THREATS AND CONSEQUENCES OF EXOTIC DISEASES

Terry Whiting
Veterinary Services Branch
Manitoba Agriculture and Food

ABSTRACT

In all previous risk assessments for outbreaks of foreign animal disease (FAD) in North America, there was only consideration of the effect of accidental introduction of highly transmissible agents such as hog cholera or foot-and-mouth disease. The events of September 11th, 2001 in New York and Washington and subsequent Anthrax scares have changed the perception of risk related to FAD. For Canadian pork and swine industries which are heavily dependent on access to the US market, the impact of even a limited introduction of FAD into either the US or Canada would be immense. If a FAD were to be intentionally introduced, the resultant outbreak probably would not be a limited incursion. Current Canadian FAD preparedness plans have been lead by the National Veterinary Service (Canadian Food Inspection Agency, CFIA) and are focused on planning the operational activities related to stamping out the disease. These "eradication plans" do not consider the overall risk management and, specifically, no consideration is given to the consequential impacts of a significant domestic outbreak or an outbreak in the United States. Risk management and contingency planning for foreign animal disease must be extended to include other activities in addition to disease eradication and be extended to include industry and producers in the planning and funding.

INTRODUCTION

Biosecurity at one time meant a boot wash and controlled access to swine barns. The tragedy of September 11th has reminded us of the need for sector bio-security and brought the topic of "Biological Terrorism" to public forum. The threat of mail dissemination of Anthrax in the US and in other countries has raised serious concerns about wider implications. Thinking about bio-terrorism is often limited to the possibility of direct threats against the health of people. Another significant form of biological terrorism, which has escaped the eyes of media is "agricultural terrorism." For this discussion we will define bio-terrorism as *"the risk caused by potential deliberate acts to destabilize the health status of a population through disease or other health threats"* and bio-security as *"health plan or measures designed to protect a population from transmissible infectious disease…including emergency response".*

The term's *emergency* and *disaster* are often used interchangeably in colloquial language. Emergencies result from incidents, regardless of their size, which are matched by adequate or nearly adequate resources. Emergencies are usually resolved quickly with minimal loss of most valued assets. Disasters result from incidents, regardless of their size, which are not matched by adequate resources. Disasters are slow to resolve and are accompanied by loss of most valued assets. The art of emergency management is to try and convert a potential disaster into an emergency. Some things that could contribute to an animal health-FAD

disaster are lack of resources, lack of political commitment to respond, failure of early detection, emergence of a type of incident that was hitherto unanticipated and malicious introduction. No one can anticipate every possible detail of all possible scenarios however; good management should be able to anticipate and plan for the probable and the likely. For instance, if hog cholera was identified in Michigan, no one should be surprised that the border crossings between Ontario and Michigan would immediately close to live animal movement. No one should expect that border to re-open for at least 60-90 days.

INFECTIOUS AGENTS

The Organization International de Epizooties (OIE), located in Paris, is recognized by the World Trade Organization as the expert reference center on animal diseases as they relate to international trade. The OIE classifies animal diseases into List A, List B and unlisted. List A diseases of swine do not occur in Canada and are very highly transmissible infectious agents with the potential for very serious and rapid spread, irrespective of national borders. List A diseases are of serious socio-economic or public health consequence and are of major importance in the international trade of animals and animal products. List B diseases are transmissible diseases that are considered to be of socio-economic and/or public health importance within countries and that are significant in the international trade of animals and animal products. Table 1 lists these diseases for swine.

The concept of transmissibility used in the OIE assessment of risk includes both consideration of the animal to animal transmission efficiency and the ability for some infectious agents to survive in pork and pork products. Most List A diseases of swine are infective agents that can survive in pork and pork products.

