



# Foreign animal disease outbreaks, the animal welfare implications for Canada: Risks apparent from international experience

Terry L. Whiting

**Abstract** — Any outbreak of an Office International des Épizooties List A disease, such as classical swine fever or foot and mouth disease, has severe consequences for animal welfare, livestock production, exports of animals and animal products, and the environment. The public concern with the animal welfare effects of methods of disease eradication that result in the destruction of large numbers of uninfected animals has initiated a reconsideration of disease eradication policy in Europe. In many recent List A disease epizootics, the financial cost of addressing animal welfare concerns in healthy animals has greatly exceeded the cost of stamping out disease in infected herds. In the event of a similar incursion in Canada, the number of animals subject to welfare slaughter will be far greater than the number of infected animals killed. Current national disease eradication plans in Canada do not address the animal welfare component of disease control methods.

**Résumé** — **Flambée de maladies exotiques et répercussions sur le bien-être des animaux au Canada : risques connus.** L'apparition d'une maladie figurant dans la liste A de l'Office International des Épizooties, comme la fièvre porcine ou la fièvre aphteuse, a des conséquences graves sur la santé animale, l'élevage, l'exportation des animaux et des produits animaux, ainsi que sur l'environnement. L'opinion publique à propos des répercussions, sur le bien-être des animaux, des méthodes d'éradication de la maladie qui impliquent l'élimination d'un grand nombre d'animaux non infectés a incité les autorités européennes à réexaminer ces méthodes. Dans le cas de la majorité des maladies épizootiques récentes figurant dans la liste A, le coût financier de l'élimination sélective des animaux infectés dépasse de loin celui de l'élimination radicale des troupeaux. Si une telle maladie devait se manifester au Canada, le nombre d'animaux abattus afin d'éradiquer cette maladie serait beaucoup plus élevé que le nombre d'animaux infectés. À l'heure actuelle, les méthodes d'éradication des maladies au Canada ne prennent pas en compte le bien-être des animaux.

(Traduit par Docteure Andrée Lesage)

*Can Vet J 2003;44:805-815*

## Introduction

A foreign animal disease (FAD) is a disease caused by a transmissible infectious agent, currently exotic to Canada, with the potential for rapid spread, the introduction of which would seriously affect access of Canadian animals and animal products to foreign markets. The primary focus of the current response policy if a disease, such as foot and mouth disease (FMD) or classical swine fever (CSF), were identified in the region is eradication by stamping out. The primary tools of stamping out a disease include early detection of disease

when introduced, rapid killing of all known infected animals, tracing of all high risk contacts, application of herd quarantine, testing of populations at risk, and, in some instances, the application of preemptive slaughter or strategic vaccination. Crucial to the success of stamping out is the early placing of high risk premises and geographic production areas under animal movement restriction (1,2). The European Community (EU) has developed comprehensive legislation and funding arrangements to support all operational activities that are required to stamp out FMD or CSF when it is introduced into a member state or states (3,4). Government sources estimate the potential financial loss of an FMD incursion into Canada would be \$30 billion (5). Independent sources estimate that the potential financial loss associated with an FMD incursion into Canada would be between \$8.3 and \$45.9 billion, depending on the scale of the epizootic (6).

Recently, in western industrialized countries where stamping out has been applied, there has been heightened public debate over the extreme costs required to achieve eradication and the ethical issues inherent in the process

Manitoba Agriculture and Food, Veterinary Services Branch, 545 University Crescent, Winnipeg, Manitoba R3T 5S6.

Address all correspondence and reprint requests to Dr. Terry Whiting; e-mail: [twhiting@gov.mb.ca](mailto:twhiting@gov.mb.ca)

Financial support for this project was provided by the Canadian Animal Health Coalition, the Alberta Farm Animal Care Association, Manitoba Agriculture and Food, and Manitoba Pork Council.

This paper was peer reviewed.

(7). The 2001 FMD epizootic in the United Kingdom (2001-FMD-UK) gave rise to 3 major forums for public discussion of the FAD response, in particular, and agricultural practices related to producing human food of animal origin, in general (8–10). Societal concerns related to control of highly infectious animal disease by stamping out fall roughly into 5 major categories: 1) the waste of food resources in a time of global hunger; 2) the environmental concerns related to carcass disposal; 3) the societal aversion to the mass killing of healthy animals as part of a disease control action; 4) the challenge associated with assuring the humane killing of animals under field conditions; and 5) animal suffering on farms due to conditions that develop secondary to animal movement restrictions (7).

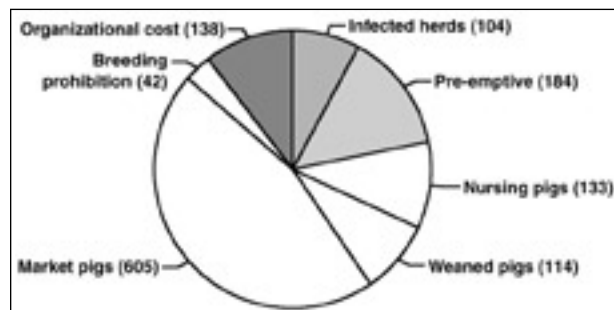
There is general agreement in Britain that the direct effect of morbidity and mortality on large numbers of infected animals is the primary threat to animal welfare posed by FAD (9). With respect to FMD, the Royal Society for the Prevention of Cruelty to Animals (RSPCA) (UK) believes that given the severity of the disease to the individual animal and the highly infectious nature of the agent, slaughter is the best outcome for infected animals. This application of slaughter includes the herd in which infected animals are identified (11). The slaughter of a reasonable number of high-risk animals that appear healthy, as part of an efficient eradication program, is also acceptable to the British public at large (9).

In considering lessons in FAD eradication provided by the experiences of other countries, the introduction of an FAD into Canada would result in 3 separate emergencies: 1) a small scale emergency related to the control of animals on infected and high risk farms for which The Canadian Food Inspection Agency (CFIA) has the legislative mandate and fiscal resources to address; 2) a far larger generalized on-farm financial emergency related to the closure of the US border leading to export disruption, manifest as an acute fall in livestock value; and 3) an emergency related to welfare problems developing consequential to animal movement restrictions put in place by the stamping out response and the US border closure. The most critical animal welfare problem would be an immediate inability to provide housing for thousands of isowean and nursery pigs. The 2nd and 3rd type of emergency could also result from an FAD incursion into the USA while Canada remained disease free. Emergency planning for an FAD-related event needs to take into account all 3 types of emergency.

This paper is limited to discussion of the welfare risks to animals consequential to either FAD stamping out operations in Canada or a serious trade interruption with the USA; that is, primarily, the ability to deliver welfare slaughter programs and assuring a humane death for animals killed on the farm. Relevant examples of lessons provided by other regions that have experienced FAD epizootics are included.

### Disease eradication: Describing incursions

The financial consequences of FAD epizootics are often classified as either direct or indirect costs. Costs are direct if the emergency responders must pay out the cost



**Figure 1.** Direct costs associated with disease eradication, totaling 1.32 billion US\$ attributed to specific activities in the 1997 classical swine fever outbreak in the Netherlands (12). Consequential indirect losses to farmers and other related industries were an additional 1.02 billion US\$ (19). The number in brackets is amount in million US\$. Shaded areas are operational activities for which there is a current method of funding and legislative authority to deliver in Canada. Unshaded areas are costs of animal welfare with the exception of breeding prohibition.

immediately to achieve disease control, such as compensation for animals ordered destroyed and the costs of carcass disposal. Indirect costs are losses incurred by individuals and sectors of the industry consequential to the disease occurrence, such as down time on empty farms and loss of export market for meat products. Payment of indirect costs is not essential to the outcome of the disease eradication operation. Therefore, a major part of emergency planning is in anticipating the type and magnitude of direct costs and in identifying the funding agencies tasked with the various components of the emergency response.

