]. Golan et al.(2000) estimated the level and distribution of the benefits and costs of HACCP for meat and poultry in the U.S[18]. They found that reduced premature deaths due to HACCP implementation have a considerable positive impact on household income. They also studied HACCP costs defined as: i) implementation of a written HACCP plan by every slaughter and processing plant; ii) adoption of Sanitation Standard Operating Procedures (SSOPs) by every slaughter and processing plant, iii) Salmonella performance standards for slaughter and ground product plants, and iv) generic E. coli performance standards for slaughterhouses. They found that even though HACCP costs decrease the real income of households, total net benefits are positive. It follows that HACCP implementation in the meat processing industry could increase the public good benefit.

15. *Rework occurs when testing procedures are used instead of HACCP and the product is either destroyed or reworked.*
16. *For example, measuring the efficient production frontier at the farm level and conducting a technical efficiency analysis and its decomposition to isolate the effects of HACCP.*
17. *A general equilibrium model.*
18. *Economy-wide benefits were computed with a computable general equilibrium model.*

Modelling the potential effects of on-farm food safety programs

APPENDIX B

The purpose of this appendix is to provide a framework to evaluate the various potential effects of OFFS based on HACCP processes. This framework will later be extended to capture sector-specific characteristics when evaluating the distribution of benefits and costs related to OFFS. Figure B1 represents the initial product market equilibrium in a given industry. The bottom left diagram depicts the domestic market for the raw/farm product while the top left diagram depicts the retail domestic market for the processed commodity. To simplify things, it is assumed that processors directly market output to consumers. The top right diagram represents the foreign market for the processed commodity. The functions $D(p,\gamma)$ and $D(p,r,\varphi)$ represent the retail (consumers) domestic demand for the product and the processors' demand for the farm product respectively. It is assumed that there exists a unitary correspondence between processed and farm products, so that one unit of farm output yields one unit of output at the processing level. Similarly, the functions $S(p,r,\gamma)$ and $S(r,\alpha)$ represent the domestic processors' supply and farm supply respectively. Shifters in the farm supply function (α), in the domestic retail demand curve (γ) and in the processors' demand and supply functions (φ) are included.

For now it is assumed that the raw commodity cannot be traded and that Canada is a small exporter of the processed good. In other words, Canada's terms of trade are exogenous as illustrated by the perfectly elastic excess demand in Figure B1. At this point, imperfect competition issues are not addressed even though they are likely to be germane in modelling price transmission effects for specific industries later.

The shifters can represent a number of effects induced by the implementation of OFFS. The impacts of the implementation of OFFS are assessed by relating the benefits and costs identified in the conceptual framework to the shifters mentioned earlier. The analysis starts by illustrating these impacts one at a time to finally pool the results together.