Table 1: Diseases considered economically important to the trade in live pigs and pork products in the international marketplace

List A	List B
Foot and mouth disease (FMD)	Atrophic rhinitis of swine
Swine vesicular disease	Enterovirus encephalomyelitis
Classical swine fever (CSF, Hog Cholera)	Porcine brucellosis
African swine fever	Porcine cysticercosis
Vesicular stomatitis	Porcine reproductive and respiratory syndrome
	Transmissible gastroenteritis (TGE)
	Anthrax
	Aujeszky s disease (Pseudorabies)
	Rabies

ROUTE OF ENTRY INTO A DISEASE FREE ZONE

The major risks of introducing a FAD into Canada come from uncontrolled live animal movement, uncontrolled animal product movement and the movement of people. The Canadian Food Inspection Agency (CFIA) and Canada Customs and Revenue Agency (CCRA) provide excellent control of the risk related to movement of live animals. Canada has only one land border and that is with the USA, a country at equivalent health status for all List A diseases. Live swine can not move undetected by air. The risk of accidental introduction of a FAD by international travelers without food products is also pretty low (Bridges & Cummings 1998). The risk associated with legal meat import is well documented and measures are in place to make this route of introduction of a FAD to Canada or the USA very unlikely (Callis JJ 1996, Metcafe HE et al 1996, Horst HS et al 1996). The risk of uncontrolled meat movement is considerably higher. One estimate of the amount of illegal food products entering the U.S. is between 450,000 and 4 million-kg annually (Corso B 1997). Contaminated meat products have the potential to infect swine with FMD, CSF, Swine Vesicular Disease and African Swine Fever. The feeding of human food waste to swine is a well-recognized method of transmitting FAD's across international boundaries.

Prior to the terrorist attacks on Washington and New York City on September 11th 2001, most thinking around risk of introduction of FAD into North America was related to the control of accidental introduction. Most risk management efforts were centered on the factors *import of livestock*, *import of animal products* and *swill feeding.* Malicious introduction has to be added to the list of potential routes of introduction of FAD into North America.

HISTORY OF AGRICULTURAL TERRORISM

In the past, despite many national level research programs in biological warfare, agricultural terrorism has rarely been used. During World War I the Germans inoculated horses and mules with Anthrax and shipped them from US ports to allies. This was Germany's largest biological sabotage program in which they attempted to infect cavalry and military livestock between 1915 and 1918 in Romania, Spain, Norway, Argentina and the US. Japan is also reported to have used animal and plant pathogens against Russia and Mongolia in 1940 (Kohnen, A 2000).

However there are numerous other incidents that suggest use of biological warfare, particularly in agriculture, during World War II. For instance, Britain accused Germany of dropping small cardboard bombs filled with Colorado beetles onto potato fields in southern England. Germany itself was worried about the possibility of an enemy introducing Colorado beetles into its fields. During the Cold War there were many allegations of biological warfare from both the sides. For instance, Cuba accused the US of attacking its people and crops with a variety of biological agents. The first documented case of agricultural terrorism, however, came up in 1952 when a group called Mau Mau used plant toxin to poison 32 steers at a Kenyan Mission (Kohnen A 2000).

The attack on the twin towers in New York City could be seen as an attack on a symbol of American economic power. Modern agriculture is certainly a symbol of North American excellence and may also have some symbolic target value to individuals and groups harboring anti-American or one-issue sentiments.

BIOLOGICAL WARFARE: THE ULTIMATE FAILURE OF BIOSECURITY

A question normally arises in the mind as to why one would use biological warfare when other forms of weapons are readily available. The answer is simple. While conventional weapons can be detected in metal detectors and other machines, biological warfare agents cannot be detected easily nor do they arouse suspicion. Also livestock and crops can be easily targeted. Although most farm buildings are somewhat secure, the public has access to pastoral animals, assembly yards and livestock trailers when stopped at fueling stations. Creating a bio-weapon to kill livestock and crops is not necessary. Animal and plant specific bio-weapons such as FMD/CSF already exist in other countries' animal populations.

Apart from their easy use, agricultural attacks are in many ways nearly risk free to the perpetrator. Agents infective to animals are not infective to people carrying out the attack. Agricultural targets are soft targets or ones that maintain a low level of security and destroying a pig or a cattle population or a standing crop, will also not risk as much world condemnation as the killing of people. In some societies, the killing of pigs would not bear any negative moral connotations at all, as pigs have a distinctly lower status than ruminants and poultry. Agricultural terrorism also carries an advantage of easy escape because of the time delay prior to identification of the crime as was the case with rabbit haemorrhagic disease virus (RHDV) which was illegally released in New Zealand in August 1997 (O'Keefe JS et al 1999).