Welfare slaughter is a term used in disease 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; for example, when animals are in excess of market demands, when proper management can no longer be assured, or both (3,4,6). Meat from the carcasses of animals under movement restriction cannot be salvaged for human food under EC regulations; therefore, it is usually sent to rendering or otherwise destroyed (3,4). One lesson to be learned from the experience of recent disease eradication efforts is that the number of welfare slaughter animals rises rapidly during the course of an expanding epizootic (12). Welfare slaughter is a direct cost of FAD eradication and often far exceeds the cost of dealing with infected farms (6,12–17).

One of the most comprehensively documented cases of an FAD eradication program to date is that of the CSF incursion into the Netherlands in 1997 to 1998 (1997-CSF-NL). The outbreak involved 429 infected farms, lasted for 450 d, and cost about 2.3 billion US dollars to eradicate (12). At the time, with an annual production of live pigs of about 24 million, the Netherlands exported over 70% of its pork and live hog production to other EU countries (18). During the outbreak, about 700 000 pigs were killed on infected farms and 1 125 000 pigs were killed on contact or neighboring farms, while 2 450 000 slaughter pigs, 4 920 000 weaned

piglets, 2 760 000 nursing pigs, and 437 000 breeding pigs were purchased by the government and destroyed for welfare reasons (18). The cost of welfare slaughter in this incursion was 36% of the total cost (852 million US\$), whereas the cost of stamping out infected herds was 4% (104 million US\$) (12,19) (Figure 1). For future incursions of CSF into the concentrated swine producing areas of the Netherlands, the cost of animal welfare slaughter is expected to be a significant component of the response by the end of the 1st month of the outbreak and will be, on average, 3 times the cost of responding to infected farms (20).

The report of the UK Lessons to be Learned Inquiry (8) suggests that the need for an efficient delivery of welfare slaughter is likely in any major UK disease incursion and recommends that government should consider the welfare implications of disease control policies as part of contingency planning and identify strategies that will minimize the need for slaughter and disposal on welfare grounds. Assuring the welfare of animals is recognized as part of the current contingency plan for FMD eradication in the UK (21).

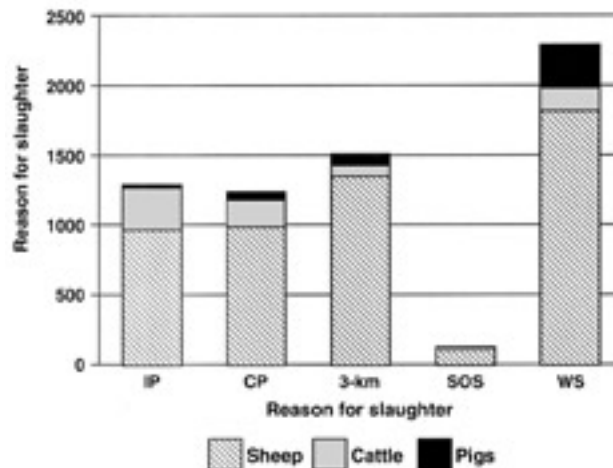
In Canada, the CFIA is the lead agency charged with responding to a domestic FAD incursion (22). The CFIA has clear legislative authority to order the destruction of and to pay compensation for infected animals or animals in contact with an infected animal (23).

### Humane issues: Animal killing in disease eradication

The killing of animals as part of FAD eradication has been identified as a logistic challenge and an area of intense public scrutiny in the EU (24); infected animals are killed immediately on the farm of origin, whenever possible, as immediate slaughter prevents virus amplification and killing animals where infection is found avoids the risk of geographic spread of disease by movement of infected animals to slaughter facilities. Susceptible animals are also killed, if 1) they are at high risk of incubating infection, because of dangerous contact with or proximity to an infected herd and 2) they are under welfare slaughter programs (Figure 2). Depending on the magnitude and duration of the movement restrictions, some animals may die due to deteriorating conditions on farms under movement restriction (11).

Animal movement restrictions may be applied to specific individual, geographically located, production units that are part of an integrated system of animal reproduction, growth, and marketing, thereby severely disrupting the production systems affected. Analysis of previous FAD incursions indicate that welfare implications are magnified under certain conditions; primarily, if the preincursion animal production industry is focused on export, if the incursion is prolonged, if the effects are in a wide geographic area, or if the incursion involves intensified livestock production (13).

A recent Australian review identified that the economic impact of FAD on a country is very dependent on the proportion of the animal industry that is directed at export production and on the time sensitivity of the animal product (25). These findings were also supported by



**Figure 2.** Animals slaughtered by species for various reasons as part of the disease control program in the 2001 foot and mouth disease epidemic in the UK. Reasons for slaughter are animals resided on an infected premise (IP), a dangerous contact on contiguous premises (CP), dangerous contact on a noncontiguous premises including the 3-km cull (3-km), slaughtered on suspicion (SOS), and welfare slaughter (WS). The total number of animals slaughtered for welfare reasons included 1 768 000 sheep, cattle, and pigs under the Livestock Welfare (Disposal) Scheme (LW(D)S), and 525 000 lambs under the Livestock Welfare Disposal Scheme-Light Lambs. The figures exclude (1) slaughtered newborn lambs where, for compensation purposes, their value was included with that of the ewe, (2) around 4000 animals of other species, primarily goats and deer killed for disease control purposes, and (3) around 3000 other animals killed under the LW(D)S (16).

economic modeling of the impact of an FMD incursion in Canada (6), which indicated that an FAD incursion into Canada, even under the best possible scenario, would result in a US border closure to live animals and animal products for a minimum 4.5 mo (6).

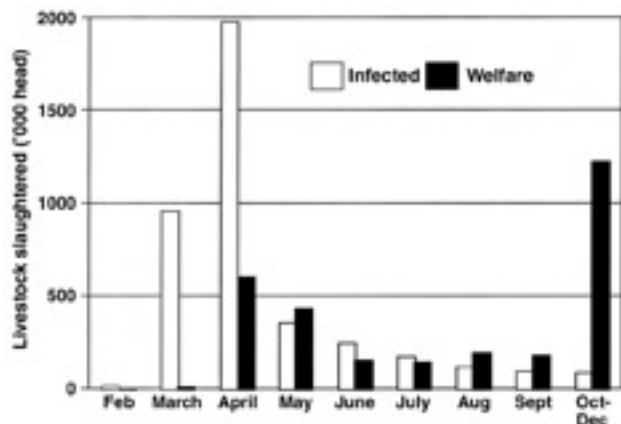
Canada, as compared with other industrialized countries, is heavily dependent on export of both live cattle and swine, as well as beef and pork. For the year 2001, the Canadian ratio of meat produced compared with meat consumed domestically is 1.29 for beef and 1.59 for pork (6). Similar ratios for the USA are 0.97 for beef and 1.03 for pork, and for Australia 3.18 for beef and 1.05 for pork. As an example, in 2001, 2 151 548 slaughter pigs and 3 168 665 weanling pigs were exported from Canada to the USA (Table 1) (26).

