APPROVED

Proposed Regulations Amending the *Health of Animals Regulations*

Pig Identification - CFIA ID 20125

A Cost-Benefit Analysis

Completed by

Andreas Boecker, Dr. Sc. agr
Associate Professor
University of Guelph
Department of Food, Agricultural & Resource Economics, FARE
Guelph, Ontario, N1G 2W1

Initially drafted by

Cody Burdett
Economist, Federal-Provincial Relations and Social Policy Branch
Department of Finance Canada
140 O'Connor street, Ottawa, Ontario K1A 0G5

Prepared for the
Canadian Food Inspection Agency

Contact

Name: David Spicer, Director
Address: Regulatory Legislative and Economic Affairs
Canadian Food Inspection Agency 1400 Merivale Road. Ottawa, Ontario K1A 0Y9
Telephone: 613-773-5889
E-mail: david.spicer@inspection.gc.ca

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1 Executive Summary

1.1 Abstract

The development of a national pig traceability system is being proposed as a response tool to mitigate the impact of a disease outbreak, food safety issue or natural disaster; and as a mean to meet consumers' increasing demand to know the origin of their food. The proposed regulatory requirements would apply from the import or birth to the death or export of domestic pigs and farmed wild boars.

Benefits of the proposed Regulations have been estimated as cost reduction from an outbreak situation with the current traceability capacity to an outbreak situation in which the proposed traceability system is in place. It should be noted that the cost mitigation that a traceability system could provide in the event of an animal disease outbreak depends on the scale of the outbreak, the length of the subsequent trade embargo and to what extent enhanced traceability can reduce the latter. For this cost benefit analysis, two outbreak scenarios have been considered:

- In case of a small scale outbreak with trade embargo duration reduced from 4.5 months to one month, the cost mitigation was estimated to be $2.35 billion.

- In case of a medium scale outbreak with trade embargo duration reduced from 12 months to slightly less than 3 months, the cost mitigation was estimated to be $4.27 billion.

Over a period of 50 years and assuming a medium scale outbreak, the proposed regulatory requirements are expected to generate a gross benefit of $1.044 billion in 2011 dollar value ($85 million annualized, using an 8% discount rate).[1] A historical probability for a foreign animal disease outbreak of 2% each year is assumed in assessing the benefits.

The cost of the traceability system over that period is estimated at $45.05 million or $3.68 million in annualized present value. There will be at the very beginning of the period (year 0), a one-time investment of $1.14 million needed for the development of a database system. The maintenance and updates of the system will require $0.285 million for each subsequent year. For compliance verification 1.13 FTE or $125,000 have been allocated annually. In the first year (or year 1), $1.84 million in 2011 dollar value are required for first-time identification of all breeding animals and animals sent to auctions, fairs and test stations, while $0.65 million annually would be required in subsequent years to identify replacement animals. The movement of all remaining animals is reported by group or lot identification at a cost of $0.05 per finished pig or $1.44 million in total. Administrative costs for the database are estimated to be $1.0 million per year in 2011 dollars, also starting from year 1.

As a result, the present value of the net benefit of the proposed regulatory amendments is estimated at $999 million ($81.7 million annualized). These results are summarised in the table found in section 1.4.

[1] In comparison, for a small scale outbreak scenario, the present value of the net benefit is estimated at $0.530 billion.

1.2 Glossary of definitions and acronyms

AAFC: Agriculture and Agri-Food Canada

Base case scenario: Describes the starting scenario in the sensitivity analysis. It is defined as Policy Option 1 (individual identification of breeding animals and animals sent to auctions, fairs and test stations with RFID tags, while all other animals are reported by group or lot when they are moved) with a discount rate of 8% and an annual outbreak probability of 2%. The outcome of changing a key variable – policy option, discount rate or outbreak probability – is compared to the base case scenario.

Baseline scenario: Refers to the current traceability practices and capacity in the pig industry. The potential benefits of the proposed regulatory amendment stem from the reduced cost in case of a foreign animal disease outbreak due to enhanced traceability compared to the baseline scenario.

BSE: Bovine Spongiform Encephalopathy, also referred to as mad cow disease

CAD: Canadian Dollar

CFIA: Canadian Food Inspection Agency

CPC: Canadian Pork Council

CSF: Classical swine fever

EU: European Union

FAD: Foreign animal disease

FARM: Food and Agriculture Regional Model, developed by AAFC

FMD: Foot-and-mouth disease

FPT: Federal, Provincial and Territorial

FTE: Full time equivalent

IGAC: Industry-Government Advisory Committee (for traceability)

NAFTA: North American Free Trade Agreement

NAFTS: National Agriculture and Food Traceability System (for farm animal species in Canada)

NAIS: National Animal Identification System, initiated by the USDA for all major farm animal species in the United States of America; not further implemented at national level as of 2010.

NPV: Net present value

OECD: Organisation for Economic Co-operation and Development

OIE: World Organization for Animal Health, previously named Office International des Épizooties

PMWS: Post-Weaning Multisystemic Wasting Syndrome

PV: Present value

RFID: Radio-frequency identification

USD: US Dollar

USDA: United States Department of Agriculture

1.3 Benefits and Costs

Benefits

Some of the benefits of the proposed Regulations are unquantifiable because the annual revenue of the pig industry is impossible to predict accurately. Production yields continue to increase, inventory costs are decreasing, and producers are establishing other supply chain efficiencies. Further, with the proposed Regulations, the international market is expanding for exports, consumer confidence in domestic products is higher and traceable products can command premium prices, if linked with the assurance of specific product attributes. However, the extent of such benefits cannot be predicted and, quantification should thus be limited to simulation purposes, e.g. to determine likely scenarios under which these benefits would offset the cost of implementation (4).

Potential quantifiable benefits from the proposed Regulations occur where animal disease outbreak costs can be reduced by a traceability system. Estimates from two independent outbreak cost analyses indicate that the net economic impact of a major animal disease outbreak, such as foot-and-mouth disease (FMD) in Canada would be at least $15.7 billion (17, 19), affecting the most economically-important livestock sectors. If an enhanced traceability, as proposed in the regulatory amendment were in place at the time of the outbreak, the costs for all sectors would be reduced by $6.1 billion or more. For the pig industry alone, if an outbreak of either classical swine fever (CSF) or FMD occurred once during the next 50 years – a probability that is based on Canadian disease outbreak history - the net present value (NPV) of the proposed Regulations to the pig industry is estimated at $530 million for the small scale outbreak scenario and at $999 million for a medium scale outbreak (please, see Exhibit 13 in section 7.1). One of the most valuable aspects of the proposed Regulations is that it would support access to domestic and international markets for Canadian livestock and meat products. Any international market closures would be shortened in duration because the disease spread and the disease itself within Canada would be quickly controlled and it would be clear which animals had been or may have been exposed to the disease.

Costs

The costs associated with the proposed Regulations for the implementation of a national pig traceability system are based on industry and government estimates. Government cost estimates comprise of the development of an information database and related training and communication ($1.14 million one-time) and an annual opportunity cost of $125,000 for compliance verification (compliance verification and enforcement activities would be conducted with existing CFIA human resources). The proposed database would receive the pig traceability information reported by the regulated parties.

The cost to industry (operators and producers) includes animal identification tags, materials and related expenses. It also includes administrative costs ($1 million annually) for the maintenance of a call centre and for communication activities. Two options were considered to capture the lowest-cost and the highest-cost scenario. Option 1 assumes that only pigs selected for breeding, and pigs sent to auctions, fairs and test stations need to be identified individually with an approved tag (based on proposed Regulations), while the movements of all other pigs are reported by group or lot. Option 2 assumes that all animals produced within Canada or moved to Canada need to be identified with an approved tag. Animal identification uses either non-electronic (visual) tags (at $0.61 each) or electronic (radio-frequency identification, or RFID) tags (ranging in costs from $1.25 as an increment to the current use of visual tags for breeding animals only under Policy Option 1, to $1.78 as the full cost in case of Policy Option 2). In addition to tag costs, data-transfer related costs for reporting animal movement have to be accounted for. Under Policy Option 1, these costs are assumed to be $0.13 per individually identified animal and $0.05 per animal identified by group or lot. Under Policy Option 2, these costs are assumed to be $0.36 per animal. For the preferred option (Policy Option 1 and RFID tags), animal identification and movement reporting costs add up to a total of $3.276 million in the first year and $2.090 million in subsequent years. For more details on the options and the costs associated with them, please see sections 3 and 5.1.

1.4 The Costs-Benefits Summary Statement

The assumption of a 2% annual likelihood of animal disease outbreak is based on the Canadian disease outbreak history. Estimated cost savings resulting from the existence of a traceability system in the event of an outbreak were used as quantifiable and attributable monetized benefits for the NPV calculation of the proposed amendment. NPV was calculated for two disease cases with different trade embargo lengths, based on data from two previous studies. The first case is a FMD outbreak with a trade embargo reduction through enhanced traceability from 4.5 to one month within NAFTA, while the rest of the world maintained a 4.5 month trade embargo. The second case is a CSF outbreak with a one year trade embargo in the baseline scenario, i.e. current traceability practices and capacity, and reductions in trade embargo impacts through enhanced traceability that are proportionate to those in the first scenario. The NPV was calculated at $999 million over a 50 year period. This translates to an annualized net present value $81.7 million. The distribution of costs and benefits across stakeholders in the pig supply chain is shown in the cost-benefit summary statement below.

In addition to these monetized benefits, the unquantifiable benefits of the proposed amendment include: improvements in consumer confidence in domestic meat products, enhanced human health and food safety, domestic supply chain efficiencies, added protection from bio-security threats, and a verifiable means of confirming animal and product authenticity, origin, compliance with international traceability guidelines and standards, and other credence attributes throughout the supply chain.

The accounting statement that follows is for a potential medium scale outbreak of CSF and the associated trade embargo that would result (estimated to be one year in duration). The benefit values represent the difference in the economic impact of an outbreak controlled more quickly with enhanced traceability in place compared to an outbreak occurring with the current traceability capacity in place. For this calculation, a 2% annual outbreak probability, an 8% discount rate and the identification of breeding animals and animals sent to auctions, fairs and test stations with RFID tags are assumed.

Exhibit 1: Cost-Benefit Statement

Costs, Benefits and Distribution		Base Year t_0 (2011)	t_1 First year** (2012)	t_{50} Final year** (2061)	Total Present Value	Annualized Present Value
A. Quantified impacts by stakeholder (in $million)						
Benefits	**Stakeholder**					
Farm Expenditures	Producers		4.81	0.11	63.56	5.20
Net Farm Income	Producers		6.84	0.16	90.33	7.38
Processing Sector	Operators		21.85	0.50	288.66	23.60
Food Retailing***	Operators		-0.12	0.00	-1.60	-0.13
Indirect/Spillover	Economy-wide		45.64	1.05	603.03	49.29
Total Benefits			**79.02**	**1.82**	**1,043.97**	**85.34**
Costs	**Stakeholder**					
Database Development & Maintenance	Government	1.14	0.26	0.01	4.63	0.38
Compliance verification	Government		0.12	0.00	1.53	0.13
Animal Identification and Movement	Producers / Operators		3.03	0.04	26.66	2.18
Administrative	Producers / Operators		0.93	0.02	12.23	1.00
Total Costs		**1.14**	**4.34**	**0.07**	**45.05**	**3.68**
Net Benefits					**998.92**	**81.65**
B. Quantified Impacts in Non-$ (Not Applicable to this analysis)						
C. Qualitative Impacts						

Positive Impacts	Stakeholders Impacted
International market share expansion	Exporters primarily
Consumer confidence in domestic products	Retailers, but benefits may spread throughout the supply chain
Price premiums for traceable products	Retailers, but benefits may spread throughout the supply chain
Inventory cost minimization	All supply chain stages
Production yield increases	Production and processing stages
Supply chain efficiencies	All supply chain stages
Improved control of product related diseases	Government cost reductions; public health
Lower costs for compensation / recovery	Government
Sustainability of a greater number of farms/operations	All supply chain stages and residents/citizens (cultural identity)

* *Quantified annual benefits by stakeholder are cost savings in the event of a medium scale CSF outbreak; converted to an expected annual value by multiplying the benefit with the outbreak probability of 2% (in $million).*

*** Values discounted to t_0 at discount rate of 8%.*

*** *Negative values indicate that a sector gains from an outbreak, e.g. by selling more of a product, due to lower prices, while maintaining margins.*

Source: Benefit estimates based on Charlebois, P. and P. Pérusse, 2004 (19)

1.5 Business and Consumer Impacts

Most of the information that would be required to be reported under the proposed pig traceability system option 1 is already recorded on a voluntary basis by the regulated parties. For option 2, the additional cost to report animal identification information with movements for all pigs to the database system would be substantial, either through necessary investment in RFID tags and readers or the additional labour to read visual tags. In the case of an outbreak and trade embargo, consumers would gain from reduced domestic prices but it is assumed that this gain would remain with enhanced traceability.

As non-monetized benefits, the proposed Regulations would strengthen international market access for the Canadian pork industry because Canada's trading partners value livestock traceability. Consumers would have more information about their food and would be better protected in the event of a disease outbreak among swine.

1.6 Distributional Impacts

The cost-benefit analysis shows costs are mainly borne by producers (estimated to be $3.18 million annually) and to a lesser extent by governments ($0.51 million annualized for database system development in base year t_0 and maintenance costs afterward). However, the cost-sharing formula for the traceability initiative is still being discussed between governments and industry.

It has been demonstrated that all the pork value chain would benefit from the proposed pig traceability system (17, 19). However, traceability implementation at farm level has a higher cost per unit of output for smaller operations than for larger operations due to the existence of economies of size and scope in recording and transferring animal movement data to the central database and the more widespread use of computer technology in larger operations (4). Contrary to this effect, the study by Serecon Management Consulting (17) pointed out that an animal disease outbreak with subsequent trade embargo would impact larger operations more severely, because of lack of income diversification and higher financial leverage. Larger operations would hence benefit more from a reduced trade embargo due to enhanced traceability.