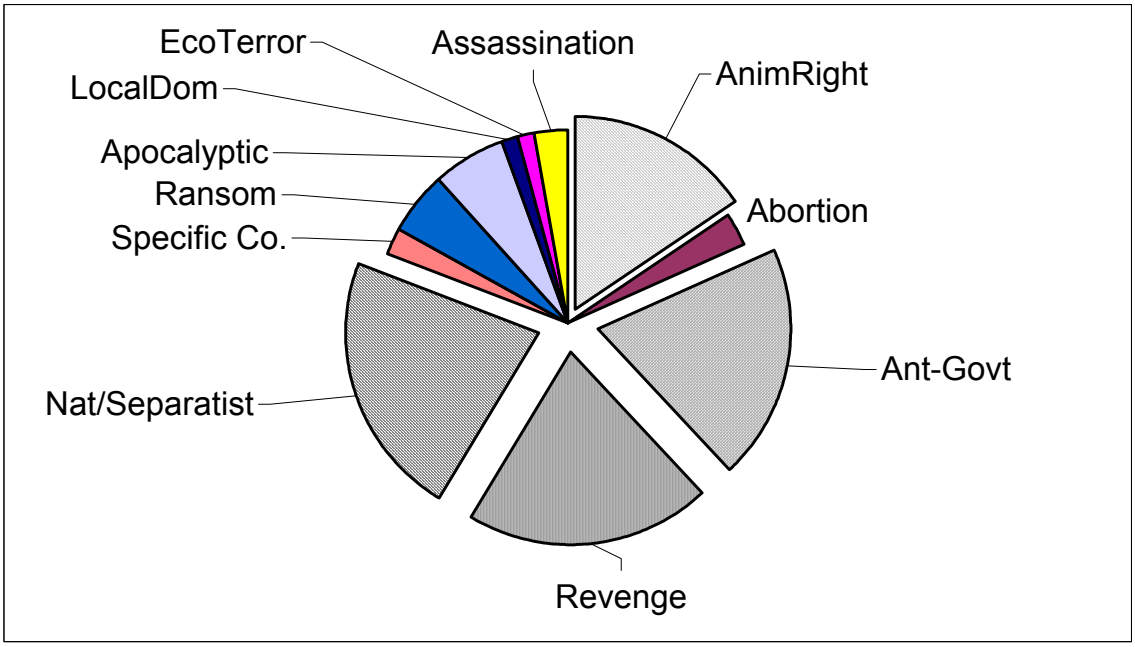
Terrorism is only possible where there are individuals or groups ideologically committed to an outcome with such conviction that they are willing to partake in criminal acts. In a recent review of 417 well-documented terrorist attacks since 1960 the most common motivation was political or ideological in nature (n=219) (Tucker JB 1999). Of the remaining cases, 160 were criminal in nature either to ransom money or to achieve revenge and only 38 were classified as state sponsored assassination (Figure 1). If history tends to repeat, then agriculture-based terrorism is most likely to come from ideologically based groups. There may be good rational to take very seriously animal rights groups and anti-US international movements. As Canadian agriculture and livestock production is very tightly aligned with US agriculture production any threat to US livestock is a threat to Canadian agriculture production.

IMPACT OF FOREIGN ANIMAL DISEASE

The financial impacts of FAD incursions are difficult to establish even in retrospect (Saatkamp HW et al 2000). One of the best-documented cases of a FAD eradication program was the 1997 CSF outbreak in the Netherlands. The outbreak involved 429 farms and lasted for 450 days and cost about 2.3 billion US$ (Horst HS et al 1999a). In a Canada-US outbreak

the actual loss of infected livestock would probably cause miniscule financial damage in comparison to the justified trade restrictions which would immediately take place as allowed by and in compliance with international agreements made under the World Trade Organization. Even a limited outbreak of hog cholera anywhere in the US or Canada would have immediate and significant impact in live animal and pork movement at the US-Canada border.

Figure 1: Motivation for the attack in 147 cases of biological terrorism documented between 1960 and 1999 (Redrawn from Tucker, J.B. 1999). If you consider nationalist motivations, animal rights, and anti-government sentiment all to be forms of ideology, then ideology accounts for over 60% of the acts of bio-terror documented in this review.