In export-focused market economies, welfare slaughter may also have a function of market support by allowing producers an option to deal with animals that are surplus to market requirements, are depreciating in value, and, in fact, may have no market value. In the 2001-UK-FMD epizootic, a special welfare slaughter program was initiated to deal with slaughter lambs and operated from 3 September 2001 until 26 October 2001 (Livestock Welfare Disposal Scheme-Light Lambs [LWDS-LL]). Slaughter lambs that could not be marketed because of a ban on exports and other movement controls and which could otherwise have faced severe welfare problems were purchased by the Rural Payments Agency at a flat rate of £10 a head and destroyed (17,27,28) (Figure 3).

**Table 1. Live swine, nonbreeding, and less than 50 kg, exported to the USA from Canada in 2001 (26)**

Destination	Origin and numbers of pigs <sup>a</sup>			Value in Canadian \$
	Manitoba	Ontario	Canada	Total Canada
Iowa	747 811	666 174	1 445 113	68 180 193.00
Minnesota	551 484	318 779	888 473	47 274 612.00
Nebraska	300 410	58 267	369 440	17 080 163.00
Other states	120 627	236 151	465 639	27 586 667.00
Total USA	1 720 329	1 279 371	3 168 665	160 121 635.00

<sup>a</sup>In addition to feeder pigs, 2 151 545 slaughter pigs and cull swine valued at \$368 877 109.00, were exported from Canada to the USA in year 2001 (26)



**Figure 3.** Temporal distribution of animal slaughter for disease control and animal welfare reasons in the 2001 foot and mouth disease epidemic in the UK. Time period is on the x-axis. There was a large increase in animal welfare slaughter in the final stages of the disease eradication due to the Livestock Welfare Disposal Scheme-Light Lambs, which was initiated to deal with slaughter lambs that could not be marketed because of a ban on exports and other movement controls, and that could otherwise have faced severe welfare problems to overwinter (27).

### Welfare assurance: Scope and capacity

The proportional cost of measures taken to avoid animal suffering has been accounted for by financial analysis of previous FAD incursions. However, accurate documentation of the financial impacts of FAD incursions is difficult to establish even in retrospect (13). In recent incursions of FAD into countries that are members of the Office International des Epizooties (OIE) with stamping out as their national policy, the scale of welfare slaughter was such that its cost was one half to 10 times that of eradicating the disease on infected farms (Table 2) (13–17).

The 2000 CSF incursion into Britain (2000-CSF-UK) also demonstrated the importance and scope of on farm animal welfare concerns inherent in FAD eradication by stamping out. Britain had been free of CSF since 1986. The initial herd was found to be infected on August 8th (29) and the Pig Welfare (Disposal) Scheme (PW(D)S) was introduced 21 d later (30). Although this was a small disease incursion with only 16 confirmed infected herds, approximately 600 other premises were placed under movement restriction (30). In total, 75 000 pigs were

slaughtered as potentially infected under the Animal Health Act with a value of £4.4 million, whereas to meet welfare obligations a total of 181 223 pigs from 286 holdings in 1440 separate consignments were slaughtered at a cost of over £13 million (16,30).

Even in the case of a very moderate FAD incursion, welfare slaughter operations will exceed the cost for disease control. In Europe, for incursions of CSF, if 8 or more herds are infected on the day of identifying the 1st case, the costs of welfare slaughter will exceed the cost of stamping out (13).

In considering Canadian current trading patterns in live animals and animal products, it is estimated that in a small FMD outbreak with 50 infected herds, 4 200 000 animals would be killed under welfare slaughter programs, while only 10 000 infected animals would be killed, an animal welfare versus disease control impact ratio of about 400:1 (6). In this scenario, 12 983 farms would be directly affected with an initial net impact of \$9.8 billion and a further trade impact of \$3.9 billion (6). The financial expenditure to control disease would be less than 1% of the overall cost/loss of the incursion (6). If zoning could be introduced, it is estimated that 2 900 000 animals would have to be destroyed for welfare reasons, a 31% reduction, and that the negative economic effect of \$13.7 billion could be reduced to \$8.3 billion (6). Zoning is a provision to renew trade in animals and animal products for the geographic area of a country that is demonstrated to be free of the disease of concern (31).

It is reasonable to assume that Canadians, like Europeans, would demand a high level of animal welfare assurance during an FAD eradication effort. The provision of objective inspection services to assure animal welfare has been integral to the operation of eradication activities in other countries. In the FMD incursion in the Netherlands in 2001 (2001-FMD-NL), welfare problems were evaluated by private veterinary practitioners using standard forms to quantify the degree of welfare concern. This system was supported by an audit of 10% of the cases by a government veterinarian (32).

Veterinarians were in critical short supply early on the 2001-FMD-UK eradication effort (9,17). To deliver veterinary services in response to this incursion, 1800 additional British temporary veterinary inspectors and 700 veterinarians from other countries were utilized (33). In addition to the disease investigation and surveillance, there were over 250 000 veterinary inspections

**Table 2. Relative impact of disease control and welfare assurance programs in recent eradication programs for Office International des Épizooties List-A diseases**

Outbreak	Disease	Number of farms	Duration	Costs for welfare slaughter <sup>a</sup>	Costs for disease control <sup>b</sup>	Units	Reference
1990 Belgium	CSF	113	10 mo	128	53	Million Euro	13
1993 Belgium	CSF	7	4 mo	9.5	12.3	Million Euro	13
1994 Belgium	CSF	45	8 mo	28.6	16.8	Million Euro	13
1997 Belgium	CSF	8	2 mo	4.1	5.9	Million Euro	13
1997–98 Netherlands	CSF	429	450 d	9.2	0.7	Million animals killed	14
2000 Japan	FMD	4	195 d	899	332	Million yen	15
2000 United Kingdom	CSF	16	144 d	181	75	Thousand animals killed	16
2002 United Kingdom	FMD	2026	337 d	2	4	Million animals killed	17

CSF — Classical swine fever  
FMD — Foot and mouth disease

<sup>a</sup>Costs are reported in monetary value or in animals killed depending on the method of reporting in the original reference

<sup>b</sup>Includes the value of destroyed animals and the cost of destruction and burial where the units used were monetary

prior to movement for welfare reasons and more than 18 000 veterinary inspections prior to on farm welfare slaughter or prior to transportation to a central slaughter facility (33).

In any response to a serious FAD incursion into a previously disease-free region, there will be a shortage of veterinary personnel. In the 2001-FMD-UK incursion there was severe competition for veterinary support between disease control activities and animal welfare assurance programs (8).

### **Welfare assurance: Euthanasia**

The welfare risk for animals subjected to on-farm killing is a risk separate from the animal suffering that occurs subsequent to deteriorating conditions on farms placed under movement restriction. In the 2001-FMD-UK incursion, a target was set to kill all animals in infected herds within 24 h of identification and all animals in high-risk contact herds within 48 h of identification (9). The operational demand of killing large numbers of animals in a short period of time put individual animal welfare at risk due to lack of skilled personnel, inability to muster and restrain animals, piecemeal compensation of slaughter workers, and the pressure of time demands (9). In addition, in the case of commercial poultry, there is no scientifically validated method of mass humane slaughter (24).

The UK maintains a national licensing program for slaughtermen to assure competency in delivering humane killing in abattoirs, knacker's yards, and on-farm (34). Licensed slaughtermen were recruited and available to deliver on-farm killing services in the 2001-FMD-UK incursion. No similar licensing or competency assurance system is in place in Canada. The Farm Animal Welfare Council (FAWC) (UK) identified severe operational deficiencies in the delivery of mass euthanasia of farm animals under field conditions on premises having widely different facilities (35).

In criticism of the 2001-FMD-UK response, the RSPCA and the FAWC both recommended that to assure the humane treatment of animals, a veterinarian must be present on every farm where animals are being slaughtered, whether for welfare or disease control purposes (11,35).