2 Regulatory Issue

2.1 Context of the Regulation

Traceability may be defined as the ability to trace and follow food, feed, food-producing animals or substances intended to be, or expected to be incorporated into a food or feed, through all stages of production, processing and distribution. There are three pillars to livestock traceability systems: the identification of animals, the ability to follow their movement, and the location where these animals have transited. Among the Federal, Provincial and Territorial (FPT) Governments, only Quebec has enacted regulations covering the three pillars. This is mainly due that not all jurisdictions have a legislative framework which provides the regulatory-making authorities covering the three pillars. Consequently, a FPT Government regulatory approach is being used to support the development of livestock traceability systems and the 2009 FPT agricultural ministerial announcement that livestock traceability systems should be mandatory by the end of 2011. The development of a traceability system for the pig sector, along with bovine, ovine and poultry, was prioritized by the FPT Ministers in 2006.

At the federal level, the livestock identification and some movement reporting requirements are covered under Part XV of the CFIA-administered *Health of Animals Regulations.* The regulatory-making authorities are provided under the *Health of Animals Act.* The first identification and movement requirements under the *Health* *of Animals Regulations* were introduced in 2001 with the bovine and bison sector. Ovine identification requirements were introduced in 2004.

Under the Federal livestock identification and traceability program, enforcement actions may be taken on non-compliant parties, including letters of non-compliance and monetary penalties under the *Administrative Monetary Penalties Regulations.*

The proposed amendment to Part XV of the *Health of Animals Regulations* to introduce pig traceability would greatly enhance Canada's ability to mitigate the impact of a disease outbreak or food safety issue originating from or affecting the Canadian pig herd, and would meet consumers' increasing demand to know the origin of their food. In the absence of such system, the pig industry, and the entire Canadian livestock sector, remains vulnerable towards sanitary issues or natural disasters.

2.2 The Issue Description

The Canadian pig sector is highly dependent on exports. There is increasing demand from foreign consumers and governments to know the origin of imported food and the conditions under which it was produced (e.g. organic food). In the event of a disease outbreak in Canada affecting swine, the lucrative export market for pork products would rapidly close. The impact of a disease outbreak could also affect public health (in the event that the disease could be transmitted from pigs to humans) and other economically important livestock sectors (e.g. foot-and-mouth disease affects cattle and sheep). Tourism in affected areas may also be greatly impacted, by a disease outbreak due to the implementation of movement restrictions to reduce the risk of spreading disease and/or to reduce the risk of infecting the population.

While the impact of a disease outbreak/sanitary issue could be great, the probability of it occurring is relatively small given the implementation of preventive tools such as bio-security and on-farm food safety programs; both of which are funded under the *Growing Forward* framework. The probability of a disease outbreak is increasing over time due to climate change and the increased movement of people and animals worldwide. A national pig traceability program would help mitigate the effects of a disease outbreak or food safety issue and enable a more rapid and effective response by the Canadian government and industry. In order to implement such a national program, Government intervention is necessary.

2.3 The Regulatory Proposal: An Overview of Objectives

The main objectives of the proposed Regulations are (a) to reduce the impacts of a disease outbreak, food safety issue or natural disaster resulting from and/or affecting the pig sector, (b) to better protect public health and animal health, and (c) to support the Canadian pig industry to meet international standards to export.

These objectives support the Canadian Food Inspection Agency's (CFIA) strategic outcome for a "safe and accessible food supply and plant and animal resource base".

2.4 The Baseline Scenario: A Description of Current Traceability Capacity

In a 2008 swine movement study conducted in Canada (29), it was demonstrated that up to 35 pig herds could be infected with CSF before it was detected and disease control measures could be implemented. It was predicted that 'a single case of foreign animal disease in swine in Canada is unlikely because within 42 days, more than half the simulated introductions resulted in spread to other herds'. Once the disease has been detected, complete, accurate, and up-to-date traceability information made available 24/7 to veterinarians would be crucial in rapidly and efficiently controlling the spread of the disease.

Under the proposed Regulations, pig traceability data would be made available on a continuous basis to veterinarians for the management of a sanitary issue and to inspectors to verify compliance. The information would be verified for accuracy through audits and inspections from existing resources.

A detailed account of current and proposed traceability capacities in the pig sector is presented in section 6.2.1 Options Description.

3 Options Considered

Three regulatory and non-regulatory options were considered.

- Status Quo (a voluntary, phased-in implementation of a national pig traceability system)

  Since 2007, a voluntary, national pig traceability system based on the proposed Regulations is being phased in by the Canadian Pork Council (CPC). Through this initiative, a nationally unique shoulder slap tattoo number has been allocated to each pig producer or pig barn, national tags have been made available to producers and technology to facilitate pig movement reporting has been developed. However, as the experience with the National Animal Identification System (NAIS) in the United States of America has shown, a voluntary system may have low participation rates. With potentially incomplete pig identification and movement information being reported, the efficiency of the traceability system would be jeopardized.

- Amend the *Health of Animals Regulations* to include the introduction of a pig traceability system based on the principle of movement reporting – Preferred Option, labelled Policy Option 1 in the analysis.

  A traceability system based on the principle of movement reporting rather than identification is the preferred option as the unique identification of each animal would be cost-prohibitive and pigs tend to be transported in groups. However, breeding animals and animals sent to auctions, fairs and test stations would be identified individually. Under the proposed Regulations, the quality of the movement information reported would be verified by asking both the sender and receiver to report the same movement. As this information is already recorded as standard business practice, the additional effort due to the regulatory amendment is to transfer this information to a central database.

- Amend the *Health of Animals Regulations* to include the introduction of a pig traceability system based on the individual and unique identification of each pig, labelled Policy Option 2 in the analysis.

  The cattle, bison and sheep identification programs are based on the principle that an approved tag bearing a unique identification number must be applied to each animal before it leaves its farm of origin. This model was used for these species because the cost of the identification tags is low compared to the value of the animals. The other reason each animal is identified with an approved tag is that management information is kept for each of the animals. This model is also true for individual pigs which have been selected for breeding and pigs sent to auctions, fairs and test stations (and is reflected in the proposed Regulations) but is not used for market pigs as it would be cost prohibitive.

Policy Option 1 is the preferred option as it would increase the efficiency and effectiveness of the traceability system and would better protect the livelihood of pig producers and the overall Canadian economy, the health of Canadians. This option would also limit the environmental impacts of an animal health issue, and reflects the position of the Canadian pig sector. Government's intervention in modifying the Regulations based on this option is required as the efficiency of a traceability system is highly dependant on the quality, timeliness, completeness and availability of the information being reported by the different parties. Such a goal would not be met under a voluntary system with the information held at each site, but mandatory, up-to-date reporting to a centralized database.

4 A Profile of Affected Parties

4.1 Pig producers

As of April 1, 2011, 11.8 million pigs were raised on 6,950 farms mainly located in Ontario (34%), Quebec (26%), Alberta (11.5%) and Manitoba (10.6%)(22). When compared to 2004 figures, the inventories of pigs decreased by 19% while the number of farms reporting pigs decreased by 47% (22). The decrease in the number of pig farms has accelerated over the last years for reasons such as health challenges (circo-virus), macro economic factors (fluctuating currency exchange rates), U.S. public policies (affecting feed costs), economic cycles (a demand reducing recession); as well as trade inhibiters (U.S. country-of-origin labelling)(23).

The Canadian pig industry still largely depends on exports with an annual value between $2.6 and $2.8 billion between 2004 and 2010 (23), representing approximately 7% of the total Canadian agri-food trade. Total non-U.S. exports have increased by more than eight times in the last fifteen years (23). It is recognized that a differentiation strategy can assist the Canadian pig industry's efforts to grow in these markets. In 2008, Canada had 17.4% of the world pork export market share, compared to other markets that have implemented traceability systems for pigs, e.g. the European Union which has 24.7% of the export market (25).

Although relatively small, the import of pork has increased steadily, a seven fold increase from 1993 to 2008. Total pork consumption has decreased in Canada relative to other red meats.

In 2008, the CPC undertook an intensive review of the situation and developed a Strategic Transition Plan (23); one that respects the prudent role and capacity of government, while underscoring the primary responsibility of agricultural entrepreneurs to succeed or fail based on the merits of their efforts. A description of the anticipated industry situation in 2014 was given:

- Domestic disappearance of Canadian produced pork at 730,000 tonnes, an increase of 150,000 tonnes from 2008 (combination of import replacement and increased domestic consumption)
- Export of 4 million live pigs to the U.S. – a reduction of 5.3 million from 2008
- Total pork exports of 1 million tonnes of which only 20% will be to the U.S.
- Total domestic slaughter of 21.5 million – a reduction of 0.2 million from 2008
- A reduction in total production from 31 million in 2008 to 25.5 million pigs
- Domestic market share of 88% compared with 75% in 2008

Traceability was identified in the Strategic Transition Plan as a means by which those objectives could be met. The proposed traceability requirements would also apply to the farmed wild boar sector, a relatively minor industry from an economic perspective. In 2006, approximately 21,000 wild boars were raised on 256 farms (26).

4.2 Operators of abattoirs

In 2011, approximately 90% of pigs slaughtered in Canada were received in 34 federally-inspected abattoirs (27); the other pigs are slaughtered in approximately 190 provincially-inspected abattoirs. The operators of federally- and provincially-inspected and mobile abattoirs are already subject to traceability requirements under Part XV of the *Health of Animals Regulations* as they have to report the identification number of the approved tag borne by the slaughtered bovines and bison.

At the international level, meat demand is mainly driven by income and population growth and urbanization. Considering these factors have been growing the fastest in developing countries, growth in livestock product trade has become increasingly dependent on demand from developing countries as demand in developed countries has been rather stable.

Over the past decade, a series of animal diseases or food safety crises such as FMD in Europe and Latin America and Bovine Spongiform Encephalopathy (BSE) in North America has exacerbated the segmentation of international meat markets and markets will remain very sensitive to animal health outbreaks and regulations. Despite these incidents, imports of red meats by countries of the Pacific Rim have increased dramatically since 1990. This trend is confirmed in the Organisation for Economic Co-operation and Development (OECD) Outlook, which estimated that nearly 60% of the growth in the world consumption is expected to come from this area.

The USDA Agricultural Projections to 2020 provide estimates of annual growth rates in global pork consumption and shipments from major exporters of around 0.75% and 1.3% respectively (44). Major importers are China and East Asia, Russia, Mexico and the USA.

Domestically, growth in the red meat industry is tied to export markets. International market conditions remain favourable for Canada since competition from large South American producers is limited by FMD outbreaks. Supply conditions, however, will not be as favourable as they were in the 1990s. Animal diseases are affecting Canada's red meat industries. Post-Weaning Multisystemic Wasting Syndrome (PMWS) is affecting pig production (28).

4.3 Order buyers and operators of auctions, assembly yards, off-site disposal sites

Unlike the other species already covered under Part XV of the *Health of Animals Regulations*, i.e. bovine, bison and ovine, very few order buyers and operators of auctions, assembly yards and off-site disposal sites are custodian of pigs. These operations are already subject to traceability requirements under Part XV of the *Health of Animals Regulations* as bovines, bison and ovine transit through their operations.

5 Costs & Benefits: Identification and Description

5.1 Costs of the Regulatory Proposal

The costs associated with the proposed Regulations for the implementation of a national pig traceability system are based on industry and government estimates regarding database enhancement and development, as well as depreciation and maintenance, animal identification materials and labour, and administrative costs.

5.1.1 Government Costs

Government costs include the development of the information database, related software, and necessary training and communication. These costs are a one-time expense and estimated at $1.140 million in the first investment period[2]. Maintenance cost and depreciation need to be taken into consideration too. Assuming depreciation to be at 20% of the initial investment cost annually and another 5% for maintenance and software updates, $285,000, or 25% of the initial set-up costs would need to be allocated to these purposes as annual operating cost. Compliance verification and enforcement activities have been estimated to require 1.13 FTE with corresponding expenses, totalling $125,000 per year. Although these activities would be conducted with existing CFIA human resources, the costs need to be included in the cost-benefit analysis since the agents and resources involved would have been allocated to other useful activities in the baseline scenario.

5.1.2 Industry Costs

Industry costs (operators and producers) include animal identification and administrative costs. The administrative costs include the cost of call centre operations, administrative support, and other communications and are estimated to be at $1 million per year (36, 37). The call centre plays a central role in providing producers with assistance and advice as well as in entering and managing animal identification and movement data.

Ideally, or in the long run, all producers and other agents in the pig industry would transfer their animal identification and movement data electronically over the internet for maximum data accuracy and timeliness. While electronic systems are already preferable for larger operations where computer and internet use is standard practice[3] and helps reduce cost of data storage, management and transfer, not all operations can be assumed to switch to an electronic system for a number of reasons:

- Operators in remote areas with limited or no internet access may require different modes of data transfer.
- Operators who do not use computers due to religious or other beliefs cannot be forced to use electronic data transfer.

Therefore, the call centre responsibilities include entry of data into the database system that has not been sent in an electronic format that is compatible with the automatic data transfer requirements of the database system. This transfer, e.g. by fax, phone, or mail provides flexibility for farmers to choose their preferred or least cost method for data transfer and, for a transition period will likely increase compliance. Due to the concentration of pig production in operations with receipts well over $250,000, it is fair to say that the share of animal identification and movement data that is not transferred electronically will be rather small and continue to decrease in the future, as the sector further consolidates.

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[2] $0.98 million for database development and $0.16 million for training and communication costs, provided through *Growing Forward Framework Agreement.* For an overview of the framework agreement, please see (45).

[3] According to Farm Credit Canada, 73% of Canadian farms with receipts of $50,000 or over reported internet use in 2009 (http://www.fcc-fac.ca/en/learningcentre/journal/stories/200909-6_e.asp), and 69% of those with internet connection had high speed internet. In the past two years these numbers have likely risen further.