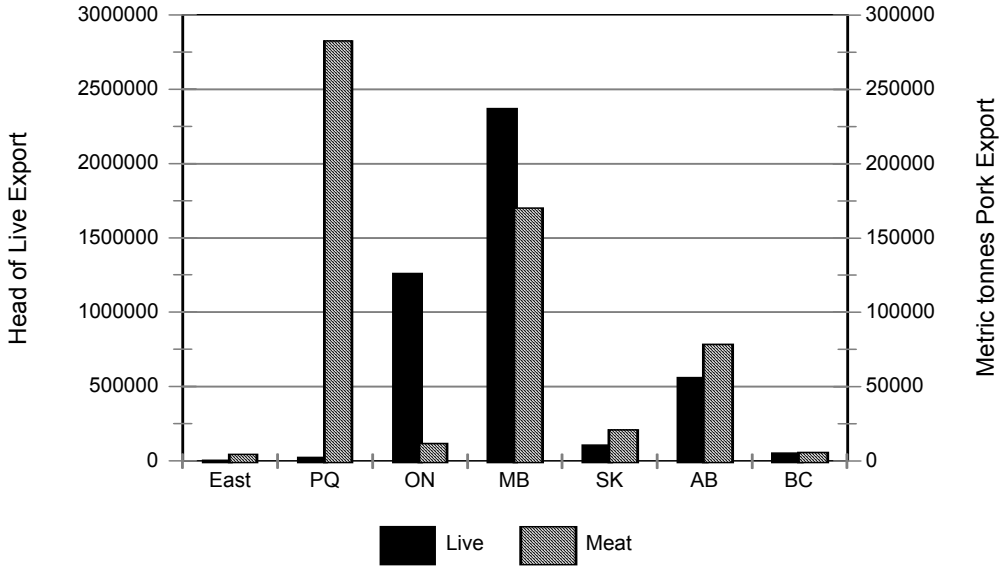
Manitoba and Ontario are particularly sensitive to export access for live pigs. The development of multi-site production in western Canada produces a very time-sensitive commodity in iso-weaned piglets (5-6 kg). Many iso-weaned piglets are exported to fairly specialized nursery facilities in the USA. Of the provinces of Canada, Quebec has the most mature pork production industry as export in live animals is primarily breeding stock and the overwhelming volume of exports are in finished pork product (Kellar, J. et. al. 2001) (Figure 2).

POTENTIAL ECONOMIC DAMAGE

The main tools of response to contain a FAD outbreak are animal movement restriction, immediate killing of infected and contact animals and active surveillance. In most eradication

operations animal movement restrictions or quarantine are applied to all animals at risk due to geographic proximity or due to recent contact (trace-in-trace-out).

Figure 2: Regional volumes of export in pork and live pigs in the year 2000. Hatched bar is pork export in metric tonnes (right axis) solid bar is live pigs exported (left axis). Quebec has a mature pork production chain with only finished product exported whereas Manitoba and Ontario are large exporters of live pigs. (Redrawn from Kellar, J. et. al. 2001).