### **Welfare assurance: Carcass disposal**

Carcass disposal methods can become a contentious focus of public debate, as was the case with open pyre burning in the 2001-FMD-UK incursion (8,9). Method of carcass disposal is not normally considered as a risk to animal welfare. However, severe competition for resources between disease eradication and disposal activities effectively stalled the Livestock Welfare (Disposal) Scheme (LW(D)S) in the 2001-FMD-UK incursion (8).

It is probable that under an actual FAD incursion into Canada there will be severe competition for carcass disposal resources between disease control programs and welfare slaughter programs, as has been the case in incursions elsewhere (8,12). Carcass disposal of animals has been the focus of a recent CFIA national planning meeting (36). At this meeting, only the challenge of disposing of infected material was considered.

In the early stages of an FAD incursion, slaughter facilities could not be expected to continue to slaughter and process livestock, if there was no immediate prospect for sale. The slaughter process adds value to the carcass, which may never be realized under the trade restrictions and market failures subsequent to an FAD outbreak. It would be an error in FAD contingency planning to count on the use of normal slaughter channels to deal with overcrowding of animals on farms.

### **Current responsibilities for emergency management in Canada**

In general, emergency management in Canada is based on the "bottom-up" principle, in that initial responsibility for emergency response normally rests with those directly affected. If, however, private resources alone cannot effectively manage the response, government action may be required. Depending on the severity of an emergency, the established sequence of responsibility is local (municipal), then provincial, and then federal, with federal involvement only upon provincial request or when the emergency falls under a federal mandate (37). The most comprehensive legislation in Canada to deal with emergencies is the Emergencies Act (38). The Emergencies Act specifies 4 types of national emergencies: public welfare, public order, international, and war. National emergencies are situations so severe as to

necessitate measures that exceed both provincial competencies and the normal authorities of the federal government. A disease in animals may be declared a national public welfare emergency under this act if the presence of disease is significantly serious to result in a danger to life or property, social disruption, or a breakdown in the flow of essential goods, services, or resources (38).

The Food and Agriculture Emergency Response System (FAERS) was developed largely in response to the January 1998, Ontario-Québec ice storm; it is an attempt to describe a foundation for response to an agricultural emergency coherent with the Emergency Preparedness Act, the Emergencies Act, the National Support Plan, and the Federal Policy for Emergencies (37). Provincial departments of agriculture and other agri-food sector stakeholders, Agriculture and Agri-Food Canada (AAFC), and the CFIA have jointly established the FAERS to facilitate federal-provincial-industry collaboration. For the purpose of FAERS, "an emergency is defined as an abnormal situation requiring prompt action beyond normal procedures in order to prevent injury or damage to people, plants, livestock, property, or the environment" (36). The FAERS is an all-hazards emergency management system, designed to link the federal, provincial, and private sectors to better manage and coordinate response to emergencies.

Mandated emergencies are a specific type of emergency described in the FAERS manual. An FAD is a "mandated" emergency with the CFIA as the lead agency. However, the CFIA component of FAD eradication, as described by disease eradication plans (1,2), does not follow the FAERS management principles of a comprehensive bottom-up emergency preparedness and response system, as management is centralized and there is no consideration given to the consequential impacts of disease presence on the agricultural trade of a region.

In Canada, animal welfare concerns related to an FAD response currently represent a nonmandated emergency, as the CFIA does not have the legislative responsibility in areas other than infected herd eradication or preemptive slaughter. Under FAERS, in nonmandated agricultural emergencies, AAFC and the CFIA will jointly determine which of the 2 organizations will take the lead and which will provide a support function. In general, AAFC is expected to take the lead when the emergency support primarily relates to providing financial compensation to farmers (37). Therefore, if a Canadian emergency response to an FAD were to develop, as currently prescribed, only part of the management would be directed centrally from Ottawa, namely that part dealing with the infected and high-risk herds. The consequential effects of the incursion would, in theory, be managed according to the FAERS principles; that is, the local authority, municipality, or province has first responder obligations.

On February 5, 2001, Prime Minister Jean Chrétien announced the creation of the Office of Critical Infrastructure Protection and Emergency Preparedness (OCIPEP) (39). Generic emergency response models that are in place for fire, flood, tornado, and earthquake are organized at the subprovincial level through provincial Emergency Measures Organizations (EMO) and nationally through the OCIPEP. The Minister of National

Defense is responsible for the OCIPEP, which also encompasses the previous functions of Emergency Preparedness Canada. The function of the OCIPEP in any FAD response in Canada has not been tested.

One program now administered by the OCIPEP is the Disaster Financial Assistance (DFA) Program. Disaster Financial Assistance is intended to be available for eligible costs when a natural disaster, such as a flood or an earthquake, creates an unreasonable financial burden. Assistance is generally provided to help local governments, individuals, full-time farmers, small businesses, and some nonprofit organizations. Government funds under DFA are approved on an event by event basis. In principle, assistance is not available for loss of income and opportunity or inconveniences (40). Foreign animal disease is currently not one of the emergencies listed as eligible for DFA programs, although, as an emergency, the economic impact of FAD on the rural community is very similar to, but more extensive than, other natural disasters covered by this program. Disaster Financial Assistance is similar in organization to existing agricultural safety net programs in that, it is a financial program to offset individual or small business losses after the fact. Post-disaster compensation programs, such as DFA, are not designed to fund the active operational responses necessary to assure animal welfare in the process of an FAD eradication.

At present, it is unclear how government support of operational demands and assistance to farmers at the time of an FAD outbreak would be valued and delivered in Canada. The lesson provided by Taiwan in failing to eradicate the 1997 FMD incursion is that overall FAD contingency planning should include the worst case scenario, which is, at least, temporary transition to a nonexport market situation and its social and financial implications. Under a real emergency, it may be impossible to eradicate an FAD from a region immediately.

Canada does have previous experience in dealing with regionally based economic disasters through the implementation of the northern cod fishing moratorium in July 1992. The Atlantic Groundfish Strategy (TAGS) was established in May 1994 to provide income support, labor market adjustment, and training options for those affected by the closures of various fisheries; it has cost 1.9 billion dollars, with the major part coming from Human Resources Development Canada (41).

### **Paying for direct costs: Disease control and animal welfare**

All forms of emergency compensation to farmers must be funded and set at a rate that encourages voluntary participation, if the goals of disease eradication are to be reached. In setting rates of compensation, a balance must be struck that will result in buy-in from the farming community while a scheme of last resort is maintained. Clearly, for a disease eradication program to be successful, it must not be more profitable for a farmer to have an infected herd rather than a disease-free herd, yet the consequence of having an infected herd must not be so onerous that the farmer will not report the disease. Similarly, in developing compensation for welfare slaughter, the compensation program must not be so

financially attractive as to encourage animal neglect in order to qualify or so punitive as to result in animal abandonment.

During the 2001-FMD-UK outbreak, the LW(D)S was introduced to alleviate the suffering of animals that were not directly affected by FMD but could not be moved to alternative accommodation or pasture, or sent to market because of movement restrictions (17). The scheme was modeled after the PW(D)S developed in the 2000-CSF-UK incursion (17). The 1st FMD-infected herd was identified on February 19th, 2001; the LW(D)S opened on March 22nd and closed on December 31, 2001. In setting up the scheme, the government expected that farmers would pursue all other means of retaining or marketing their animals and turn to the scheme only as a last resort. In the final accounting, farmers received £205 million for the slaughter of 2 million noninfected animals (17).