The animal identification costs include the aggregate costs of approved tags and additional on-site labour requirements related to tagging and recording or reporting of information. As most breeding operations already tag their animals with visual tags as a standard business practice for performance monitoring and management, no initial costs for tagging equipment and labour cost for tagging are included under Policy Option 1, while costs for RFID tag reading and data transfer are. However, the additional cost of RFID tags has to be included for Policy Option 1. Further, Policy Option 2, under which all animals born in Canada and moved into Canada have to be identified, requires including the cost of tagging equipment, labour cost for tagging and the tag costs.

The calculation of animal identification and data transfer costs starts with the cost of tags. As a not-for-profit industry organization, PigTrace Canada (44) offers visual tags at prices between $0.56 and $0.96 per tag, depending on order size and tag type. RFID tags cost between $1.76 and $2.16.

For Policy Option 1 which basically requires operations with breeding stock to purchase RFID tags, an average order size of 100 tags is assumed. The corresponding order prices are $1.94 for RFID tags and $0.69 for visual tags, leading to an additional cost of $1.25 per RFID tag over the currently used visual tag.

For Policy Option 2, an average order size of 500 is assumed. The corresponding order prices are $1.78 for RFID tags and $0.61 for visual tags. These costs will be used directly for Policy Option 2, with either RFID or visual tags, as it is not current practice to individually identify all pigs produced.

For Policy Option 1, only breeding animals and those sent to auctions, fairs and test stations are tagged with RFID tags. Further assumptions were made that swine breeding animals on average live for three years, hence a third of the breeding herd would subsequently be identified per year. In 2010, approximately 1.332 million swine breeding animals were kept in Canada (22). A critical aspect of tagging cost is the retention rate, for which the following performance standard has been set: after 12 months retention is 99%; after 18 months, 97%. Since the average life span of a breeding animal is three years, it is further assumed that, after 18 months retention is reduced by two percentage points per half year, leading to an average retention rate of 97% per year: 99% in the first year, and 96% in the second and in the third year of a breeding animal's average life span. Hence, except for the first year, tagging cost would need to be multiplied by a factor of 100/97 or increased by 3.1%. For Policy Option 2, a retention rate of 100% is assumed for tags.

The following table details the numbers for each of these scenarios for the base year (t_0) and every subsequent year.

Exhibit 2: Tag costs of policy options for animal identifications

Scenario	Year	Animals to be tagged	Cost per tag	Total cost per year	Annualized over 50 years
Policy Option 1 with RFID tags for breeding herd	First year (t_1)	1,332,000	$1.25	$1,665,000	$671,236
	Subsequent (t_2-t_{50})	457,732	$1.25	$572,165	
Policy Option 2 with RFID tags for all animals	First year (t_1)	29,654,400	$1.78	$52,784,832	$51,346,420
	Subsequent (t_2-t_{50})	28,780,132	$1.78	$51,228,635	
Policy Option 2 with visual tags for all animals	First year (t_1)	29,654,400	$0.61	$18,089,184	$17,596,245
	Subsequent (t_2-t_{50})	28,780,132	$0.61	$17,555,881	

For Policy Option 1, costs for reading and transferring the tag/movement information of individual animals to the database would arise, as these activities are not standard business practice. In addition, cost of reporting the movement of animals that are identified by group or lot identification need to be accounted for. For Policy

Option 2, the cost of applying the tags would need to be added to identification and movement data recording and transfer. RFID tag applicators and readers would need to be purchased and additional efforts expended on tagging the animals, and reading, recording and transferring the movement data. While an estimate of these additional costs is presented in the next paragraph, it has to be pointed out that identifying every single pig with ear tags may result in higher loss rates or reduced feed conversion rates due to the additional stress. However, no study was found that could provide results to base an estimate of these costs. The following assumptions were used to estimate the additional costs related to tagging, other than the costs of the tags.

- Tagging takes place at the farrowing stage. Loss rates after weaning are not accounted for. If they were to be accounted for, costs would rise proportionately to the loss rate.

- Tag applicator costs are estimated at $0.005 per pig for RFID tags and at $0.002 per pig for visual tags. According to PigTrace (44), the price per RFID tag applicator is $66.94 and $27.73 per visual tag applicator. Further, four years useful life per applicator (4: page 15) and an interest rate of 8% were assumed. Additionally, it was assumed that two applicators were needed per farrowing barn of 300 sows as a typical size, or based on 25 weaned pigs per sow and year, one applicator for 3,500 pigs.

- Labour cost for tagging is estimated at $0.23 per pig, based on a wage rate of $14 per hour. The USDA study on NAIS (4: page 83 ff.) considers tagging only cull breeding stock and assumes 15 minute set-up time and one minute to apply the tag to a pig before transport. However, set-up time has a measurable impact only on tagging animals in small number lots, which would be more applicable to cull breeding stock. Therefore, set-up time is not included, while the estimated time of one minute per animal is maintained. This requires 30 seconds per animal, including set-up costs for a team of two – one catches the animals, one applies the tags.

- Reading cost for RFID tags are estimated at $0.082 per animal sold. This reflects the annual cost of ownership of one RFID wand reader at $600 per piece, plus $300 for software at each of roughly 7,000 pig operations, assuming an interest rate of 8% and a useful life of three years per reader (4). This, however, does neither include stationary RFID readers at abattoirs, auction barns or fairs nor maintenance or repair/replacement costs. In case of visual tags, no investment in readers would be necessary but the labour cost of reading and recording the tags at the source and the destination of each transport will likely be higher than $0.082 per animal. Assuming $14 per hour as above, that would be equivalent to 21 seconds per animal per transport.

- Then, the tag numbers of transported animals would need to be recorded and reported to the database. For RFID tags a completely automated process would be assumed that would require hard and software, as well as updates but little labour input other than for set up and updates. For visual tags, required labour input would be considerably larger and depend on which data transfer options were available. Cost would be lowest, if tag number lists could be faxed to the database call centre where the data would be entered into the system. Cost would be considerably higher, if farmers had to enter the tag numbers manually into the database online. The USDA study on NAIS assumed identification by lots and that farmers could choose the least cost solution for recording and reporting.[4] This does not fit the options presented here: Either

[4] It should be worth to mention that the NAIS report (4) only considered identifying breeding animals (and animals sent to auctions, fairs and test stations) individually, while all other pigs were identified by group or lot, as in our Policy Option 1. Because only cull breeding animals are identified in NAIS and the costs for that are spread across all animals, the costs per animal sold in the NAIS study are much lower than our estimates that use key assumptions from the NAIS study, but for all animals. Furthermore, for Policy Option 2, the losses between weaning and slaughter were not considered, because outside of the scope of this study. If all animals receive their tag right after weaning, the number of tags applied would account for that loss rate and thus be accordingly bigger than the number of animals slaughtered (what is currently assumed). Including post-weaning losses could generate an increase by 3% to 5% for tag and tagging costs.

RFID or visual tags for all animals. However, the share of 72.9% of recording and reporting in total cost reported in (4) could serve as lower bound for this cost item of Policy Option 2: 72.9% of $0.0588 equals $0.043 per market pig (4: page 100).

- For animals whose movement is reported by group or lot identification (Policy Option 1, all animals except breeding animals and animals sent to auctions, fairs and test stations), the data recording and transfer cost are estimated at $0.05 per pig. How these estimates were derived from the numbers presented in the USDA study on NAIS (4) is documented in the appendix.

In sum, Policy Option 2 would trigger a minimum additional annual cost for the industry of about $0.36 per pig or $9.6 million in total. These costs will be added to the tag costs for the cost-benefit analysis, yielding a total cost $2.14 per animal for the RFID tags and $0.97 per animal for the visual tags.

For Policy Option 1, the cost of reading the RFID tags at $0.082 per animal and of data transfer at $0.043, or a total of $0.13 would need to be added to the incremental RFID tag cost, totalling $1.38 per individually identified animal. For the animals identified by group or lot, the additional cost is $0.05 per pig.

5.2 Benefits of the Regulatory Proposal

Evaluating and accounting for the benefits of an improved pig identification and movement reporting system presents a variety of challenges. To begin, traceability systems are necessarily customized for their intended uses. That is, the type of information maintained and reported is specific to the characteristics of a given industry and its unique products and supply chain. For this reason, many benefits observed from the implementation of other traceability systems may not be generalizable to the pig sector in Canada.

These types of benefits include consumer price premiums for traceable products, production yield increases through transparent input and output data recording, cost savings through inventory minimization, and other supply chain or market efficiencies, including increased access to international markets. It should be noted that the potential does exist for these benefits to be realised in the Canadian pig sector but that the magnitude of these benefits would only be known once the system is functioning at full capacity.

Therefore, the accounting of benefits attributable to the proposed Regulations must be observed through the cost minimization of the economic consequences of an outbreak of animal disease in Canada. Disney *et al.* (21) identify that these types of benefits include limiting the spread of a disease, enabling faster trace-back of infected animals, limiting production losses due to disease presence, reducing the costs of government control, intervention and eradication, and ultimately minimizing potential trade losses. In this analysis, the focus is on the reduction of outbreak costs to the pig sector of one animal disease at a time. This focus puts the results of this analysis at the lower boundary of potential benefits of the proposed Regulations for four reasons:

a) A number of animal diseases affect more than one species. Thus, effective traceability for one species or sector also benefits other sectors with species that can be affected by that disease. FMD, which is used in this study, is a case in point. However, to avoid double counting between regulatory amendments for different sectors, these benefits are not quantified here.

b) The benefits of a traceability system in one sector are not limited to one disease at a time. This analysis uses a point estimate of a FAD outbreak probability that has been based on historical data. However, increasing globalization in the exchange of goods and services as well as in personal and business travel may actually increase this probability in the future. The protection against more than one disease can best be addressed by changing the outbreak probability in the sensitivity analysis.

c) The benefits from enhanced traceability depend on how much the system could limit the duration of a trade embargo if it was in place and whether the embargo would be shorter for all importing countries. This analysis builds on a particular study (17) that assumed a shortened trade embargo for countries of the North American Free Trade Agreement (NAFTA) only, while the rest of the world kept the trade embargo at full length. Should in reality, however, all importing countries lift the trade embargo earlier because of the traceability system, the benefit would be increased correspondingly.

d) The quantifiable benefits of traceability systems are not limited to major incidents. Smaller incidents, for example caused by residues of substances that are banned in one importing country, can be resolved more quickly with effective traceability, leading to shorter and less pronounced trade disruptions with this country. While quantification of these minor benefits is possible, it is beyond the scope of this analysis.

Finally, because demonstrating a certain level of sector-wide traceability is becoming increasingly important for international market access, a further potential benefit arises. Due to the discrete nature of this benefit, it is hard to forecast. However, there are two approaches to deal with this uncertainty in cost-benefit analysis when appropriate economic models are used. First, one can introduce explicit assumptions about the loss of export value, if the current traceability capacity is maintained and an enhanced traceability system not implemented. For instance, the USDA publication on NAIS (4) used three scenarios of current exports (in US$) lost due to not implementing NAIS: 10%, 25%, and 50%. Second, and also done in (4) one can estimate, by way of simulation, what the increase in exports would need to be to offset the additional cost of the traceability system.

6 Literature Review and Methodology

6.1 Literature Review

6.1.1 Related Studies

The threat of a livestock disease outbreak or other animal health events in North America is real (15). A literature review allows asserting that a traceability system for the pig industry, as well as for any other animal production industry, present important public and private benefits (2, 3, 5, 6, 9, 11, 12, 13, 16). A traceability system allows for substantial costs reduction related to an animal disease outbreak or food safety incident (13) similarly to a zoning system based on the World Organisation for Animal Health (OIE) principles would reduce by 45% the economic impacts of an animal disease outbreak such as FMD (17).

Many countries have implemented their own pig traceability system and each system is different and has its own characteristics (13, 14). Many countries which have mandatory pig traceability system demand that imported products meet the same identification standards (15).

A traceability program is considered to be an essential element to achieve food safety policies (13). A traceability system should be considered as contributing to public benefits (6). According to McEvoy *et al.* a mandatory traceability would achieve a more optimal level of benefits than a voluntary system as the industry would focus on meeting private benefits objectives (12).

There is no economic model sufficiently precise to quantify the costs of implementing traceability for the pig industry. Since pig production practices are not comparable to cattle production practices, it is not possible to extrapolate from economic models developed for the bovine industry (13).

A study contracted by Agriculture and Agri-Food Canada (AAFC) in 2007 attempted to establish costs for the livestock industry for implementing an electronic identification system (1). Data obtained did not allow for the development of a representative economic model. However, this study indicates that implementation costs at the farm will vary depending on multiple elements such as the size of the business, the existing infrastructures, the production model, and the complexity of the animal identification system that will have to be implemented. It seems that there is a potential for some economies of scale and size, therefore smaller businesses may be more impacted than larger businesses (4). Due to standard business practices in pig production, it seems that a traceability system using the slap tattooing method instead of an electronic identification system would be preferable to the industry.

Several elements affect the costs of a traceability system (7, 8, 9, 10, and 16). In light of available information, the costs will vary significantly depending on the characteristics and on the objectives of a proposed program such as: the quantity of information that must be recorded on each animal or lot of animals (e.g. birth location, movements, feeding program, veterinary cares, breed, parents, etc.); the number of processing steps through which the animal identification is maintained (e.g. identification from the farm to slaughter, from the farm to retail, etc); and the speed aimed for tracing the source of a disease outbreak (e.g. 48 hours, 5 days, etc.).

Costs and benefits will depend on the objectives of the traceability system. During the development of a traceability system, it is important to define what those objectives are and to indicate that the costs and benefits analysis is based on those objectives (11).

6.1.2 Quantification & Valuation Techniques

As stated above, the quantification and valuation of benefits focuses entirely on the reduction of cost associated with an animal disease outbreak. In essence, the benefit of enhanced traceability originates from the reduction in time it takes to identify the source(s) and effectively contain and eradicate the disease. Hence, duration and extent of an outbreak are the key variables that determine the cost of an outbreak (4, 16, 17, and 33).