Figure B1:
Initial market equilibrium

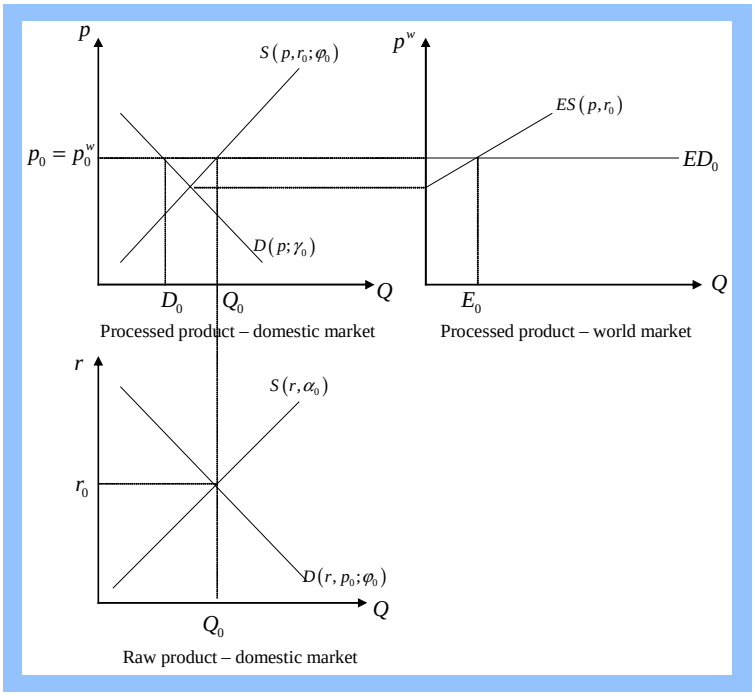


Figure B2 illustrates a downward shift of the farm supply function resulting from an OFFS-induced cost reduction in farm operations. This assumes that efficiency benefits and productivity gains outweigh the additional costs that must be incurred to implement the OFFS. As a result, the farm price unambiguously declines, but farmers' surplus is likely to increase after on-farm food safety due to increased production levels. The decline in the farm price brings about a downward shift in the supply of processed goods. The joint surplus of processors and farmers increases because the world price is unaffected and export sales increase. Free trade and the small country assumption keeps the price of the processed good and hence the consumer surplus from changing.

Figure B3 illustrates an upward shift of the farm supply function resulting from an OFFS-induced cost increase. This situation occurs if additional costs related to implementing on-farm food safety procedures outweigh any potential benefit. The farm price unambiguously increases, and farmers' surplus is likely to decrease after implementation of the OFFS. The increase in the farm price brings about an upward shift in the supply of processed goods due to the increase in processors' costs. The joint surplus of processors and farmers decreases because the world price is unaffected and export sales decrease. Free trade and the small country assumption keeps the price of the processed good and hence consumer surplus from changing.

Figure B2:
The impacts of positive OFFS benefits in the supply chain under free trade