During the operation of the LW(D)S, in addition to regular veterinary inspection for disease control purposes, 80 inspectors from the RSPCA visited 1750 premises that had applied to the scheme. Turnaround time for processing an application was about 6 wk, because of the high participation rate. Welfare conditions on 850 of the farms inspected were considered to be so bad that, in normal circumstances, the RSPCA would have prosecuted the farmer under the Protection of Animals Act 1911 for causing unnecessary suffering (11).

In the delivery of insurance programs, “moral hazard” is defined as a situation where, after purchasing insurance, potential beneficiaries of an insurance program change their behavior to increase the probability of a successful claim (20,42,43). The risk of moral hazard is inherent in any FAD-related compensation program, and this was demonstrated in the LW(D)S. In the application of the program, an inflated compensation schedule led to overapplication and competition between real animal welfare concerns and farmers reacting to financial incentives. The rates were extremely attractive to farmers and the volume of applications overwhelmed the Rural Payments Agency, which administered the scheme. The program was offering £85 for a pregnant ewe, while the market price was £45 to £50 (11). Demand for the scheme dropped off as movement restrictions were eased and the financial incentives were reduced (17). On at least some farms, farmers made no attempt to alleviate the poor welfare conditions of their animals, apparently in the hope of being accepted as a priority in the LW(D)S (11). Additional resentment was generated in the farming community where, in true situations of poor animal welfare due to movement restrictions, farmers who had animals that died of starvation or other welfare-related causes during the 6-week wait time for processing a LW(D)S slaughter application were not compensated (11). In addition, those farmers who managed animals under movement restriction but did not become infected or were not slaughtered out for welfare reasons were not eligible for compensation.

Historically, Canada’s national disease eradication programs, as represented by the bovine brucellosis, bovine tuberculosis, and chronic wasting disease eradication initiatives, have been funded 100% federally from general revenue. As none of these diseases is particularly infective or spread rapidly, animal movement restrictions

affect only the infected herd, and if depopulation is promptly executed, welfare problems are minimal. Canada has no national method for funding animal welfare assurance requirements of an FAD response situation. Animal welfare has traditionally been largely a provincial regulatory responsibility, supported by non-profit organizations, such as animal cruelty prevention societies for companion animals and animal welfare councils for domestic farmed animals (44–46). In addition, federal involvement in animal welfare assurance includes cruelty to animals prohibitions under the Criminal Code (47) and humane transportation regulations made under the federal *Health of Animals Act* (48).

In relation to disease control, “compensation” in Canada refers to the empowerment of the CFIA to pay monies from general revenue to farmers for animals ordered killed or treated because they are infected or thought to be infected with a reportable disease under the administration of the *Health of Animals Act* (49). This Act also provides for reimbursement for some consequential costs of disease control, such as carcass disposal and transport of animals to slaughter (23,49).

In Canada, national animal disease control programs and national security are 2 of the few government programs funded 100% from federal general revenue. The Canadian taxpayer may not be willing to pay for future animal health programs, as was the case in the past. The cost sharing templates articulated in the recently negotiated Federal-Provincial-Territorial Agriculture Policy Framework agreement suggests that future funding of agricultural programs will be cost shared between industry, and national and subnational governments (50).

The handling of the 2000-CSF-UK incursion and the 1997-CSF-NL incursion benefited from well designed, largely moral hazard free, welfare slaughter and infected herd disposal compensation programs. In both cases, the sheer magnitude of the liabilities incurred by the incursion resulted in subsequent retooling of animal welfare funding for FAD control. During the 2000-CSF-UK incursion, the PW(D)S was jointly funded with direct government funding of about 70% of the animal’s “value,” with industry topping up the payments via a £4 million government loan to be repaid by producer levy (8). Subsequent to the 2000-CSF-UK incursion, concern over the ability to deal with the expenses related to the welfare of pigs during an FAD eradication has resulted in the development of the Pig Industry Development Scheme for the Management of Disease Risk for Great Britain (51). The new producer-funded scheme is intended to assure the delivery of the animal welfare component of disease control programs where the consequential cost of eradication greatly exceeds the commitment of the government. A similar industry government cost sharing agreement has been implemented in the Netherlands subsequent to the 1997-CSF-NL incursion (20).

### **Special welfare risk in modern swine production**

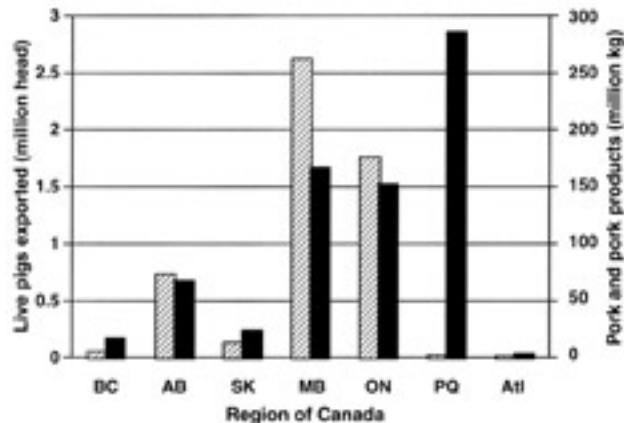
Animal movement restrictions have an impact on the management of all farmed species. However, the time

until significant welfare problems develop differs depending on the class of animal. Canadian commercial laying hens raised in cages, for instance, will never become overcrowded or suffer due to inclement weather if the farm is placed under quarantine, as they are non-reproductive, housed in environmentally controlled buildings, and are not growing and requiring additional space. However, if layer chicken flocks were placed under movement restriction and forced to age beyond their productive life, producers would become reluctant to continue to incur feed and labor costs to maintain their unproductive flocks. A similar situation would arise in the market hog, broiler chicken, and feedlot beef sectors where, as animals grow in body weight, they would incur demerits based on standard slaughter market demands. Regardless of the cause of loss of value, animals of low or no value are at increased risk for poor welfare (52).

Ruminant production systems tend to be less time sensitive to animal movement restriction than do those of growing poultry and swine. Farmed ruminants are generally housed under much less intensive situations and multiply at a far slower rate, so that their living space requirements do not change rapidly. In general, as the method of livestock production becomes more intensive, the welfare risk related to movement restriction increases; at particular risk are intensively housed swine populations.

Swine on farms placed under movement restriction will quickly grow to exceed space available in pens, resulting in significant animal suffering (12). In the Netherlands, when the transport ban was in force, almost all farms became overpopulated with pigs within 1 or 2 wk (18). Canadian estimates for maximum time to critical overcrowding on pig farms subject to movement restriction range between 3 and 45 d, depending on the stage and the type of production system; isowean piglet production units are the most sensitive to movement interruption (53).

Multisite production systems in which isowean management is used as a nonsurgical method of deriving high health pigs from infected sows have developed and become widely implemented in the past 5 y (54). Isowean effectively prevents the transmission of conventional disease agents between pigs of different ages and may decrease the need for antibiotic use in pork production (55). Inherent in isowean programs is weaning at 17 to 21 d, all-in all-out (AIAO) management strategies, geographic separation of stages of production, disinfection of premises between production batches, strict biosecurity measures, and only housing pigs of the same age together. Many multisite production systems are large. For resources to be used efficiently, piglets within about 5 to 7 d of age must be grouped together in batches of 1000 to 2000 and managed as AIAO. In Manitoba in 2001, 30.7% of farms housing sows were isowean production units (56), with the practice becoming increasingly common in newly built or expanding operations. Isowean-based multisite production, as practised in North America, does not occur in Europe, where regulations exist to prevent weaning prior to 30 d of age. From this perspective, therefore, North American swine populations are more sensitive to interruption in free pig movement than have been those in European FAD eradication efforts.