The extent of an outbreak is typically measured in number of herds or animals infected, and primarily determine the cost of disease control, which are comprised of detection and surveillance cost, cleaning and disposal cost, zoning cost and possibly vaccination cost (17).

The duration of an outbreak can be measured in days, weeks or months. It determines the length of trade embargos and the market related costs of an outbreak, such as foregone profits at the various supply chain stages in the domestic and international markets through reduced prices and/or reduced demand. Governments may choose to engage in welfare slaughter[5] programs to compensate producers and processors for their economic loss. In addition, impacts on consumer surplus would also be estimated as a result of market effects, e.g. through reduced prices or reduced consumption.

Extent and duration of an impact depend on a number of factors:

- Effectiveness of traceability system, as indicated by compliance rates for mandatory systems, participation rates in voluntary systems, tracing success rates (4) or days to identification of disease source(s) (33);

[5] Welfare slaughter is a term used in foreign animal disease (FAD) eradication to describe the slaughter of animals that are not known to be infected by the FAD agent but have to be killed because of overcrowding or other deteriorating animal husbandry conditions on farms placed under movement restriction. This situation occurs most severely and quickly in export dependent livestock regions.

- Effectiveness of control measures, as indicated by international recognition of zoning efforts (17), detection rates of new disease cases (17) or the rigidity of control measures such as culling of infected herds (33);
- Speed of disease spread, which is determined by the nature of the disease and characteristics of the industry, as indicated by contact rates (33), which in turn is determined by amount of animal movement and concentration of animals in an area. Economic studies employ epidemiological disease spread models or functions to model spread in response to different levels of traceability and control measures (4, 33) or use expert advice from chief veterinary officers to determine meaningful outbreak scenarios (17).

Generally, the larger the extent and the longer the duration of a potential outbreak (with a correspondingly longer trade embargo) are, the larger is the potential benefit from an enhanced traceability system. In addition, at least three more factors need to be taken into consideration in the quantification and valuation of benefits, as they determine the range of impacts:

- Outbreak probability: Obviously, the higher the outbreak probability, the higher the benefit from enhanced traceability. While outbreak probabilities can only be assessed in qualitative ways, a quantitative estimate is required for valuation. Different probabilities can be used to illustrate the impact of different risk levels or for sensitivity analysis (33).
- Types of cost included: Primarily cautioning comparisons of benefits between studies, it is important to establish first which stages of the supply chain and which other sectors or societal groups are included. For example, (17) includes control cost, direct primary sector cost, cost to supply sectors to primary sector, direct processing sector cost, cost to supply sectors to the processing sector (other than primary sector), trade cost, tourism and other economic costs, and changes in consumer surplus. Although all these costs are acknowledged in (33), "only" control cost, direct primary sector cost and trade costs are included, as these are the relevant costs from a private investment perspective.
- Single or cross-sector effects: Depending on the nature of the animal disease investigated and the study objective, benefits in terms of reduced costs can accrue to a single sector (33) or to more than one sector, such as beef cattle and pigs (17) or beef cattle, pigs, ovine and poultry (4).

The estimation of animal disease outbreak costs is demanding as it demands incorporation of economic processes and disease spread/containment processes in one analysis. The most advanced modelling techniques to date integrate epidemiological disease spread functions or models with economic equilibrium models that capture relationships and adjustments in international trade, as well as within and between individual sectors. During the past five years, the use of so called equilibrium displacement models has become standard practice in economic analyses of animal disease outbreak costs (4, 33, 34, and 35). These partial equilibrium models have at their basis a farm sector model to capture the relationship between key sectors and the primary and secondary, i.e. processing sectors. As an example, the study by Charlebois and Pérusse (19) that is being used as data source for this cost-benefit analysis, is based on the "Food and Agriculture Regional Model" (FARM) that has been developed by AAFC. In these models, the modelled sectors are subjected to an exogenous shock, such as the additional cost of a traceability system and/or an outbreak event to estimate price and quantity adjustments in domestic sectors and international trade. Different impact estimates, or estimated value endpoints of the impact, would result from changes in the same determinants of outbreak extent and duration as discussed above.

There are a number of alternatives to the recent modelling efforts that have been employed in earlier attempts to assess costs of animal disease outbreaks. Most notable in their difference to the theory-based models are stakeholder-based approaches, in which important determinants of market-related costs of an outbreak are estimated based on assessments by stakeholders that are elicited in individual and group interviews or workshops. The study by Serecon Management on a FMD outbreak that appears to be similar in the methods used as (43) is a case in point (17). Based on diseases-specific parameters, outbreak scenarios that differed in extent and duration of outbreak and trade embargo were developed. These were used to elicit disease control and welfare slaughter estimates and likely price and domestic demand changes in an iterative process of stakeholder consultations. Although fundamentally different in the approach to data generation and analysis from the above modelling approaches, the upper and lower bounds of impacts depend on the same key parameters, outbreak and embargo extent and duration.

The following sections on data sources will present in detail the underlying scenarios and results on which this cost-benefit analysis is to be based.

6.1.3 Supporting Data Sources

Traceability has been prioritized by the FPT Ministers of agriculture. In 2006, they announced the need for a National Agriculture and Food Traceability System (NAFTS). From this announcement, a Traceability Industry-Government Advisory Committee (IGAC) was created and serves as an advisory body to discuss issues, develop options and make recommendations to influence decision makers and facilitate the implementation of the livestock and poultry component of NAFTS. Under the aegis of IGAC, a number of reports were developed to support this cost-benefit analysis.

Cost data for this initiative were mainly taken from a funding proposal developed by the Canadian Pork Council (36, 37). These costs refer to developing, maintaining, updating and operating a database system for premises identification, animal identification and animal movement tracking. As detailed above under 5.2.3, this cost data was complemented with cost estimates for producers and processors to record and transmit animal identification and movement data to the central database, based on the USDA study on costs and benefits of NAIS in 2009 (4).

However, estimates of potential impact mitigation through traceability or similarly effective measures, such as zoning were not generated as part of this study. Therefore, data were taken from the Serecon Management Consulting Inc. report on the costs of a potential foot-and-mouth disease outbreak in 2002 (17) and from an analysis by Charlebois, P. and P. Pérusse on a classical swine fever outbreak in 2004 (19). Serecon (17) estimated the costs of an outbreak without an effective and internationally recognized zoning regime as the baseline scenario. Cost reductions from the baseline to the zoning case are to be interpreted as benefits from zoning.

Hence, in order to be able to utilize the data from (17) for this cost-benefit analysis, the assumption has to be made that the proposed traceability system is at least as effective in containing the disease and reducing the trade embargo as the zoning regime described in (17). The following two tables present the key assumptions and results respectively for the small outbreak scenario in (17). The smallest outbreak scenario in (17) was chosen for this analysis to provide the basis for a conservative estimate of benefits.

Exhibit 3: Small-scale outbreak assumptions as basis for cost-benefit analysis

	Baseline Scenario	Zoning Case
Duration (mo)	1.5	1.5
Infected Herds	50.0	50.0
Trade Embargo NAFTA (mo)	**4.5**	**1.0**
Trade Embargo Rest of World (mo)	4.5	4.5
Trade Recovery Rate (%)	36.0	36.0
Period until full Trade Recovery (yrs)	2.9	2.9
Tourism Impact (%)	5.0	5.0
Quarterly Change in Beef Price (%)	-25,-10,0,0	-10,-5,0,0
Quarterly Change in Pork Price (%)	**-25,-10,0,0**	**-10,-5,0,0**
Quarterly Change in Beef Consumption (%)	-20,-10,0,0	-10,-5,0,0
Quarterly Change in Pork Consumption (%)	**-20,-10,0,0**	**-10,-5,0,0**
Meat Import Change (%)	-10.0	-50.0

Source: Serecon management Consulting (17), page 11.

The major difference between the two scenarios is that zoning is assumed to reduce the trade embargo within NAFTA from 4.5 months to the minimum of one month. The corresponding relative cost reductions (in %) between baseline and zoning scenario results are reported in the next table. They will be applied to the results from Charlebois, P. and P. Pérusse (19) to estimate the benefits from traceability in the case of a CSF outbreak.

Exhibit 4: **Small-Scale Foot-and-Mouth Disease Outbreak Impacts (Costs in $ millions)**

	Baseline Scenario	Zoning Case	Reduction
Control Costs	30.7	30.7	0%
Direct Farm Impact	2,430.9	1,713.1	30%
Indirect Farm Impact	2,114.9	1,490.4	30%
Direct Processing Impact	3,116.3	2,357.6	24%
Indirect Processing Impact	1,246.5	943.1	24%
Other Indirect Impacts	1,059.5	801.6	24%
Tourism Impacts	450.8	450.8	0%
Total Impacts and Costs	10,449.7	7,787.3	25%
Consumer Gain	(659.3)	(659.3)	0%
Initial Net Impacts	9,790.3	7,128.0	27%
Trade Losses	3,915.3	1,207.1	69%
Net Economic Impact	**13,705.6**	**8,335.1**	**39%**
Infected Animal Disposal (# of animals)	10,224	10,224	0%
Welfare Disposal (# of animals)	4,182,119	2,946,959	30%
Beef Sector Adjustment Factor (%)	20.0	14.0	30%
Hog Sector Adjustment Factor (%)	18.0	13.0	28%

Source: Serecon management Consulting (17), page 11.

However, the economic impacts, i.e. costs of the outbreak in the above table and in (19) cannot be used directly as a basis for estimating the benefits from the proposed traceability system enhancement. The following features of (17) require specific data manipulation to adjust the data to the circumstances of this cost-benefit analysis:

a) The Serecon report only presents aggregate results for pig and bovine sectors in sum. This requires isolation of the pig sector impacts.

b) The trade losses accrue over a period of more than one year after the end of the trade embargo. There is no indication in the report that these costs have been discounted to the outbreak year. This needs to be done to avoid overestimating benefits.

c) The results are in 2001 dollar value. In addition, the production value and export share of that value of the pig sector has changed over time so that cost estimates need to be adjusted to reflect recent/current circumstances and structures.

d) The export structure (to NAFTA vs. to Rest of World) of the pig sector has changed considerably since 2001 so that the assumed benefits from traceability due to the shortened within NAFTA trade embargo will have to be adjusted.

The data manipulation procedures to address these issues will be fully described in section 6.2.3 data manipulation below.

6.1.4 Risk Assessment Results

A survey of Canadian swine producers summarizing farm-types at-risk of foreign animal disease (FAD) and the routine movement of animals, semen and workers among swine farms, as observed during a 42-day period was conducted in 2008 (29). From the producers who completed questionnaires, 17% represented swine-herds with no swine or semen movement on or off the farm during the 42 days, 57% were sow herds or farrow-to-finish herds with limited movement onto the farm but movement off the farm, and 26% were swine-herds with movements on and off the farm. A substantial number of premises (>50% in some provinces) with swine also kept other animal species on the same premises.

The authors applied the empirical movement data from the survey in a stochastic simulation model to estimate the number of herds infected and the basic regional distribution of infection that could be expected to occur if the FAD was not detected and routine movements were permitted to occur up to 42 days after infection with a FAD of a single randomly selected herd. Forty-five percent of the simulations did not involve spread beyond the index farm, whereas 34.8% involved spread among five or more farms after 42 days of routine movement.

Based on 2008 study, Christensen (30) found that seven weeks after the detection of the FAD, 22 farms instead of 50 farms would have been infected with the implementation of the proposed traceability system. This is based on the infected farm detection rate increasing from five per week to seven, and on the basis of one new infected farm every two weeks (moderately-fast spreading disease).

Further, due to the unpredictability, variability, and relative infrequency of animal disease outbreaks, the quantification of benefits and costs are only commensurable over a time period which is likely to feature an animal disease outbreak. Following the work of Disney *et al.* (2001) and from Canadian disease outbreak history, the present value of the proposed amendment will make the assumption for illustrative purposes that a single primary FMD or CSF outbreak will occur in Canada over a 50-year time frame. A further assumption is made that the outbreak is as likely to occur at any point within this period. This translates to a constant annual probability of outbreak of 2%.

This assumption is necessary, as there is currently no available risk assessment of the actual probability of an animal disease outbreak in Canada. The most recent outbreak of FMD in Canada was in 1952, while the latest CSF outbreak occurred in 1978 (18). While this represents 58 and 32 years respectively, the likelihood of outbreak is believed to exist at constant or increasing levels due to the current state of integration in the international livestock market. Additionally, outbreaks of both FMD and CSF have occurred or continue to exist in countries that are important trading partners for Canada[6].

[6] FMD outbreaks have been reported in Japan in 2000 and the U.K. in 2002. CSF still exists in Mexico and major outbreaks have been reported in Belgium in 1990,1993,1994, and 1997, in the Netherlands in 1997-1998, and in the U.K. in 2000 (18, 21)

As regards the extent of possible damage to society, which is primarily determined by extent and duration of an outbreak, it has to be noted that farm operations have increasingly implemented bio-security measures that would likely limit the extent of an outbreak compared to assumptions made in (17). This would lead to reduced control costs and direct farm impacts.

6.2 Methodology

6.2.1 Options Descriptions: Baseline Scenario and Policy Options 1 and 2

There are three options for the cost-benefit analysis. First, the baseline scenario reflects the current traceability practices and capacity in the Canadian pig sector. Second, an enhanced traceability capacity under the proposed Regulations is labelled Policy Option 1 and is based on identifying all breeding animals and animals sent to auctions, fairs or test stations with a RFID tag, while all other animals are reported by group or lot when they are moved. Third, a slightly more enhanced traceability capacity would be achieved under Policy Option 2 when all animals born in Canada or moved to Canada are identified with RFID tags. The following exhibit compares the current traceability capacity (baseline) with the enhanced capacity under the proposed Regulations.