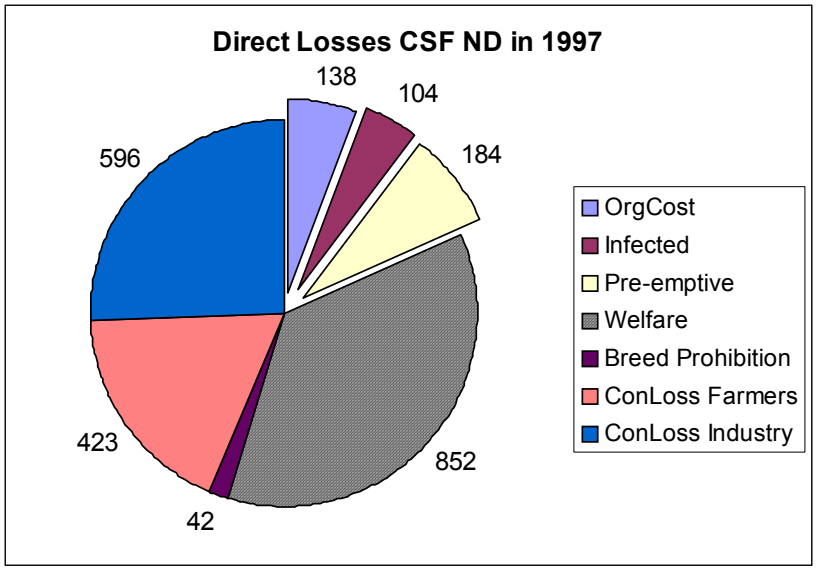
In Europe the costs associated with destroying infected herds represents a small component of the impact of eradicating CSF. In the standard EU stamping out protocol, all infected herds are depopulated as soon as possible. In the 1997 CSF outbreak in the Netherlands, more than ten million swine were destroyed (Meuwissen MPM et al 1999). Movement restrictions, in this case lasting 450 days, caused about five million disease free swine to exceed market weight (130kg) and be destroyed due to overcrowding on the farm of origin and a further four million uninfected weaner weight swine (25kg) were killed due to overcrowding. With the introduction of pre-emptive slaughter (the killing of herds' prior to the detection of disease), a large number of high-risk herds were also depopulated. However; destruction due to herd depopulation of both infected and high-risk herds is a small component of the overall numbers of pigs destroyed (Figure 3).

HUMANE ISSUES

The disease eradication response plan in the European Community includes the option to kill pigs for welfare reasons with full compensation to the farmer (Council Directives 80/217/EEC and 85/511/EEC)). Pigs killed for humane reasons are disposed of as infected material. Overcrowding will occur on fixed population farms (feeder barns) as pigs exceed market

weight. On breeding farms in addition to every pig growing and requiring more space, new pigs are being added to the population with each weaning.

Figure 3: Direct losses due to the epidemic of classic swine fever in the Netherlands in 1997 (From Horst, H.S. et. al. 1999a). The total cost was estimated at 2,339 million US$. The numerical labels indicate the losses in million US$ associated with that particular activity. OrgCost is the expense associated with administration and office support for the response program. Infected refers to the cost for compensation and destruction of infected farms. Pre-emptive refers to the cost of destroying herds in close proximity to infected herds or high-risk trace outs. Welfare is the cost of purchasing pigs from farms under quarantine for some time, due to pigs outgrowing the space available on the farm. In this outbreak, there was a breeding prohibition on some herds with compensation for down time. ConLoss refers to consequential losses to farmers and the related industries. In the current CFIA-FMD&CSF stamping out plan there is authorization for compensation (Federal monies via the CFIA) for Federal organizational costs and herds ordered destroyed due to infection and for preemptive slaughter in FMD only (Anon. CFIA 2001, Anon. CFIA 1997). If a large outbreak similar to Netherlands-CSF-1997 occurred in Canada, we would have 82% of the costs of the outbreak response unfunded under our current national FAD response model.



Quite early in the Netherlands 97-98 outbreak the volume of suspect pig meat was exceeding the rendering capacity of the country. A simple solution was to kill nursing piglets at 14 days of age, i.e. a smaller body weight, when a reasonable "value" for compensation could be established. After several weeks of consultation with industry the authorities went forward with piglet killing. It lasted about 3 days until public outcry put an end to it. Public outcry against piglet killing caused a return to raising weaners to 25 kg and killing as the farm became overcrowded. After a cooling off period, nursing pig slaughter was successfully re-initiated. This point emphasizes that the killing of healthy animals is not viewed as a morally

neutral decision in the eyes of the public. Humane issues are a significant risk to manage when planning for emergency situations requiring the destruction of animals.