**Figure 4.** Canadian regional volumes of export in pork and live pigs in the year 2001 (26). Region is indicated on the x-axis. The black bar is pork export in million kg (right axis) hatched bar is live pigs exported in million animals (left axis). Québec (PQ) has a mature pork production chain with predominantly finished products only being exported, whereas Manitoba (MB) and Ontario (ON) are large exporters of pork products and live pigs. British Columbia (BC) and the Atlantic Region provinces (Atl) have relatively small export volumes. The financial impact of an export moratorium secondary to a foreign animal disease incursion in Canada or the USA would not be shared equally by all regions. Manitoba, for instance, is the major Canadian regional exporter of pigs and pork products and contains only 3.7% of the Canadian human population, while Ontario contains 38%, based on the 2001 Census.

The impact of a US border closure to live animals from Canada would have an immediate effect on both isowean (17 d, 5 kgBW) and nursery (25 kgBW) pig welfare, as pigs originating in Canada could not be moved into the purpose built housing in the USA. Of all the Canadian provinces, Québec has a mature pork production industry where the majority of production is exported in the form of pork and pork products and export of live animals is primarily breeding stock (26) (Figure 4).

The short-term effect of international border closure to meat and animal products would have an immediate impact at the farm level with a severe depression of slaughter weight pig prices. In 1997, Taiwan was a major exporter of pork. In the week following identification of FMD on the main island, the price of 100-kg weight slaughter pigs fell from 200 US\$ to 60 US\$ in a system where cost of production was estimated to be 140 US\$ (57).

In a recent Canadian study, larger specialized and intensive farms, especially swine farms, tend to be heavily leveraged and are at increased risk of business failure in the response phase of an FAD incursion (6). Severe welfare conditions impacting on a large number of animals could arise rapidly with the economic failure of large integrated livestock farming business, where insolvency could trigger the loss of essential resources, such as public utilities, hired labor, or feed supply.

## Conclusions

Lessons provided by the experiences of other countries in eradicating an FAD indicate that the introduction of an FAD into Canada would result in 3 separate types of



emergency; namely, those related to infected farms, fiscal impacts of export market disruption, and animal welfare. The CFIA has responsibility for dealing with infected farms. The federal agricultural minister through AAFC and provincial partnering has traditionally delivered income support to farmers in times of unforeseen financial disaster and would be the apparent lead agency on rural economic stabilization. Currently, however, there exists no significant infrastructure to respond to animal welfare concerns. The national emergency response funding and organizational structure (OCIPEP) has had no previous experience with this sort of disaster. There is currently neither legislative framework nor preauthorized funding to meet direct costs that government and industry would incur to assure an effective animal welfare component of response to an FAD.

Animal welfare assurance is integral as a direct cost to the FAD eradication operation. Failure to assure animal welfare may result in failure to eradicate the FAD. Currently, national FAD contingency plans exist for dealing only with infected farms. It is a gross error to misconstrue these plans as effective comprehensive emergency management strategies.

The CFIA has a commitment to eradicate an FAD identified in Canada (22); however, there could be a very substantial emergency in Canada without an FAD ever having been identified here. A US border closure does not constitute a mandated emergency under the current FAERS agreement; therefore, there is currently no mandated federal response (37). An FAD limited to a single state in the USA, such as Iowa, would have significant repercussions in live animal markets for isowean piglets in Canada and the USA. Isowean piglets require immediate housing, and a significant volume of that specialized housing would be unavailable under a scenario where state-imposed animal movement restrictions disrupted historic trade. A lack of housing for this type of animal would result in significant negative repercussions on farm animal welfare in Canada.

Many provinces are generating Foreign Animal Disease Eradication Support Plans (FADES). These plans are essentially designed to assist the CFIA in the stamping out of infected herds. There is no provision within the FADES initiative to discuss animal welfare slaughter or other consequential effects of dealing with infected herds that will be concurrent demands on provincial and industry resources (35).

This failure to recognize the impact of an FAD on animal welfare may not be limited to Canada. In a recent review of FAD emergency preparedness in North America, animal welfare was not mentioned in any of the plans of the USA, Canada, or Mexico (22). A 2001 report commissioned by the National State Departments of Agriculture Research Foundation found that the US national disease control system is, in general, adequate (58). However, the subcommittee reporting on FAD eradication response did not make mention of welfare slaughter (59). This suggests that failure to recognize welfare slaughter as part of the direct costs of an FAD eradication program and failure to act on lessons provided by 1997-CSF-NL and the more recent FAD incursions in Europe and Asia are shared throughout North America. Unfortunately, in the event of an

outbreak, this lack of foresight will have the greatest impact on the most export dependent of the North American livestock regions, which is Canada.

Individuals are often unable or unwilling to imagine the potential devastation that could be caused by low frequency catastrophic events and will not take measures to protect against the potential loss (42). In the insurance field, this behavior is referred to as "cognitive failure" (20,42). The lack of acknowledgment by governments and the industry of the current risks to animal welfare posed by the threat of an FAD incursion is similar in nature to "cognitive failure" displayed by individuals in similar circumstances.

No amount of effort can eliminate the risk of damage from FAD. To reduce the risk of economic damage as far as possible, a range of coordinated actions by government, the farming industry, and others in the rural economy working together in partnership are required (8). Perhaps the most vital lesson to be learned from the 2001-FMD outbreak in the UK, as was previously documented in the 1997-CSF-NL incursion is, that for regions not having recent experience in an FAD disaster, a lesson given is not a lesson learned.

## Recommendations

For Canada, the organizational principles of large scale killing under field conditions need defining and setting out clearly to provide operational guidelines for those having to set up and implement procedures on farms having widely different facilities.

Steps must be taken immediately to correct the fact there is no current funding, legislative authority, or significant contingency planning for comprehensive FAD emergency management in Canada. New options for funding agri-food disaster response must be developed rapidly under a federal-provincial-territorial agricultural agreement.

There is a critical need for renewed veterinary leadership in Canada in the area of emergency management and farm animal welfare. Veterinary training for an FAD response, thus far centered on clinical skills, must be expanded to managing farm animal welfare, as this will likely be the major veterinary contribution to FAD eradication. Subsequent to 2001-FMD-UK, the chief veterinary officer became the director of Animal Health and Welfare, responsible for policy on all animal health, welfare, and veterinary matters (60). There is no equivalent position in Canada.

Provincial level veterinary authorities must not be lulled into the belief that the activities described in FADES plans describe the limit of provincial involvement in an FAD response. Although the CFIA has a vital policy function and will make the decisions on disease control issues, it will have a limited function to play in the overall emergency response. Livestock industries, organized at the provincial level, must engage OCIPEP and AAFC through their provincial EMOs to assume leadership in the preparation of the response to an FAD. In addition, the DFA must be adequately supported and extended to the arena of FAD control.

## Acknowledgments

This work was sponsored by the Canadian Animal Health Coalition. A steering committee including Dr. Denna Benn, chair of the Animal Welfare Committee, Canadian Veterinary Medical Association; Ms. Susan Church, Alberta Farm Animal Council; Mr. Mike Cooper, Canadian Meat Council; Mr. Ron Douglas, Canadian Pork Council; Dr. Allan Preston, Manitoba Agriculture and Food; and Mr. Matt Taylor, Canadian Animal Health Coalition provided direction on the scope of the project and made comments on a previous draft. Mr. Jim Wainwright, Manitoba Emergency Measures Organization, also made independent comments on an early draft of this paper. The author gratefully acknowledges the generous permission given by Mr. Keith Davis, National Audit Office, Press Office, 157–197 Buckingham Palace Road, Victoria, London, to reprint Figure 2 in this paper, which is from: The 2001 Outbreak of Foot and Mouth Disease. Report by the Comptroller and Auditor General, HC 939 Session 2001–2002; 21 June 2002, Part One, Figure 12 “Animals slaughtered for disease control and welfare purposes”.