While one can assume that, in case of a FAD outbreak, Policy Option 2 would contribute to a faster identification of the outbreak source(s) than would Policy Option 1, it is impossible to say at this stage of knowledge whether and to what extent that would translate into additional benefits. The critical question is whether the source is identified within 48 hours of the discovery of a FAD outbreak. Furthermore, the USDA report on NAIS (4: 110) states that the most critical factor in achieving the 48 hour trace-back is the availability of all data – premises ID, animal identification and animal movement – in electronic format. This would be achieved by both options, so that no further distinction in performance between the two options is presented. However, as has been discussed above, major cost differences exist between the two options.

Exhibit 5: Current traceability capacity and enhancement under proposed Regulations

Type of information	Baseline Scenario: Current Traceability Capacity	Policy Option 1 & 2: Traceability Capacity as Proposed in Regulatory Amendment
Domestic pig movement	Some movement information is voluntarily kept in records by custodians of the animals. ➢ **Incomplete** ➢ **Not rapidly accessible** ➢ **Not verified for accuracy**	All pig movements are being reported within 48 hours to a database accessible to veterinarians. ➢ **Complete** ➢ **Accessible 24/7** ➢ **Verified for accuracy**
Import, export	The consignment of pigs being imported and exported is captured but their destination and/or departure point is not always provided. ➢ **Incomplete** ➢ **Not rapidly accessible** ➢ **Not verified for accuracy**	All pig exports and imports are being reported within 48 hours to a database accessible to veterinarians. ➢ **Complete** ➢ **Accessible 24/7** ➢ **Verified for accuracy**
Location	Location information where pigs are kept, assembled or disposed of is collected voluntarily or through provincial regulatory requirements. ➢ **Fairly complete** ➢ **Verified for accuracy** Some of the information is kept in provincial databases ➢ **Not rapidly accessible**	Location information where pigs are kept, assembled or disposed of has been collected voluntarily, and will be made available to veterinarians. ➢ **Complete** ➢ **Verified for accuracy** ➢ **Accessible 24/7**
Pig identification	All pigs sent to abattoirs are identified through market driven requirements. Most pigs selected for breeding are identified on a voluntary basis. All pigs being imported or exported are identified from a regulatory requirement. ➢ **Incomplete** ➢ **Verified for market hogs** ➢ **Not rapidly accessible**	All pigs sent to abattoirs, fairs, test stations, all pigs selected for breeding, and all pigs being imported or exported are identified from a regulatory requirement. ➢ **More complete** ➢ **Not verified** ➢ **Accessible 24/7**

The enhanced traceability capacity under Policy Options 1 and 2 over the baseline scenario is assumed to reduce outbreak costs in the same way as an internationally recognized zoning regime would whose impact on outbreak costs was analyzed in the study by Serecon (17). As this cost-benefit analysis relies on the results presented in (17) to estimate the benefits of enhanced traceability, the changes in key determinants of outbreak costs assumed for the analysis in (17) need to be presented and discussed here:

a) Serecon (17) included three FMD outbreak size categories in their analysis of the impact of an internationally recognized zoning regime: small, medium, large. Enhanced traceability with its capacity to identify the source and contain the disease quicker would make a small FMD outbreak scenario the most likely so it was used as basis for the current cost-benefit analysis.

b) Based on expert interviews and advice, Serecon (17) estimated that a trade embargo would last 4.5 months in the baseline scenario, i.e. without effective zoning. With effective and internationally recognized zoning, the trade embargo was assumed to be only one month, i.e. reduced by 3.5 months;

c) As a consequence of the reduced trade embargo length, the following market effects were assumed:

- a reduced price impact in the sector; -10% and -5% in first and second quarter after outbreak instead of -25% and -10% under the baseline scenario;
- a reduced domestic demand impact in the sector; -10% and -5% in first and second quarter after outbreak instead of -25% and -10% under the baseline scenario.

The results from (17), after the appropriate and necessary adjustments laid out in section 6.2.3 Data manipulation were used to estimate the cost reductions due to enhanced traceability in case of a small scale FMD outbreak. For a medium sized CSF outbreak, the study by Charlebois and Pérusse (19) was used as a basis for assessing the outbreak costs. The authors used the Food and Agriculture Regional Model (FARM) model by AAFC with time intervals of one year so that their outbreak scenario was forced into a one year trade embargo. However, since that study did not estimate the reduction in outbreak costs due to enhanced traceability or effective zoning, a cost reduction due to traceability was assumed that is proportionate to the reduction obtained after adjusting the Serecon (17) results.

6.2.2 Model

For the purpose of this analysis, the costs and the potential cost reduction/mitigation through enhanced traceability of two distinct animal disease outbreak scenarios in Canada will be used for a cost-benefit analysis. The first is a small scale FMD outbreak scenario (17), while the second is a medium scale CSF outbreak (19). Assumed cost reductions through enhanced traceability are assumed to be proportionate to the ones identified in (17) for an effective and internationally (within NAFTA) recognized zoning regime, as described in section 6.1.3 Supporting Data Sources.

Without access to the original data and economic models used in the two studies above, no additional modelling effort for economic analysis has been undertaken for this cost-benefit analysis. Instead, benefits – i.e. reduced outbreak costs – of enhanced traceability as derived from these two studies are used for a net present value (NPV) analysis of the required investment under the proposed Regulations. Costs of the different options to implement the Regulatory amendment have been presented in detail in section 5.1 Costs of the Regulatory Proposal and will be entered into the NPV analysis and subsequent sensitivity analysis.

6.2.2.1 Model Parameters & Assumptions

While the benefits associated with enhanced traceability have already been determined in the studies (17) and (19), three parameters have to be chosen for the calculation of the net present value of the investment in enhanced traceability. These are:

a) the discount rate,

b) the outbreak probability, and

c) the costs associated with a specific policy option and animal identification technology.

None of these parameters are certain at this point in time. Hence, for all three, a base case scenario has to be defined as a starting point for the subsequent sensitivity analysis. These are 8% discount rate, 2% outbreak probability and Policy Option 1 with RFID technology. Each will be varied systematically to provide information on how the net benefit will be affected by changing parameters. Since NPV analysis will be conducted for both a small scale FMD outbreak and a medium scale CSF outbreak, the analysis also provides insights into the impact of different outbreak scales with subsequently different trade embargo lengths. Differences in costs between the two policy options with different animal identification technologies have been detailed in section 5.1 and need not be repeated here.

6.2.2.2 Functional Forms of Impacts

As pointed out above, original models and data used in (17) and (19) could not be accessed. Therefore, no further details can be provided about a functional form of impacts. But it needs to be pointed out that multi-sector and/or multi-region models such as FARM used by (19) consist of a whole system of equations that does not allow describing an impact on the sectors and regions included with a specific functional form. Rather, the impact is derived from a comparative static analysis. E.g., in case of (19) consumer and producer surplus with a CSF outbreak over the study period are compared to consumer and producer surplus without this external shock.

NPV analysis was conducted using benefit estimates derived from (17) and (19) and cost information presented in 5.1. A formulaic representation of the NPV of annual traceability costs subtracted from the product of the estimated cost savings and the likelihood of outbreak is provided below:

$$NPV = \sum_{t=0}^{T} \frac{\left(\left(p_t \left(outbreak_{base} - outbreak_{trace} \right) - C_t \right) \right.}{\left(1 + i \right)^t}$$

Where: p_t = probability of an outbreak (2%)
C_t = total annual costs
i = discount rate (8%)
t = investment period (year)
$outbreak_{baseline}$ = economic impact of an outbreak without zoning/traceability
$outbreak_{trace}$ = economic impact of an outbreak with zoning/traceability

6.2.3 Data Manipulations

The following data manipulations have been performed to adjust the data in (17) and (19) to match the circumstances and objectives of this study.

6.2.3.1 Isolating pig sector impacts

The results in (17) are presented as aggregate for the pig and bovine sector combined. As both sectors would require enhanced traceability to achieve the estimated outbreak cost reductions but this study investigates the pig sector only, the objective of this study requires separating the outbreak cost for the pig sector only. However, the sector adjustment factors which describe the scale back (in %, see Exhibit 6 below) required to absorb the shocks of lost export demand and reduced domestic demand can be used to estimate the share of the pig sector in total outbreak costs. This calculation is done for each scenario as follows:

(i) Multiply the 2001 gross production value of each sector with its adjustment factor to obtain the absolute scale-back amount in 2001 dollars.

(ii) Divide the pig sector's absolute scale-back by the sum of both sectors' absolute scale back to obtain the pig sector's share in the total scale back.

Exhibit 6: Estimation of isolated pig sector impacts

	Baseline Scenario		Policy Option 1	
	Cattle	Hog	Cattle	Hog
Gross production value (USD million)	3,414	2,488	3,414	2,488
Sector adjustment/scale back (%)	20	18	14	13
Sector adjustment/scale back ($million)	683	448	478	323
Sector share in total scale back	60%	40%	60%	40%

Source: Serecon (17), Statistic Canada (40, 41), FAO (39)

(iii) Multiply the estimate in each cost category with this share. However, (17) does not document how the estimate for each cost category was obtained so that the pig sector's share in the individual categories might be different from the overall share. In particular, pigs tend to be more prone to welfare slaughter because of living in confinement (21). But in the absence of any disaggregated information, the adjustment for each individual category cannot be determined.

Exhibit 7: Adjustment of Serecon (17) benefit estimates to pig sector ($ million)

	Baseline Scenario		Policy Option 1 or 2	
	Bovine & Pigs	Pigs only	Bovine & Pigs	Pigs only
Control Costs	30.7	12.3	30.7	12.3
Direct Farm Impact	2,430.9	972.4	1,713.1	685.2
Indirect Farm Impact	2,114.9	846.0	1,490.4	596.2
Direct Processing Impact	3,116.3	1,246.5	2,357.6	943.0
Indirect Processing Impact	1,246.5	498.6	943.1	377.2
Other Indirect Impacts	1,059.5	423.8	801.6	320.6
Tourism Impacts	450.8	180.3	450.8	180.3
Total Impacts and Costs	10,449.7	4,179.9	7,787.3	3,114.9
Consumer Gain	(659.3)	(263.7)	(659.3)	(263.7)
Initial Net Impacts	9,790.3	3,916.1	7,128.0	2,851.2
Trade Losses	3,915.3	1,566.1	1,207.1	482.8
Net Economic Impact	**13,705.6**	**5,482.2**	**8,335.1**	**3,334.0**

Source: Serecon *(17), own adjustments.*

6.2.3.2 Discounting trade losses to year of outbreak

The trade losses accrue over a period of 2.9 years (17) after the end of the trade embargo, until the export level before the outbreak is reached again. There is no indication in the report that these costs have been discounted to the outbreak year. However, it is stated in the report (17: p.8) that, " (the) first year's trade impact is already included as the major part of the processing sector's direct impact." Therefore, the trade impacts starting with the 8th month after the end of the trade embargo need to be discounted to the year of the outbreak. The same discount rate of 8% that is used for calculating the net present value is applied to the trade losses of the pig sector as calculated under a) above. The resulting discounted trade losses are 9.5% less than the original figure.

Exhibit 8: Pig Sector trade losses discounted ($ million)

Baseline Scenario		Policy Option 1 or 2	
Original	Discounted	Original	Discounted
1,566.1	1,417.8	482.8	437.1

6.2.3.3 Adjusting for sector growth

The pig sector saw steady growth in quantities and value between 2001 and 2004/2005 and then has seen a downturn first in production value and then in quantities produced. This was primarily due to the appreciating Canadian dollar against the U.S. dollar, the H1N1 virus impact on demand and a weakening economy after the start of the financial crisis in 2008. As the cost of an outbreak is a direct function of the size of the industry and exports, it is necessary to adjust cost estimates for these changes.

As the Serecon report is apparently based on the 2001 sector data, that year's statistics are used for comparison. As the production quantities and value of the Canadian pig sector has been changing fairly rapidly recently, the three year average of 2008 to 2010 has been chosen to represent the current situation of the sector. Further, according to AAFC most recent medium term outlook (32), the pig industry will only be 1.4% larger in 2020 than in 2004.

The following table compares the 2008/10 figures for farm production (number of market pigs), meat production, and export quantities and value with the 2001 base year. It further allows comparison of the 2008/10 figures with the above mentioned medium term outlook comparison with the year 2004:

Exhibit 9: Pig industry development 2001 to 2008/2010*

	2001	2004	2008/10	2001 to 2008/10	2004 to 2008/10
farm production (thousand market hogs)	26,042	31,380	28,761	+10%	-8%
meat production (metric tonnes)	1,862,592	2,074,798	2,094,199	+12%	1%
export (metric tonnes)	718,703	931,287	1,089,163	+52%	17%
export (CAD million)	2,213	2,654	2,702	+22%	2%

** Three year average of 2008, 2009 and 2010.*
Source: Statistic Canada (40)

The numbers show that the physical domestic production has increased about 10% since 2001. However, export has grown considerably faster, by more than 50% in quantity and more than 20% in value. Given the increased exposure to the risks of a foreign animal disease outbreak due to the higher export volume and share, it appears reasonable that the estimated economic impact be adjusted by 15% to account for sector growth and increasing exports. Finally, although farm production in 2008 to 2010 is eight per cent below the 2004 level and thus about 10% lower than the projected 2020 level (32), no further sector growth is assumed for three reasons. First, the difference between current and projected farm production is relatively small. Second, exports are above the projected growth. Third, recent volatility in the market makes it impossible to project a steady growth path.

The following table reports the 2008/10 numbers on which the benefit part of the net present value calculation will be based.