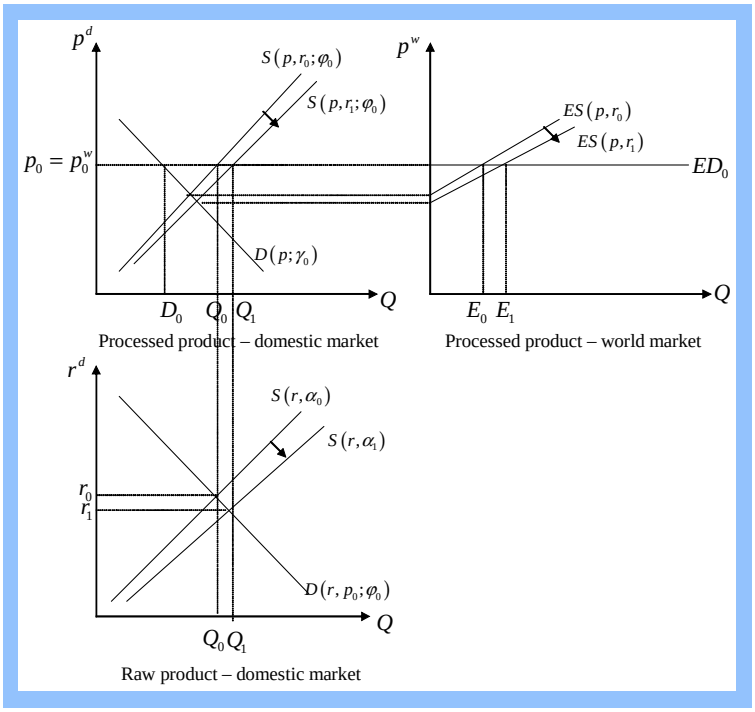


Figure B3:
The impacts of net OFFS costs in the supply chain under free trade

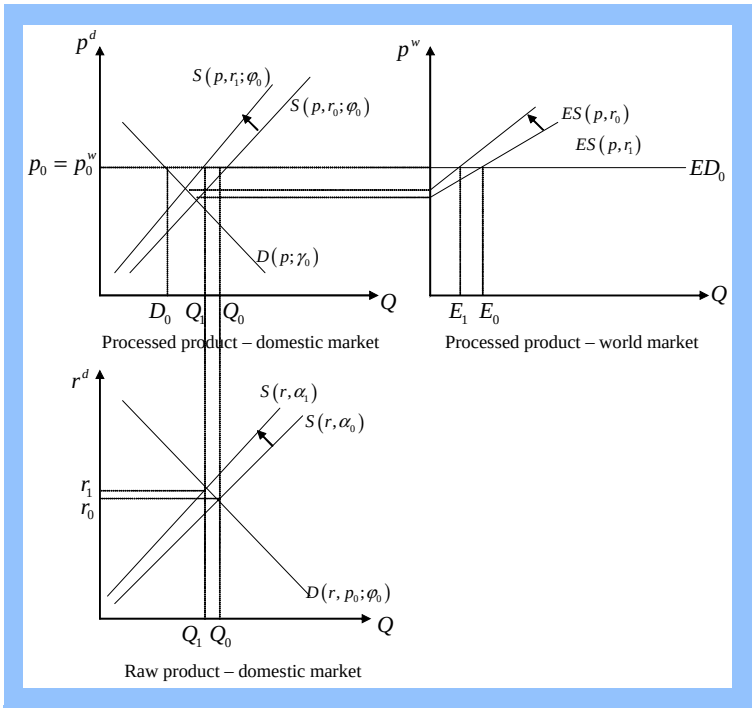


Figure B4 illustrates a similar story as in Figure B2 but the analysis now allows for product differentiation in the foreign market. This is why Canadian exporters do not face a perfectly elastic import demand curve for their product in the right-hand panel. The implementation of on-farm food safety processes is assumed to reduce producers' marginal costs and thus cause a rightward shift of the farm supply. The farm price declines further in this instance than when excess demand is perfectly elastic. This happens because of the feedback from the decrease in the retail price on the demand for raw products. The declining import demand makes the increase in exports smaller than in Figure B2. However, domestic consumers see their surplus increase, thanks to the declining import demand. Hence, consumers indirectly benefit from the OFFS even though the only direct benefit assumed occurs at the farm level. The lower farm price yields overall net benefits in spite of the reduction in the price of processed products.

Figure B5 assumes that the implementation of an OFFS has no net impact on the farm supply curve, as efficiency gains are completely offset by higher costs from the implementation of quality controls. However, it is assumed that HACCP processes induce an upward shift in the processors' demand for farm products due to lower marketing costs for processors. The new OFFS equilibrium is represented by the equilibrium values with subscript 1. The shift in the processors' demand for the raw product increases the farm price. As a result, the supply of processed goods increases, but only moderately due to the increase in the farm price. There are no effects

Figure B4:

The impacts of positive OFFS benefits in the supply chain under free trade

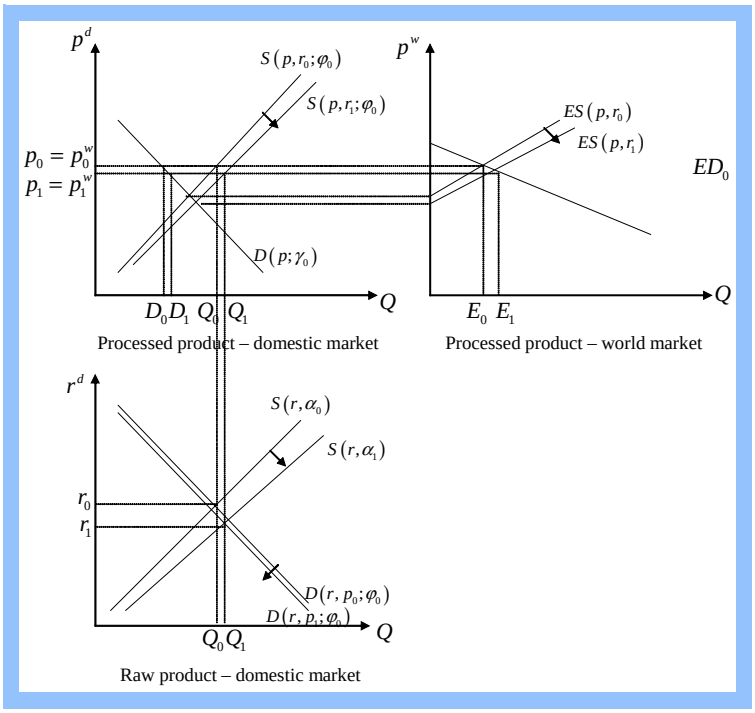
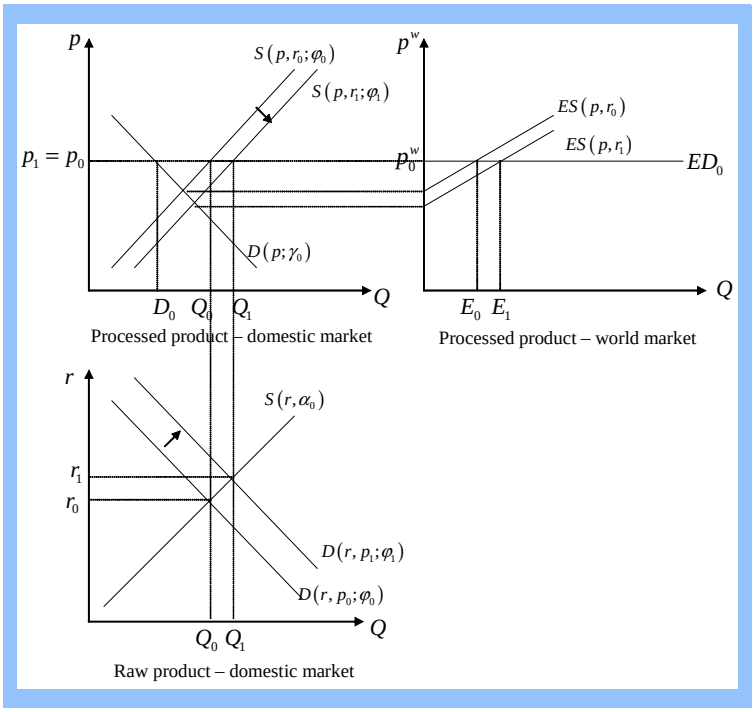