CVJ

## References

1. Canadian Food Inspection Agency, Foreign Animal Disease Unit, Animal Health Section. Foot And Mouth Disease Strategy (Draft). May 2001. Last accessed 12/5/2003 [www.inspection.gc.ca/english/anima/heasan/fad/fmd/fmdtoce.shtml](http://www.inspection.gc.ca/english/anima/heasan/fad/fmd/fmdtoce.shtml)
2. Canadian Food Inspection Agency, Foreign Animal Disease Unit, Animal Health Section. Classic Swine Fever Strategy (Draft). February 1997. Available from: Staff Veterinarian, Foreign Animal Diseases, Canadian Food Inspection Agency, Animal Health Division, 59 Camelot Drive, Nepean, Ontario K1A 0Y1.
3. European Union, Council Directive 2001/89/EC of 23 October 2001 on Community measures for the control of classical swine fever (Text with EEA relevance). Last accessed on 12/5/2003 [http://europa.eu.int/eur-lex/en/consleg/main/2001/en\\_2001L0089\\_index.html](http://europa.eu.int/eur-lex/en/consleg/main/2001/en_2001L0089_index.html)
4. European Union, Council Directive 85/511/EEC of 18 November 1985 introducing Community measures for the control of foot and mouth disease (with amendments). Last accessed on 12/5/2003 [http://europa.eu.int/eur-lex/en/lif/reg/en\\_register\\_035030.html](http://europa.eu.int/eur-lex/en/lif/reg/en_register_035030.html)
5. Canadian Food Inspection Agency, 2002–2003 Estimates, Part III — Report on Plans and Priorities. 22 pp. Canadian Government Publishing (PWGSC), Ottawa, Ontario K1A 0S9.
6. Seracon Management Consulting Inc. (2002). Economic impacts of a potential outbreak of foot and mouth disease in Canada. 53 pp. Available from: Canadian Animal Health Coalition, 2543b Chicoutimi Drive, Northwest, Calgary, Alberta T2K 2A5.
7. Anonymous. Final Report. International Conference on Control and Prevention of Foot and Mouth Disease, Brussels 12–13 December, 2001. Last accessed 12/5/2003 <http://www.cmlag.fgov.be/eng/conference.html>
8. Anderson I. (Chair). Foot and mouth disease 2001: lessons to be learned inquiry. HC 888 Crown Copyright 2002. 187 pp. Last accessed 12/5/2003 <http://www.fmd-lessonslearned.org.uk/nav/report.htm>
9. Follett B. Sir (Chair). Infectious Diseases in Livestock. London: The Royal Society, 2002. 160 pp. Available on the Royal Society Website <http://www.royalsoc.ac.uk/policy/> Accessed 12/5/2003.
10. Curry D. Sir (Chair). Report of the Policy Commission on the Future of Farming and Food, January 2002, 152 pp. DEFRA, Area 8B, 9 Millbank, C/O Nobel House, 17 Smith Square, London SW1P 3JR. Last accessed on 12/5/2003 <http://www.cabinet-office.gov.uk/farming/>
11. Royal Society for the Prevention of Cruelty to Animals. Submission to the Lessons Learned Inquiry No. 439, March 2002, 68pp. RSPCA Wilberforce Way, Southwater, Horsam, West Sussex, United Kingdom RH13 9RS.
12. Meuwissen MP, Horst SH, Huirne RB, Dijkhuizen AA. A model to estimate the financial consequences of classical swine fever outbreaks: principles and outcomes. *Prev Vet Med* 1999;42: 249–270.
13. Saatkamp HW, Berentsen PB, Horst HS. Economic aspects of the control of classical swine fever outbreaks in the European Union. *Vet Microbiol* 2000;73:221–237.
14. Dijkhuizen AA. The 1997–1998 outbreak of classical swine fever in the Netherlands. *Prev Vet Med* 1999;42:135–137.
15. Sugiura K, Ogura H, Ito K, Ishikawa K, Hoshino K, Sakamoto K. Eradication of foot and mouth disease in Japan. *Rev Sci Tech Off Int Epiz* 2001;23:701–713.
16. Wrathall A, Mitchell T. Report of the Chief Veterinary Officer Animal Health 2000, Chapter B1. Ministry of Agriculture, Fisheries and Food, Publications, Area 609, 1a Page Street, London, SW1P 4PQ.
17. Bourn J. The Outbreak of Foot and Mouth Disease, Report by the Comptroller and Auditor General. HC 939 Session 2001–2002: 21 June 2002, 133 pp. The Stationary Office, London.
18. Plumiers FH, de Leeuw PW, Smak JA, Elbers ARW, Stegeman JA. Classical swine fever in The Netherlands 1997–1998: a description of organization and measures to eradicate the disease. *Prev Vet Med* 1999;42:139–155.
19. Horst HS, Meuwissen MP, Smak JA, Van der Meijs CC. The involvement of the agriculture industry and government in animal disease emergencies and the funding of compensation in Western Europe. *Rev Sci Tech Off Int Epiz* 1999;18:30–37.
20. Meuwissen MPM, Van Asseldonk MAPM, Huirne RBM. Alternate risk financing instruments for swine epidemics. *Agric Syst* 2003;75: 305–322.
21. Department for Environment, Food and Rural Affairs, Interim foot and mouth contingency plan. Version 3. 141 pp. Last accessed on 14/05/2003 <http://www.defra.gov.uk/animalh/diseases/fmd/contingency/contplan.pdf>
22. Bowman QP, Arnoldi JM. Management of animal health emergencies in North America: prevention, preparedness, response and recovery. *Rev Sci Tech Off Int Epiz* 1999;18:76–103.
23. Statutes of Canada. Health of Animals Act (1990, c. 21), Health of Animals Regulations (C.R.C., c. 296) Part 52, Part 53. Last accessed 14/05/2003 <http://laws.justice.gc.ca/en/H-3.3/fulltoc.html>
24. European Commission: Report of the Scientific Veterinary Committee (1997). The killing of animals for disease control purposes. Adopted 30 September 1997, 27pp. Last accessed on 14/05/2003 [http://europa.eu.int/comm/food/fs/sc/oldcomm4/out19\\_en.html](http://europa.eu.int/comm/food/fs/sc/oldcomm4/out19_en.html)
25. Productivity Commission 2002, Impact of a foot and mouth disease outbreak on Australia, Research Report, AusInfo, Canberra. 174 pp.
26. Statistics Canada, Agriculture and Agri-Food Canada, Trade and Evaluation Analysis Division, International Markets Bureau, Market and Industry Services Branch, 930 Carling Avenue, Ottawa, Ontario K1A 0C5.
27. DEFRA/DCMS. Economic cost of foot and mouth disease in the UK March 2002. 26 pp. Last accessed on 14/05/2003 <http://www.defra.gov.uk/corporate/inquiries/index.asp>
28. Younger D. Livestock welfare disposal scheme-light lambs (LWDS-LL) Intervention Board Notice, 31 August 2001, 3 pp. Last accessed on 14/05/2003 [http://www.scu.co.uk/papers/2001/lwds/lwds\\_ll01.htm](http://www.scu.co.uk/papers/2001/lwds/lwds_ll01.htm)
29. Anonymous. EC bans the export of live pigs from England as classic swine fever outbreak spreads. *Vet Rec* 2000;147:202.
30. Wrathall A, Mitchell T. The Report of the Chief Veterinary Officer Animal Health 2000. 76 pp. Ministry of Agriculture, Fisheries and Food, Publications, Area 609, 1a Page Street, London SW1P 4PQ.
31. Office International des Epizooties. International Animal Health Code, 11th Edition, 2002, Chapter 1.3.5, Zoning and regionalisation. Last accessed on 14/05/2003 [http://www.oie.int/eng/normes/mcode/A\\_summry.htm](http://www.oie.int/eng/normes/mcode/A_summry.htm)
32. deKlerk PF. Carcass disposal: lessons from The Netherlands after the foot and mouth disease outbreak of 2001. *Rev Sci Tech Off Int Epiz* 2002;21:789–796.
33. Lavender A, Mitchell T. The report of the Chief Veterinary Officer Animal Health 2001. 95 pp. Department of Environment, Food and Rural Affairs. DEFRA Publications, Admail 6000, London, SW1A 2XX.