Exhibit 10: Adjusted data for Cost-Benefit Analysis for small scale FMD outbreak ($ million)

	Baseline Scenario		Policy Option 1 or 2	
	2001	2008/10*	2001	2008/10*
Control Costs	12.3	14.1	12.3	14.1
Direct Farm Impact	972.4	1,118.3	685.2	788.0
Indirect Farm Impact	846	972.9	596.2	685.6
Direct Processing Impact	1,246.5	1,433.5	943	1,084.5
Indirect Processing Impact	498.6	573.4	377.2	433.8
Other Indirect Impacts	423.8	487.4	320.6	368.7
Tourism Impacts	180.3	207.3	180.3	207.4
Consumer Gain	-263.7	-303.3	-263.7	-303.3
Trade Losses (discounted to outbreak year)	1,417.8	1,630.5	437.1	502.7
Net Economic Impact	**5,333.9**	**6,134.0**	**3,288.3**	**3,781.5**

** Numbers for 2008/10 are obtained by multiplying 2001 figures with 1.15.*

Furthermore, the export structure of the pig sector has changed considerably since 2001. The share of exports within NAFTA in total exports has shrunk from 69% in 2001 to an average 43% in the years 2008, 2009 and 2010. Under the assumption that only exports within NAFTA will enjoy a shortened trade embargo in acknowledgement of effective traceability, a larger share of exports, i.e. 57% that went to the rest of world in 2008/10 as compared to 31% in 2001, will be affected by a longer trade embargo. However, it is not possible to quantify the impact of this structural change in export destinations because the study did not provide the computational details of the model. Instead, when interpreting the results it is important to note that the benefits, i.e. saved costs of an outbreak are likely slightly overestimated.

However, it is also possible that countries importing from Canada other than USA and Mexico will acknowledge the enhanced traceability capacity, which would lead to a shortened trade embargo to all or a part of these exports, too. This in turn would lead to correspondingly increasing possible cost reductions of an outbreak and thus greater potential benefits from enhanced traceability. But due to the large uncertainty around such decisions (see above), no attempt is made to quantify these possible additional benefits. Instead, this is to be taken into consideration in the interpretation of results.

6.2.3.4 Adjustments and consistency check with Charlebois & Pérusse results

Since an outbreak of CSF would primarily affect the pig sector, the adjustment of the results by Charlebois and Pérusse (19) does not require isolation of the impacts on the pig sector. The authors, however, report results for 2004, the outbreak year, and for the recovery period 2005 to 2008. These costs have not been discounted to the year of the outbreak (32). Hence, a corresponding adjustment has been made and is documented in the appendix. Finally, an adjustment for sector growth has not been conducted, because the sector has basically not grown in farm production and meat production between 2004 and the average of period 2008 to 2010, while exports have grown 4% in nominal value and 17% in quantity.

Charlebois and Pérusse (19) have also estimated the costs of a FMD outbreak with the same methods that were used for the CSF case. Their method differs from that used by Serecon (17), as is for example documented in the different cost categories used. Further, Charlebois and Pérusse (19) excluded trade losses as an explicit cost category contributing to the overall impact, because trade losses were factored into farm and processor level impacts. However, this difference in methodology opens up an opportunity for checking the consistency of the overall impact between the two studies.

Isolating the pig sector impact from the overall FMD impact and discounting at 8% the impacts in the years 2005 – 2008 to 2004 yielded a total cost of the outbreak of $11.70 billion. This is more than twice as much as the cost estimate of $5.32 billion shown in the table above, as based on the Serecon study (17). However, this difference is not unreasonable for two reasons. First, between 2001 and 2004 the sector grew significantly: by about 10% in domestic slaughter weight, 20% in farm production of animals, 20% in pork export value, 30% in pork export quantities and 60% in live animal exports. Second, the Serecon study (17) assumed a baseline scenario with a trade embargo of 4.5 months with a subsequent recovery period of two years and 10.5 months. Although without possibility to quantify this, the one year trade embargo with a recovery period of four years, as assumed by Charlebois and Pérusse (19) would be expected to produce significantly larger impacts. After controlling for sector size, the remaining difference could thus be interpreted as the effect of a much more severe trade embargo and, subsequently, a longer recovery period. In sum, it is fair to say that both studies produced comparable estimates of costs associated with a FAD outbreak in Canada.

6.2.4 Treatment of Risk & Uncertainty

Due to the fact that the cost-benefit analysis is not based on primary research, sensitivity analysis of key parameters appears to be the appropriate method for risk analysis. Before describing the intended sensitivity analysis, we will turn to a short discussion of uncertainties in the analysis.

Investments in traceability are characterised by relatively low uncertainty about the cost of developing, implementing, and running a system and fairly large uncertainty about potential benefits. The cost of state of the art technology is known and replacement rates due to obsolescence or depreciations can be projected from previous experience. Therefore, there is little uncertainty around cost estimates, other than the more fundamental question which costs to include.

As stated above, benefits of a traceability system are measured in terms of costs saved in case of disease outbreaks or other production and trade disrupting incidents. The benefits depend primarily on extent and duration of an outbreak. While there is little uncertainty around the likely impacts from known and well researched diseases, new and emerging diseases do pose a challenge in quantification of risk due to the large uncertainty about control cost and response of trading partners.

This leads over to the area of greatest uncertainty, the prediction of extent and duration of trade embargos in response to an outbreak. Although OIE and World Trade Organisation have procedures and criteria in place for establishing and terminating embargos, trading partners are not bound by them. For political reasons, importing countries can maintain embargos well beyond what is plausible from the viewpoint of internationally accepted procedures and criteria. Examples are the barred U.S. beef exports to South Korea due to BSE or the extended export ban of Canadian live cattle to the U.S. due to BSE. In those two cases, enhanced traceability would not have reduced the trade embargo. Since the results in studies on the cost of outbreaks typically rest on the assumption of normally functioning trade procedures, the impact of this uncertainty is that the benefits from reduced animal disease outbreak costs can be considerably smaller than under the assumed normal circumstances.

The chart below details the plan for the intended sensitivity analysis in areas where uncertainty is limited and the changes in parameters can thus be interpreted in a meaningful way.

Exhibit 11: Parameters for Sensitivity Analysis

Parameter	Base case	Sensitivity, lower bound	Sensitivity, upper bound
Outbreak probability	2%	1%	4%
Discount rate	8%	12%	5%
Policy Option and technology choice	Policy Option 1 with RFID tags	Policy Option 2 with RFID tags	Policy Option 1 with RFID tags

Policy Option 2 with visual tags is considered as an additional scenario for the sensitivity analysis to reflect current practice in the EU – identifying all animals with visual tags, i.e.

7 Costs and Benefits Valuation

Due to the fact that only Policy Option 1 is compared to the current traceability capacity in the pig sector and that all relevant costs to the proposed Regulations have been monetized, the results for the base case will be presented in the following section. The impact of Policy Option 2, which is entirely due to cost differences, will be presented in the subsequent sensitivity analysis.

7.1 Costs and Benefits of Policy Option 1

As laid out in sections 5 and 6, the following figures describe costs and benefits and key parameters of the base case scenario for cost-benefit analysis. The differences in the net benefits between the two diseases are primarily due to the different assumptions about the length of the trade embargo and of the subsequent period to recover to export levels prior to the outbreak made in the original studies.

Exhibit 12: Parameters for Net Present Value Calculation of Policy Option 1 for FMD and CSF ($ million)

Item	FMD*	CSF**
Net benefit from enhanced traceability in case of outbreak = Net economic impact of disease outbreak in baseline scenario minus Net economic impact of disease outbreak under policy option 1	2,351.27	4,266.86
Data base development and implementation (at t_0);	1.140	1.140
Depreciation and maintenance of database system in subsequent years	0.288	0.288
Animal identification and movement reporting costs,, annualized	0.741	0.741
Administrative cost of running and auditing the traceability system	1.125	1.125
Outbreak probability (based on historic Canadian data)	2%	2%
Discount rate	8%	8%

** Based on reduction of 4.5 month global trade embargo to one month trade embargo for exports within NAFTA, both with 2.875 years recovery (to pre-outbreak export levels) after end of embargo.*

*** Based on one year trade embargo with 4 years recovery (to pre-outbreak export levels) after end of embargo, and cost reductions due to enhanced traceability that are proportionate to FMD case.*

Given these parameters, the NPV analysis over a 50 year period produced the following results.

Exhibit 13: Base Case Net Present Value of Policy Option 1 (RFID tags)

Item	FMD	CSF
Total benefit (present value)	$575.3 million	$1,044.0 million
Total cost (present value)	$45.1 million	$45.1 million
Net present value (NPV)	$530.2 million	$998.9 million
Annualized NPV	$43.3 million	$81.7 million

From these numbers, benefit-cost ratios of 17 and 31 emerge for FMD and CSF emerge respectively. It has to be noted that each net present value originates only from the benefits associated with the outbreak of one disease. The benefit could increase further:

- as the number of diseases increases that are considered a realistic threat of economic significance and if the probability that any of these diseases breaks out increases;
- as other incidents, e.g. food safety related, with a production and/or trade disrupting effect can also be limited in their impact on domestic or export markets;
- as benefits to other sectors from this sector's enhanced traceability, e.g. in case of diseases that affect more than one species, such as FMD, are included
- as a trade embargo was lifted sooner by more importing countries, affecting more of exports positively than the 70% assumed in (17) as the share of exports going to North America.

Improved international market access needs to be discussed as a further benefit. While traceability alone will not achieve this goal, it will become increasingly important to have certain levels of sector-wide traceability for improved international market access. However, this benefit is hard to forecast or estimate endogenously with an appropriate economic model. Two options have been presented in (4) to circumvent this uncertainty in cost-benefit analysis. First, one can introduce explicit assumptions about the loss of export value, if the current traceability capacity is maintained and no traceability system implemented. Second, one can estimate, by way of simulation what the increase in exports would need to be to offset the additional cost of the traceability system. For instance, for the 50% export loss scenario without NAIS the cost-benefit analysis published by USDA (4) predicted slightly reduced pork retail and wholesale as well as slaughter hog prices. The same study estimated that an increase of beef exports by 8% to 34% would be needed to offset the additional cost of NAIS, depending on the assumed adoption rate of the voluntary NAIS.

7.2 Risk & Sensitivity Analysis

As laid out in section 6.2.4, risk analysis focuses on a straightforward sensitivity analysis and includes outbreak probability and discount rate as most important parameters. In addition, the impact of Policy Option 2 with RFID and visual tags is included in the sensitivity analysis.

Compared to the base case, there is one parameter level for each outbreak probability and discount rate that will increase the net present value and one that will reduce it. For producer recording and data transfer cost, both parameter values will produce results that will reduce the NPV compared to the base case. Nonetheless, one will lead to a higher NPV than the other so that the six parameter values in total can be split in groups of three. Changing all the parameter values in one group simultaneously will thus produce either the lower boundary of estimates or the upper boundary, as is shown in the chart for FMD below.

Exhibit 14: Results of Sensitivity Analysis ($ million)

	Foot-and-Mouth Disease				Classical Swine Fever			
	PV of benefits	PV of costs	NPV	NPV annual.	PV of benefits	PV of costs	NPV	NPV annual.
Base case	575.3	**45.1**	**530.2**	**43.3**	1,044.0	**45.1**	**998.9**	**81.7**
Discount rate = 5%	858.5	**66.2**	**792.3**	**43.4**	1,557.9	**66.2**	**1,491.8**	**81.7**
p(outbreak) = 4%	1,150.6	**45.1**	**1,105.5**	**90.4**	2,087.9	**45.1**	**2,042.9**	**167.0**
Joint upper bound	1,717.0	**66.2**	**1,650.8**	**90.4**	3,115.8	**66.2**	**3,049.7**	**167.1**
Discount rate = 12%	390.5	**31.3**	**359.3**	**43.3**	708.7	**31.3**	**677.4**	**81.6**
p(outbreak) = 1%	287.6	**45.1**	**242.6**	**19.8**	522.0	**45.1**	**476.9**	**39.0**
Option 2/ RFID tags	575.3	**773.6**	**-198.3**	**-16.2**	1,044.0	**773.6**	**270.4**	**22.1**
Joint lower bound	195.3	**526.0**	**-330.7**	**-39.8**	354.3	**526.0**	**-171.6**	**-20.7**
Option 2/Visual tags	575.3	**360.7**	**214.6**	**17.5**	1,044.0	**360.7**	**683.3**	**55.9**

** PV stands for present value; NPV for net present value.*

The Net Present Value for FMD remains larger than $200 million (or $17 million per year) for all scenarios except Policy Option 2 with RFID tags and the joint lower bound scenario, as well as Policy Option 2 with visual tags. In the former two cases, the NPV even turns negative. For CSF, the Net Present Value is considerably larger and turns negative only in the joint lower bound scenario.

8 Distributional Analysis

The studies from which the cost of animal disease outbreak data and the estimated cost reduction though mitigation strategies were taken, allow to some extent to assess distributional impacts. For example, Charlebois and Pérusse (19) report that grocery retailers actually gain from an outbreak of CSF. In addition, the magnitude of impacts at different levels of the supply chain is also reported. However, it is not possible to assess how severe the impacts would be to the individual supply chain stages.

With regards to horizontal distribution of the benefits of an enhanced traceability system, the two studies do not report any disaggregate results for different size categories of farm operations or processors. But one can rely on the USDA study on NAIS (4) that the unit cost, e.g. per market hog, of conducting traceability activities such as data recording and transfer, is considerably larger for smaller operations than for large operations. That USDA study (4) reports that the cost per market hog for full traceability may be up to 25 times as high for the smallest size category as for the larger size category.

In addition, a traceability system that reduces the extent, duration and impact of a trade embargo should also favour larger operation s in a different way. The larger operations tend to be more specialized and thus more dependent on fewer income sources and are more highly leveraged when compared to the smaller, typically mixed farm operations. A trade embargo with the subsequent market impacts would thus put larger operations at a bigger risk of bankruptcy than smaller operations. The reduction in extent and duration of the trade-embargo should thus benefit the larger operations more than the smaller ones.

Finally, provinces would be affected differently by the regulatory amendment, depending on the level of export out of a province. Obviously, provinces with a high export share in sector output would benefit more from the amendment than provinces that have low export shares or are net importers of pork.