Figure B5:

The impacts of positive OFFS benefits at the processing level in the supply chain under free trade



on the domestic retail price since the country is a price-taker on the world market.

Exports increase following the increase in the supply of the processed commodity. Farm price has increased and farmers definitely benefit from implementing the OFFS. Here, the producer-to-processor effects of on-farm food safety have positive implications for producers. Processors also gain from on-farm food safety. Because the retail price remains unchanged, consumers' welfare remains also unchanged.

As depicted in Figure B5, Figure B6 assumes that on-farm food safety processes induce an upward shift in the processors' demand for farm products due to lower marketing costs. However, this scenario assumes that mandatory on-farm food safety increases the production costs of farmers and thus shifts the farm supply curve inward. This case provides an illustration of the complicated producer-to-processor type of effects discussed in tables 1 through 4. This also represents a first step in integrating all industry-wide OFFS-induced effects into a single framework.

The shift in the processors' demand for the raw product combined with the increase in producers' marginal cost undoubtedly increase the equilibrium farm price. The effect on producers' welfare is however indeterminate. As a result, the supply of processed goods increases, but moderately due to the increase in the farm price and in the farmers' marginal cost. There are no effects on the domestic retail price since the country is a price-taker on the world market. Exports increase under the OFFS but consumers' welfare remains also unchanged because the retail price remains unchanged.

Figure B6:

The combined impacts of OFFS benefits at the processing level and increased costs at the farm level under free trade