34. Her Majesties Stationary Office. Statutory Instrument 1995 No. 731, The Welfare of Animals (Slaughter or Killing) Regulation, Schedule 1, Regulation 4(3) The Licencing of Slaughtermen. Last accessed on 14/05/2003 <http://www.hmso.gov.uk/index-content.htm>
35. Farm Animal Welfare Council. Foot and mouth disease 2001 and animal welfare: Lessons for the future, January 2001, Submission to the Lessons Learned Inquiry. No. 2120 March 2002. 22 pp. Farm Animal Welfare Council, 1A Page Street, London, SW1P 4QP.
36. Geale DW. FMD-Post UK 2001: CFIA's 2002 initiatives. Proc 54th Annu Conv Can Vet Med Assoc, July 17–20, 2002 Halifax, Nova Scotia. pp 189–194.
37. Canadian Food Inspection Agency. Food and Agriculture Emergency Response System (FAERS). FAERS Manual January 1999. 19 pp. Last accessed on 14/05/2003 <http://www.inspection.gc.ca/english/anima/heasan/fad/faerse.shtml>
38. Statutes of Canada. Emergencies Act. R.S., 1985, C22 (4th Suppl). Last accessed on 14/05/2003 <http://lois.justice.gc.ca/en/E-4.5/text.html>
39. Government of Canada. The Office of Critical Infrastructure Protection and Emergency Preparedness Website. Last accessed 14/05/2003 <http://www.ocipep.gc.ca/index.asp>
40. Emergency Measures Organisation Manitoba. Disaster Financial Assistance. Policies and Guidelines Private Sector. 8 pp. Last accessed on 14/05/2003 <http://www.gov.mb.ca/gs/memo/private.html>
41. Government of Newfoundland. The Atlantic Ground Fisheries Strategy, An analysis of the program on a regional basis. Economics and Statistics Branch, Department of Finance, P.O. Box 8700, St. John's, Newfoundland A1B 4J6. Appendix 1.1. Last accessed on 14/05/2003 <http://www.gov.nf.ca/publicat/tags/text/content.htm>
42. Skees JR, Barnett BJ. Conceptual and practical considerations for sharing catastrophic/systemic risks. Rev Agric Econ 1999;21: 424–411.
43. European Commission, Agricultural Directorate General, Directorate A. Working Document Risk Management Tools for EU Agriculture with a Special Focus on Insurance. 84 pp. January 2001. Last accessed 14/05/2003 [http://europa.eu.int/comm/agriculture/publi/insurance/index\\_en.htm](http://europa.eu.int/comm/agriculture/publi/insurance/index_en.htm)
44. Statutes of Manitoba, Chapter A 84, The Animal Care Act. Animal Care Regulation A84-126/98, Manitoba Gazette Aug 15, 1998, Vol 127, No 31, pp 984–996. Last accessed on 14/05/2003 <http://www.canlii.org/mb/regu/crm/20030312/a.html>
45. Statutes of Manitoba, (RSM 1990, c223), The Winnipeg Humane Society Foundation Incorporation Act. Queens Printer, Winnipeg, Manitoba. Last accessed on 14/05/2003 <http://web2.gov.mb.ca/laws/statutes/private/c22390e.php>
46. Manitoba Farm Animal Council, Inc. 1994. Manitoba Corporations Act, Corporation No. 3104443, 36 Scurfield Boulevard, Winnipeg, Manitoba R3Y 1N9.
47. Statutes of Canada. Criminal Code (R.S. 1985, c. C-46) Section 444–447. Last accessed on 14/05/2003 <http://laws.justice.gc.ca/en/c-46/text.html>
48. Statutes of Canada. Health of Animals Act (1990, c. 21), Health of Animals Regulations (C.R.C., c. 296), Part XII Transportation of Animals. Last accessed on 14/05/2003 <http://laws.justice.gc.ca/en/H-3.3/C.R.C.-c.296/index.html>
49. Statutes of Canada, Health of Animals Act, (1990, c.21) SOR/2000-233, Compensation for destroyed animals regulations. Registration 8 June 2000. Last accessed on 14/05/2003 <http://laws.justice.gc.ca/en/H-3.3/SOR-2000-233/index.html>
50. Agriculture Canada. Federal-Provincial-Territorial Framework Agreement on Agriculture and Agri-Food Policy For the Twenty-First Century. Last accessed on 14/05/2003 [http://www.agr.gc.ca/puttingcanadafirst/index\\_e.php?section=info&page=gen](http://www.agr.gc.ca/puttingcanadafirst/index_e.php?section=info&page=gen)
51. Brown N. Regulatory impact assessment: the pig industry development scheme 2000 (Confirmation) order. 5 pp. Last accessed on 14/05/2003 <http://www.defra.gov.uk/corporate/ria/pidsria.pdf>
52. Lawrence CJ. Animal welfare consequences in England and Wales of the 2001 epidemic of foot and mouth disease. Rev Sci Tech Off Int Epiz 2002;21:863–868.
53. Barga LL, Whiting TL. Time to critical overcrowding of Manitoba swine barns in the event of restriction on animal movement. Can Vet J 2002;43:855–862.
54. Harris DL. Multi-Site Pig Production. Ames, Iowa, Iowa State Univ Pr, 2000, 217 pp.
55. Dritz S, Tockach MD, Goodband RD, Nelssen JL. Effects of administration of antimicrobials in feed on growth rate and feed efficiency of pigs in multisite production systems. J Am Vet Med Assoc 2002;220:1690–1695.
56. Statistics Canada, Census of Agriculture. Manitoba Market Analysis and Statistics Section, Manitoba Agriculture and Food, 810–401 York Avenue, Winnipeg, Manitoba R3C 0P8.
57. Yanc PC, Chu RM, Chung WB, Sung HT. Epidemiological characteristics and financial costs of the 1997 foot and mouth disease epidemic in Taiwan. Vet Rec 1999;145:731–734.
58. Nolen RS. Review finds US animal disease control system adequate, but needing improvement. J Am Vet Med Assoc 2002;220: 432–433.
59. National Association of State Departments of Agriculture Research Foundation. The Animal Health Safeguarding Review Results and Recommendations, October 2001, 144 pp. Last accessed on 14/05/2003 [www.aphis.usda.gov/vs/pdf\\_files/safeguarding.pdf](http://www.aphis.usda.gov/vs/pdf_files/safeguarding.pdf)
60. Scudamore JM, Haris DM. Control of foot and mouth disease: lessons from the experience of the outbreak in Great Britain in 2001. Rev Sci Tech Off Int Epiz 2002;21:789–796.