9 Ex-post Cost-Benefit Analysis for Evaluation and Review

For the implementation of a traceability system uncertainty associated with cost estimates for setting up and operating the system is considerably less than the uncertainty around benefit estimates. This holds in particular for this analysis where the quantified and monetized benefits depend on the occurrence of a low probability and high impact event such as a FAD outbreak. Hence, the costs associated with a functioning traceability system can be monitored in a fairly straightforward way as part of an annual review process. In particular, the following costs should be subjected to regular assessment:

- The cost of developing and implementing the enhanced database system were estimated to be at $1.14 million in 2011 dollar value. After that task is completed, an ex-post assessment should identify the actual expenditures for this task. Similarly, an annual review process can easily establish whether $285,000 is sufficient to cover depreciation and maintenance of the database system.
- Internal analysis has established that the animal movement information would be verified for accuracy through audits and inspections from existing resources valued at $125,000 per year. Once the traceability system would be running, it can be established on an annual to tri-annual base whether existing resources were sufficient. However, it first needs to be established what the resource demand for this task is to determine whether more resources have to be provided than had been predicted. Of course, increased resource demand during the first years of establishing an effective and efficient auditing system should be expected.
- For industry, monitoring of the annual administrative cost (estimated at $1 million per year) requires separation of the costs associated with animal identification and movement reporting from those for other activities in the same expenditure category, such as giving advice through the call centre or other communication.

After a traceability system has been implemented and an outbreak occurs, one can perform ex-post analysis of the cost of the outbreak. But no matter how precise such a cost estimate might be, the estimation of the system's benefit remains uncertain, because the impact of the disease outbreak in the presence of lower traceability capacity is now hypothetical and has to build on assumptions about trade embargo length and extent. Nonetheless, ex-post analysis of outbreak costs is required for benefit estimation based on reasonable assumptions. More importantly, it is essential for future improvements of the system and crisis response. However, in the absence of a disease outbreak or similar sanitary incident, the performance of a traceability system can be monitored in several ways:

- In order to function reliably in a disease outbreak event, minimum accuracy levels (or maximum error rates) as well as minimum compliance rates of producers and other stakeholders have to be achieved. Such targets can be based on technical analysis, i.e. simulation, and/or on experience in other sectors or jurisdictions. While audits to verify accuracy of movement data transferred to the central database would be conducted, compliance rates and adequate enforcement need to be addressed too.

- Similarly, performance with respect to the three criteria on which the proposed Regulations would improve the current traceability capacity – completeness; 24/7 accessibility; verification of movement data – should be subjected to regular audits.
- The effectiveness of the system in supporting recalls for food safety reasons can be monitored by including animal movement traceability in mock recall exercises, e.g. to identify the source of unauthorized substance application to animals.
- Mock disease outbreaks and containment exercises should be performed on a regular basis on intra- and interprovincial levels as well as international level, as has been done by Agri-Traçabilité Québec. The outcome of such exercises has to be assessed against the established performance standards for national livestock and poultry traceability (42):

Within 48 hours of the relevant CVO[i] or Competent Authority[ii] being notified[iii] of a sanitary issue or natural disaster or in the prevention or preparedness of such issue, it must be possible to…

1) Establish the location(s)[iv] where a specified animal[v] has been kept during its life[vi].

2) Establish the location(s) from where animals at a given site were received.

3) Establish a listing of all animals that have been kept on the same location as the specified animal at any stage during those animals' lives.

4) Determine the current location of all animals that have been kept on the same site as the specified animal at any time during those animals' lives.

5) Determine the identification number and movement history of all conveyances used to transport animals to and from a given location.

6) Establish the location of a specified animal immediately prior to importation into Canada or the location of a specified animal immediately subsequent to exportation from Canada.

7) Establish the location and date at which deceased animals were sent, transported, received and disposed of (both on- and off-site), and a listing of those animals if identified individually.

[i] *The 'relevant CVO' means the Federal, Provincial or Territory Chief Veterinary Officer in the jurisdiction where the specified animal is located or has been traced to.*

[ii] *For the purposes of these Targets, the 'Competent Authority' means the Federal, Provincial or Territory Designated Authority.*

[iii] *For the purposes of these Targets, 'notified' means the relevant CVO or Competent Authority is aware of an incident that required tracing.*

[iv] *For the purposes of these Targets, 'Location' means the legal description and/or geographical coordinates; contact; species/product kept, assembled or disposed of; and business type information of any definable parcel of land (premises), building or parts of a building located in Canada (except for Standard no. 6).*

[v] *For the purposes of these Targets, "animal" could refer to either an individual animal or a group of animals, depending upon the identification requirements for that species.*

[vi] *For the purposes of these Targets, the life of an animal in Canada refers to the events from its birth at a Canadian location or import into Canada, up until its death (on-farm or at slaughter) or export from Canada*

10 Conclusions & Recommendations

This cost-benefit analysis investigated the net benefits of enhanced traceability capacity under the proposed Regulations. It did not undertake primary research to estimate such benefits. It relied on two previous studies on outbreak costs (17, 19) and the likely cost savings (17) and adjusted the results to fit the current situation of the Canadian pig sector. This analysis considered two disease outbreak scenarios: a small scale outbreak of FMD and a medium scale outbreak of CSF. Benefits of enhanced traceability are defined as cost savings in an outbreak event.

Estimates required for particular cost elements were obtained from or based on various sources. First, estimates of the development and maintenance of a database system as well as of associated administrative costs were based on a contribution agreement between the Government of Canada and the Canadian Pork Council. Second, animal identification costs were based on primary research and an in-depth analysis published by the USDA in 2009 (4). Costs and benefits were used as input for a net present value analysis over a period of 50 years, with t_0 set in 2011.

Two policy options were considered as alternatives to the current state of traceability in the pig industry. For Option 1 it is assumed that only pigs selected for breeding and pigs sent to auctions, fairs and test stations are identified (as specified under the proposed Regulations). For Option 2, it is assumed that all pigs born in or moved to Canada need to be identified. For identification, two technologies are considered: visual tags and RFID tags. The key difference between the two options is that, while Option 2 requires animal movement data to include the identification of every individual animal, Option 1 requires this only for a subset of animals and allows movement data for the majority of animals to be identified by group or lot. As shown in the table below, the choice between these two options has the biggest impact on the costs of the traceability system, followed by the choice of identification technology. Database and administrative costs are relatively small in comparison and are not subject to change in this analysis.

Exhibit 15: Cost estimates for animal identification options and database system ($ million)

Cost category	Cost element	Present value* (PV)	Annualized
Animal identification and movement reporting	Policy Option 1 / RFID tags	26.66	2.18
	Policy Option 2 / visual tags	342.30	27.98
	Policy Option 2 / RFID tags	755.19	61.73
Database System	Development & Maintenance	4.63	0.38
	Administration	12.23	1.00
	Compliance verification	1.53	0.13

** Discount rate for calculation of present value is 8% over a period of 50 years*

Although the different animal identification options would likely affect the timeliness and accuracy of the information in the event of an outbreak differently, these differences cannot be quantified without further information on their performance in an outbreak situation and without knowing whether importing countries would treat the options differently in the process of recognizing the traceability system as facilitating trade embargo reductions.

Without any difference in potential benefits between the above combinations of policy options and animal identification technology options, the recommendation is straightforward: Choose the one with the lowest present value costs. This would be Policy Option 1 with visual tags. But one needs to take other factors also into account, such as additional time demand for reading the tags and higher rates of reading and recording error.

Furthermore, future technology advancement and subsequent adoption in industry will reduce the cost of RFID tags and increase the robustness of RFID reading systems and thus provide major long term advantages to this technology (4: page 14).

The cost increase when moving to Policy Option 2 is, however substantial, so that without further benefits from tagging all animals, it cannot be recommended. However, one potential benefit might be that importing countries might require identification of all animals individually in the future. In that case, which is currently mandated by EU law for EU pig producers, the use of visual tags would be the only feasible option. Due to the higher cost per tag, RFID tags under Policy Option 2 produced a negative net present value for FMD when combined with the base case scenario assumptions for discount rate (8%) and outbreak probability (2%) in sensitivity analysis. For CSF, the use of RFID tags under Policy Option 2 still leads to a positive net present value for 8% discount rate and 2% outbreak probability. However, when combined with a higher discount rate or a lower outbreak probability, net present value turned negative too. Opposite to that, Policy Option 2 with visual tags produced positive net present values: $215 million for FMD and $683 million for CSF. While the line of reasoning about the long term advantages of RFID tags presented above also applies here, whether this option was the most feasible, would depend on how many importing countries require individual identification of all animals.

However, two additional arguments lead us to conclude that Policy Option 1 (with RFID tags) be the preferred option. First, for RFID technology the cost difference between Policy Option 1 and Policy Option 2 is $729 million per year. Without the need to respond to major importing countries' requirement to identify all animals individually, there is no need to invest in what could be called excessive traceability capacity. Second, should the individual identification of all animals become a requirement for exporting to major importing countries, a switch to Policy Option 2 can still be considered without incurring major costs for adapting the system. There is a clear benefit of postponing the more expensive and comprehensive traceability solution to a future situation when it might become the option with the largest net benefit.

11 Appendix

11.1 Data Appendix

The costs (and the potential cost reduction/mitigation) of two distinct animal disease outbreak scenarios in Canada have been analysed. The first outbreak scenario estimates the economic cost of a small scale FMD outbreak, which has the potential to infect pigs, sheep and cattle. The second scenario evaluates the impact of a CSF outbreak, which is a pig specific virus. Both diseases are classified notifiable diseases by the OIE; representing a main responsibility and priority of the CFIA. Both FMD and CSF are highly contagious to their respective livestock hosts, but are not communicable to humans.

Scenario 1: Foot-and-Mouth Disease Outbreak

In 2002, the Canadian Animal Health Coalition, livestock industry stakeholders, and federal and provincial government departments and agencies commissioned an economic evaluation of the impact of an outbreak of FMD in Canada (17). Three outbreak scenarios where simulated in the report (small, medium, and large) and the economic costs were determined to be between $13.7 and $45.9 billion. These costs are reflective of the traceability capacity of the livestock sector at that time, which has not significantly changed since the time of the study. In addition to the evaluation of the baseline scenarios of an FMD outbreak, the report includes detailed estimates of cost reductions that are possible through a disease control response that includes livestock sector compartmentalization, or *zoning*. Zoning represents a very basic form of traceability, and although the cost savings available from a more comprehensive system are likely to be greater; the findings of the report remain an illustrative and quantifiable proxy for the benefits attributable to the proposed amendment. The zoning model used by the authors would allow half of Canada (in this case eastern Canada) to resume exporting within NAFTA again after one month, while exports to the rest of the world would have been banned for 4.5 months. It is expected that a comprehensive traceability system would provide the necessary tools to further reduce the quarantine/infection zone thus allowing a larger proportion of the industry to remain in export markets.

For the purpose of the cost benefit analysis, the most conservative outbreak impact simulation (small scale) will be used to evaluate the potential cost savings of a traceability system specific to pigs. The results from Serecon (17) on which this cost-benefit analysis is based, and the necessary data adjustment steps have been reported in full in the main body of the text.

Scenario 2: Classical Swine Fever Outbreak

An outbreak of CSF would have a similarly devastating impact on the livestock sector, and particularly the pig sector, in Canada. An analysis of the economic impact of an outbreak and the resulting one year trade embargo on the export of livestock and meat products has was conducted (19). The length of the embargo suggests a medium sized outbreak, likely impacting between 200-400 herds[7]. The analysis does not feature an assessment of the economic impact in the event that an animal identification and traceability system is in place or when zoning capacity exists. Therefore, the reduction estimates are derived from the findings of the Serecon FMD report described in Scenario 1.

A summary of the economic impacts of a CSF outbreak and the estimated cost mitigation from a pig-specific traceability system is provided in the following table. Excerpts from the cost-benefit analysis statements for the small-scale FMD outbreak and the medium-scale CSF outbreak scenarios are provided on the following pages.

[7] An outbreak of CSF in the Netherlands in 1997 impacted 429 farms and lasted for a period of 450 days. This is expected because the pig farm density and production model in the Netherlands are similar to some regions in Canada (21, 31).

CSF outbreak costs (Charlebois & Pérusse, 2004)	Charlebois & Pérusse / 2004 data			**Adjusted to this CBA (2008-2010 average)**		Explanations
Costs in current $million	Baseline	Traceability	Cost reduction in %	Baseline	Traceability	All cost estimates in Charlebois and Pérusse (2004) were first adjusted by discounting the figures for the 2005 to 2008 recovery period to the outbreak year (at a discount rate of 8%). Then each cost category was subjected to the procedure described below. No further adjustment to account for sector growth was undertaken, because the sector in 2004 was about the same size as the average of 2008 to 2010, and little growth projected for the future.
Control Costs	14.12	14.12	0.00%	14.12	14.12	Control costs are determined from the Serecon Report, other outbreaks of CSF have reported direct disease control costs between $7.6-68 million ($CDN) depending on the length and magnitude of the outbreak (Whiting, 2003).
Farm Expenditures	991.50	698.73	29.53%	879.75	619.97	This is the loss of factors of production with no alternative use, this includes the welfare slaughter of animals. The reduction % is based on farm level decrease observed in the FMD simulated outbreak with zoning (Serecon, 2002).
Net Farm Income	1,259.74	887.76	29.53%	1,250.27	881.08	While farm level cash receipts decrease due to the one year trade embargo and subsequent four year recovery period, so do farm level expenditures. The difference between the two numbers is the change in net farm income. The traceability reduction of this loss is assumed to be the same (in %) as the FMD farm level cost savings in Serecon (2002).
Loss to the Processing Sector	5,235.10	3,960.55	24.35%	4,845.86	3,666.08	The cost reduction is based on the expected reduction from both direct and indirect impacts, specific to the processing sector, obtained from the Serecon FMD simulation.
Food and Beverage Store Gains	-44.77	-40.29	10.00%	-65.39	-58.85	This is a conservative reduction estimate, based on the possibility that regardless of zoning, containment or product safety media efforts, the initial outbreak may impact consumer choices for the economically relevant period.
Indirect Spill over Costs	10,418.22	7,764.14	25.48%	9,674.68	7,210.01	The spill over costs are evaluated as 140% of the direct costs, the reduction % from traceability is based on the changes to the direct costs (all cost categories above).
Consumer Gains	-1,998.06	-1,998.06	0.00%	-1,938.16	-1,938.16	The increase in consumer surplus is substantially higher than the FMD outbreak (Serecon), this is likely due to the increased trade embargo period (1 year). Similarly, no reduction occurs during the disequilibrium phase of the outbreak.
Trade Loses	0.00	0.00	n/a	0.00	0.00	Trade losses are not treated as an explicit cost category. The reduced export demand impacts farm and processor level outbreak costs, as well as retail performance and spill over effects.
Total Net Impact	**15,875.85**	**11,286.94**	**28.90%**	**14,661.12**	**10,394.26**	

To obtain estimates of the costs related to reporting animal movement data individually under both Policy Option 1 and 2, as well as tagging all animals for individual identification, the following calculations were done based on results and assumptions presented in the USDA study on NAIS (4) or on updated figures where available.