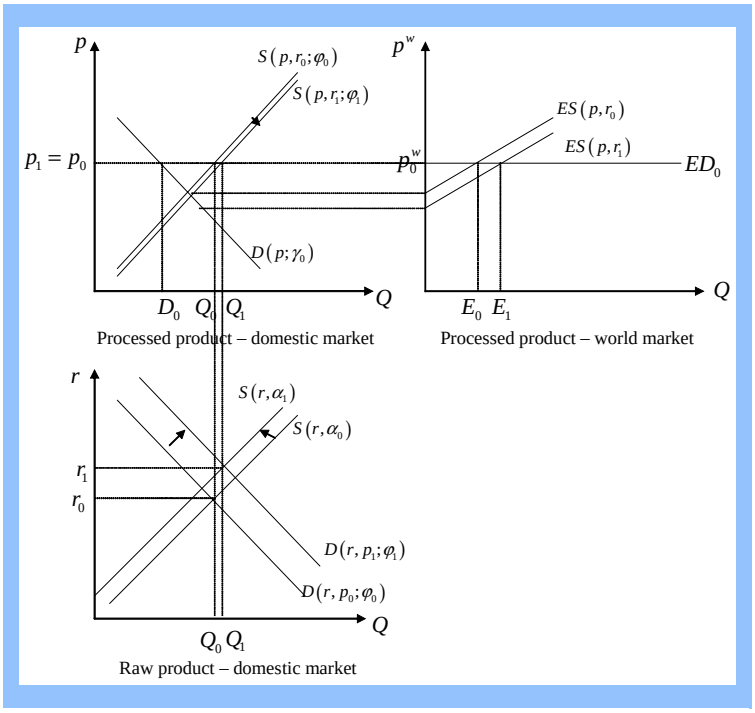


Figure B7:

The impacts of positive OFFS benefits at the processing level in the supply chain under free trade

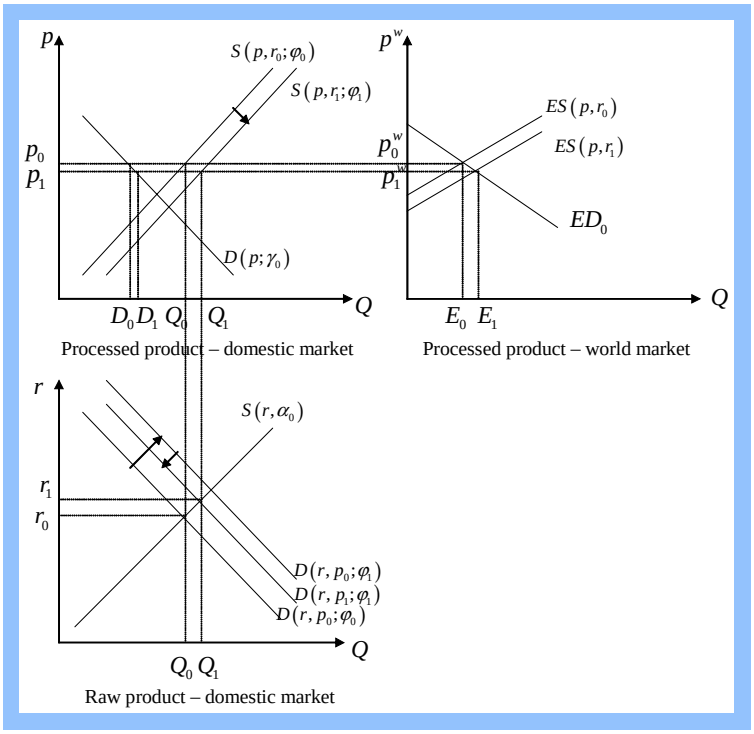
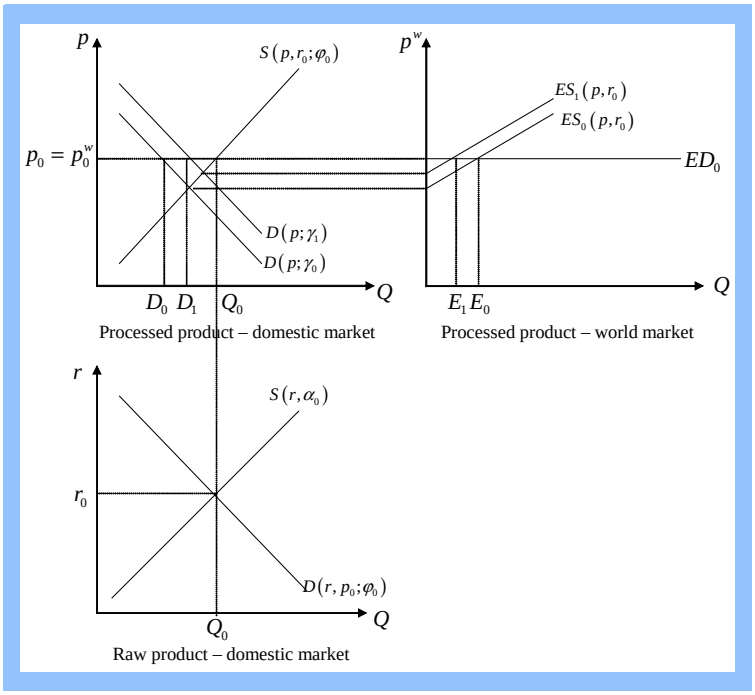


Figure B7 presents the same scenario as in Figure B5 for the case involving product differentiation on the export market. The bottom line is that gains to farmers and processors are lower than when the excess demand is not perfectly elastic. However, a downward sloping import demand yields positive benefits for consumers purchasing goods at a lower retail price.

It is assumed in Figure B8 that efficiency gain and costs offset each other at the farm level to neutralize supply-size gains. However, it is now assumed that on-farm food safety increases domestic retail demand due to consumers' increased confidence in the safety of their foods. Because of the small country assumption, farm and domestic prices remain constant and only consumers benefit from the OFFS implementation.

Figure B8:
The impacts of positive OFFS benefits at the processing level in the supply chain under free trade



If the excess demand was not perfectly elastic, the increase in domestic retail demand would increase the retail price and the world price and this would translate into an increase in farm demand. Producers benefit from this situation as well as processors. Consumers' gains are mitigated by the retail price increase but they remain positive. In that case, although on-farm food safety is assumed to have no direct effect at the farm level, there exists a positive producer-to consumer effect that increases the total profits of farmers.

The previous figures illustrate different scenarios about OFFS implications in the supply chains. Difficulties exist in integrating all individual effects into one graph. Modelling the distributional effects of OFFS will be even more complicated if additional sector-specific characteristics are included, such as imperfect competition in processing activities, supply management at the farm level, the opportunity to export the farm commodity, the trade policy of the importing country, etc. However, these distributional effects in the supply chain are extremely important when measuring the aggregate effect of implementing OFFS[19].

19. *A numerical simulation of this graphical analysis for the hog industry is presented in the hog sector report (Larue et al., 2003), and provides a guide to the potential magnitude of these changes depending on the assumptions about the relative size of benefits and costs from OFFS.*

Glossary of terms and list of abbreviations

APPENDIX C

Glossary

TERMS	DEFINITIONS
Adverse selection	Where there is hidden information prior to a transaction, e.g. uncertainty over product quality
Asset specific investment	An investment that has little or no value in an alternative use or to an alternative user
Asymmetric Information	See Information asymmetry
Bounded rationality	Limited cognitive ability of an individual to evaluate all alternatives
Consumer surplus	A measure of the benefits to consumers (buyers) of a market outcome, i.e. the excess of marginal benefit over price.
Credence characteristic	A product attribute that cannot be detected by the buyer even after purchase and consumption e.g. farm environmental practices
Cross-price elasticity	A measure of the responsiveness of the demand for product A to a change in the price of product B (e.g. butter and margarine), everything else remaining equal
Demand-side effect	A benefit or costs that manifests itself by increasing or decreasing the demand for a product
Double hurdle demand model	A probability model that determines whether a zero or positive quantity is purchased, followed by another empirical model that explains the actual quantity purchased by customers.
Economic surplus	The sum of consumer and producer surplus. A measure of the total value to society of a market outcome
Economies of scope	Reductions in average cost from producing multiple outputs
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
Gravity trade model	Relates the volume and composition of bilateral trade to countries' income, populations and distance from each other

TERMS	DEFINITIONS
Incomplete information	Where neither party to a transaction has full information
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
Pareto Optimal	A situation where it is not possible to make one person better off without making someone else worse off
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
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
Spillover	See Externality
Sunk costs	Costs that cannot be recovered
Supply-side effect	A benefit of cost that manifests itself by increasing or decreasing the supply of a product
Traceability	The ability to traceback a commodity through the supply chain, identifying where it came from
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
Utility	A measure of the benefit an individual receives from a good

Abbreviations

APF	Agricultural Policy Framework
CFIA	Canadian Food Inspection Agency
CODEX	Codex Alimentarius Commission
COFFS	Canadian On-Farm Food Safety program
EFP	Environmental Farm Plan programs
FAO	Food and Agriculture Organization of the United Nations
HACCP	Hazard Analysis, Critical Control Points
OFFS	On-Farm Food Safety programs