	Tagging costs		Reading costs
	RFID tag	Visual tag	RFID Reader
Interest Rate	8.00%	8.00%	8.00%
Tag applicator cost	$66.94	$27.73	
Reader/software cost			$900.00
Useful life years	4	4	3
Depreciation	$16.74	$6.93	$300.00
Interest	$2.68	$1.11	$36.00
Annual cost	$19.41	$8.04	$336.00
Hogs to be tagged	28,780,132	28,780,132	28,780,132
Hog farms			7000
animals/applicator	3750	3750	
labour cost/h	$14	$14	
minutes/animal	1	1	
Total labour cost	$6,715,364	$6,715,364	
Total applicator cost	$148,986	$61,718	
Total cost	$6,864,350	$6,777,082	$2,352,000
Labour cost per pig	$0.2333	$0.2333	
Applicator Cost per pig	$0.00518	$0.0021	
Total cost per pig	$0.2385	$0.2355	$0.0817

To obtain estimates of the costs related to reporting animal movement data by group or lot identification under Policy Option 1, the following calculations were done based on results and assumptions presented in the USDA study on NAIS (4: pages 80ff., Tables 5.2 and 5.6 in particular).

	Pigs sold	Data reporting costs Total	Data reporting costs per pig sold	Movements per pig	Labour cost Share in data costs	Labour cost $ per pig sold
System A (54%)						
Farrow-to-wean	64,755,701	$905,444	$0.0140	1	30%	$0.0043
Wean-to-feeder	60,141,077	$382,420	$0.0064	1	43%	$0.0027
Feeder-to-finish	56,276,832	$568,192	$0.0101	1	7%	$0.0008
Total			**$0.0304**	**3**		**$0.0078**
System B (27%)						
Farrow-to-feeder	30,246,388	$519,906	$0.0172	1	20%	$0.0035
Feeder-to-finish	28,302,967	$285,757	$0.0101	1	7%	$0.0008
Total			**$0.0273**	**2**		**$0.0042**
System C (19%)						
Farrow-to-finish	19,771,901	$1,871,146	$0.0946	1	15%	$0.0139
Total			**$0.0946**	**1**		**$0.0139**
Average per pig sold*:			**$0.0417**	**2.35**		**$0.0080**

** Average per pig sold was obtained by multiplying the respective system total with its share in finished pigs output and adding these terms up across systems. E.g., for movement per pig the calculation is 0.54*3 + 0.27*2 + 0.19*1 = 2.35.*

The USDA report differentiates three different production" systems", one spanning all three production stages (System A), one including two stages (System B) and an integrated one (System C).
Their respective shares in finished pigs output are 54%, 27% and 19%. The data reporting costs per pig sold capture hardware and software cost, cost to connect with the database system or a call centre and the clerical labour cost for reporting animal movement by the source operation. However, the assumption in (4) was that the receiving operation would not have to report the same movement data. This would require additional clerical labour cost, as hardware, software and connection costs have already been accounted for as fixed costs. Therefore, the additional clerical labour cost of $0.008 was added to the total cost of one source reporting of $0.0417 and rounded to yield $0.05 per pig sold. The share of clerical labour cost in total data reporting costs was calculated from the original data in (4: tables 5.2 and 5.6). It varied widely between production stages and between systems, as is documented in the second column from the right. These differences and the differences in total data reporting cost are primarily due to differences in lot sizes and in current computer and internet use.

11.2 References

1) Gardner Pinfold Consulting Economists Limited. 2007. Costs of Traceability in Canada: developing a measurement model, prepared for Agriculture and Agri-Food Canada.

2) Moschini, G. 2007. The Economics of Traceability: An Overview, JRC workshop, Ispra, Italy.

3) Hammitt, J. K. 2009. Benefit-Cost-Risk Analysis: Principles and Application to Traceability in the Agri-Food Chain, Harvard Center for risk analysis. Presentation made at *Co-Extra: Co-existence and traceability*, International conference. June 2-5, 2009. Paris. www.coextra.eu

4) NAIS Benefit-Cost Research Team. 2009. Direct Cost Estimates: Porcine *In:* Benefit-Cost Analysis of the National Animal Identification System; pp: 74-100. http://www.aphis.usda.gov/traceability/downloads/Benefit_Cost_Analysis.pdf

5) Velthuis, A.G.J., M.C.M. Mourits, and H. Hogeveen. 2008. Costs, benefits and reliability of livestock tracing systems in the Netherlands, Business Economics, Wageningen University, Wageningen. In: XIIth EAAE Congress: People, Food and Environments: Global Trends and European Strategies, Ghent, Belgium, 26 - 29 August, 2008

6) Looney, J.C. 2009. Comparative costs analysis of alternative animal tracing strategies towards food and mouth disease outbreaks in the Texas high plains, Thesis submitted to the Office of Graduate Studies of Texas A&M University in partial fulfillment of the requirements for the degree of Master of Science.

7) Golan, E., B. Krissoff, F. Kuchler, L. Calvin, K. Nelson, and G. Price. 2004. Traceability in the U.S. Food Supply: Economic Theory and Industry Studies, United States Department of Agriculture, Economic Research Service, Agricultural economic report number 830.

8) Souza-Monteiro, D.M. and J.A. Caswell. 2004. The Economics of Implementing Traceability in Beef Supply Chains: Trends in Major Producing and Trading Countries; University of Massachusetts Amherst, Department of Resource Economics, Working Paper no 2004-04.

9) Bailer, D. 2004. Benefits and Costs Associated with an Animal Identification System for Cattle in the United States, Utah State University, Department of Economics, Animal Identification, WEMC FS#2-04.

10) McGrann, J. and H. Wiseman. 2001. Animal traceability across national frontiers in the European Union. Rev. Sci. Tech. Off. Int. Epiz. 20(2): 406-412.

11) Harper, D. 2007. A Review of Cost/Benefit Analysis on Traceability Systems. Agriculture and Agri-Food Canada. Unpublished report.

12) McEvoy, D., M. Souza-Monteiro, and M. Diogo. 2008. Can an Industry Voluntary Agreement on Food Traceability Minimize the Cost of Food Safety Incidents?, Paper prepared for the Organized Session in the “Economics of Traceability” at the XII^th^

Congress of the European Association of Agricultural Economics Association, Gent, Belgium.

13) Madec, F., R. Geers, P. Vesseur, N. Kjeldsen, and T. Blaha, T. 2001. Traceability in the pig production chain. Rev. Sci. Tech. Off. Int. Epiz. 20(2): 523-537.

14) Meisinger, J.L., D.L. Pendel, D.L. Morris, K.E. Belk, and G.C. Smith. 2008. Review: Swine Traceability systems in Selected Countries Outside of North America, The Professional Animal Scientist 24: 295-301.

15) Meisinger, J.L., D.L. Pendel, D.L. Morris, J.A. Scanga, K.E. Belk, and G.C. Smith. 2008. Review: Animal Identification Systems in North America, The Professional Animal Scientist 24: 277-286.

16) Hobbs, J. E., M.T. Yeung, and W.A. Kerr. 2007. Identification and Analysis of the Current and Potential Benefits of a National Livestock Traceability System in Canada, prepared for Agriculture and Agri-Food Canada.

17) Serecon Management Consulting Inc. 2002. Economic Impacts of a Potential Outbreak of food and Mouth Disease in Canada, prepared for Canadian Animal Health Coalition.

18) Ackerman, G.A and J. Giroux. 2006. A History of Biological Disasters of Animal Origin in North America. Revue Scientifique et Technique de l'Office International des Epizooties, 25: 83-92.

19) Charlebois, P. and P. Pérusse. 2004. Economic analysis of a one year trade embargo on Canadian exports of livestock and red meats following a classical swine fever outbreak and foot-and-mouth disease. Research & Analysis Directorate, Agriculture and Agri-Food Canada. Unpublished report.

20) Disney, W.T., J.W. Green, K.W. Forsythe, J.F. Wiemers, and S. Weber. 2001. Benefit-Cost Analysis of Animal Identification for Disease Prevention and Control. Revue Scientifique et Technique de l'Office International des Epizooties 20:385-405.

21) Whiting, T. 2003. Foreign animal disease outbreaks, the animal welfare implications for Canada: Risks apparent from international experience. Can Vet J. 2003 October; 44(10): 805–815.

22) Statistics Canada. 2011. Hog statistics. First quarter 2011. Catalogue no. 23-010-X. 60 p.

23) Canada Pork International. 2011. Information collected on website. www.canadapork.com/en/industry-information/canadian-pork-exports.

24) Canadian Pork Council. 2008. Strategic Transition Plan: The Canadian Hog Industry's Plan for Success. 16 p.

25) United States Department of Agriculture. 2008. Economic Research Service using data from USDA. Foreign Agricultural Service, Production, Supply and Distribution database.

26) Statistics Canada. 2008. Alternative livestock on Canadian farms. Catalogue no. 23-502-X. 19 p.

27) Agriculture and Agri-Food Canada. 2010. Federally Inspected Hog Slaughter Plants 2010. AAFC Red Meat Market Information. Website: www.agr.gc.ca/redmeat-vianderouge/rpt/10tbl30_eng.htm

28) Agriculture and Agri-Food Canada. 2006. Economic Backgrounder: Macro-economic situation and outlook. Next Generation of Agriculture and Agri-Food Policy. 8 p.

29) Christensen, J., B. McNab, H. Stryhn, I. Dohoo, D. Hurnik, and J. Kellar. 2008. Description of empirical movement data from Canadian swine herds with an application to a disease spread simulation model. Preventive Veterinary Medicine 83: 170–185.

30) Christensen, J. 2011. Accrued benefit of a pig traceability system. Unpublished data.

31) Elbers, A.R.W., H. Moser, H.M. Ekker, P.A.A. Crauwels, J.A. Stegeman, J.A. Smak and F.H. Pluimers. 2001. Tracing Systems Used During the Epidemic of Classical Swine Fever in the Netherlands, 1997-1998. Revue Scientifique et Technique de l'Office International des Epizooties: 20: 614-629.

32) Gendron, C. 2011. Agriculture and Agri-Food Canada, Economic market Analysis. Personal communication.

33) Elbakidze, L. 2007. Economic Benefits of Animal in the Cattle Production Sector. Journal of Agricultural and Resource Economics 32(1): 169-180.

34) Jones, J., J. Carlberg and D. Pendell 2011. Effects of a Traceability System on the Economic Impacts of a Foot-and-Mouth Disease Outbreak. Selected Paper, Southern Agricultural Economics Association Annual Meetings, Corpus Christi, Texas, February, 2011.

35) Pendell, D.L., G.W. Grester, T.C. Schroeder, K.C. Dhuyvetter, and G.T. Tonsor. 2010. Animal Identification and Tracing in the United States. American Journal of Agricultural Economics 92:927-940.

36) Canadian Pork Council. 2010. Contribution Agreement for the Canadian Traceability Infrastructure Component of the Canadian Integrated Food Safety Initiative - PigTrace Implementation – Phase I, with subsequent amendment. TRAC-006-CPC.

37) Canadian Pork Council. 2011. Contribution Agreement for the Canadian Traceability Infrastructure Component of the Canadian Integrated Food Safety Initiative - PigTrace Implementation – Phase II. TRAC-015-CPC.

38) Council Directive 2008/71/EC. Available online via EUR-Lex (last accessed 9/18/2011): http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32008L0071:en:NOT

39) FAO 2001. FAOSTAT-Agriculture. Value of Agricultural Production. Available online: http://faostat.fao.org/site/613/default.aspx#ancor (Last accessed September 23, 2011).

40) Statistics Canada 2011a. Hog Statistics – Second quarter 2011, August 2011. Catalogue no. 23-010-X, vol. 10, no. 3.

41) Statistics Canada 2011b. Cattle Statistics – August 2011. Catalogue no. 23-012-X, vol. 10, no. 2.

42) Government of Canada 2011. National Livestock and Poultry Traceability Performance Targets. Released April 19, 2011.

43) Risk Solutions 2005. Cost Benefit Analysis of Foot and Mouth Disease Controls – A Report to DEFRA. Available online: http://www.docstoc.com/docs/47975278/Cost-Benefit-Analysis-of-Foot-and-Mouth-Disease-Controls. Last accessed Sept. 23, 2011.

44) USDA 2011. USDA Agricultural Projections to 2020. Office of the Chief Economist, World Agricultural Outlook Board, U.S. Department of Agriculture. Prepared by the Interagency Agricultural Projections Committee. Long-term Projections Report OCE-2011-1, 100 pp.

45) Agriculture and Agri-FoodCanada, Growing Forward Framework Agreement, http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1217941012105&lang=eng

46) Canadian Pork Council. 2011. PigTrace Canada, program brand name for the Canadian Pork Council's (CPC) Canadian Swine Traceability SystemWebsite, Tag Order information, available online: http://pigtrace.ca/order.php. Last visited November 14, 2011.