NORTH AMERICAN SWINE PRODUCTION ORGANIZATION

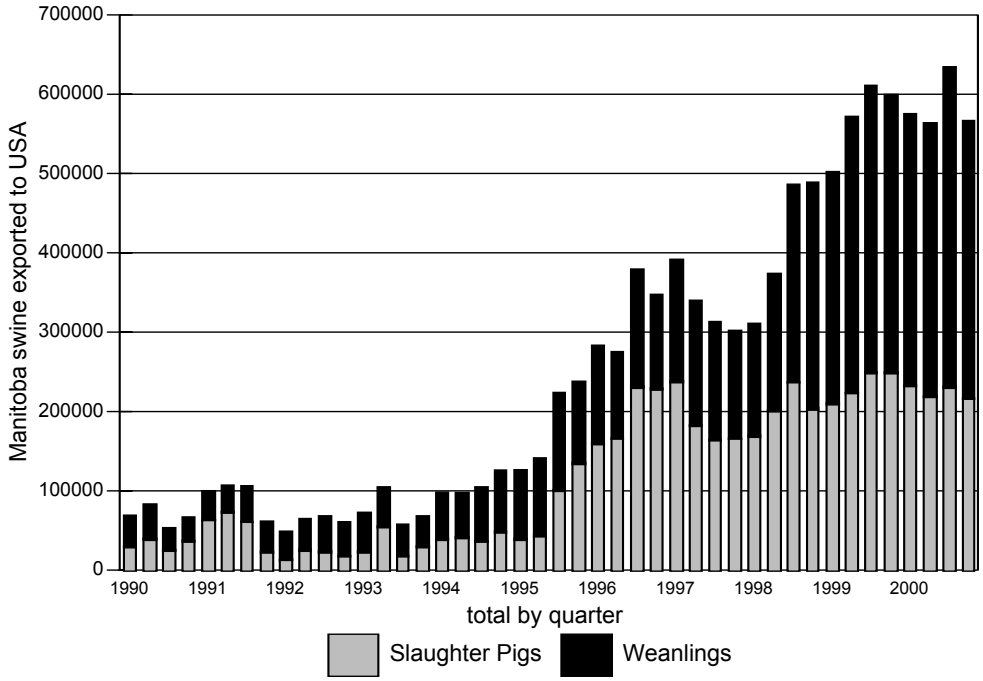
In conventional hog farming, as was most common through the '80's, pigs are born, weaned at around 30 days of age and raised to market weight often in the same building. At market weight the pigs are carrying the same profile of swine pathogens as the sow herd. Multi-site production systems (Harris DL 1999) have developed as a non-surgical method of deriving specific pathogen free pigs from infected sows and has been widely implemented in the past 5 years. Isowean effectively prevents the transmission of conventional disease agents between pigs of different ages. Inherent in iso-wean programs are all-in-all-out (AIAO) management strategies, disinfecting of premises between production batches, strict biosecurity measures and only housing pigs of the same age together. In isowean application, isolation is often best accomplished by moving the pigs to another location as an off-site nursery or to a separate wean to finish operation. Many isolated weaning production systems are large, as piglets must be grouped together within about 5-7 days of age, and managed as AIAO. To fill two 1000-head finishers, one for barrows and one for gilts per week, a pool of 5000 sows is needed. In addition to being large, isowean production is very sensitive to delays in, or problems with, pig flow.

Isowean also allows wide geographic separation between the place of a pig's birth and the location of the fattening unit. A portion of the feeder barns in the mid western USA are populated by piglets born in Manitoba and Ontario. In Manitoba, about 40% of the swine units are one-site (farrow to finish), while iso-wean based multi-site production units produce a further 40-45% of production. About 13% of commercial hog operations produce weanlings only, however this 13% of producers represents far more than 13% of the pigs born (Honey J 2000). In Manitoba, 5 major weanling producers combined produced about 500,000-600,000 weanlings in 2000. Manitoba exports about 1.5 million weanlings yearly and most of those come from weanling-only producers (Figure 4). Current data sources do not indicate how many weanlings are produced for sale to local feeder barns within Manitoba. A guess would be another 500,000-700,000 per year. This indicates that half of all pigs born in Manitoba originate on a weanling-only production site.

COST OF ANIMAL WELFARE CONCERNS

In large outbreaks of CSF in Europe the cost related to the killing of infected animals was only a small component of the overall response. In the 1997 Dutch outbreak the cost of killing infected animals was 104 $US million, less than a quarter the cost of slaughter of animals under quarantine where the facilities became critically overcrowded (Meuwissen MPM et al 1999). To answer the question, is there any reason to suspect that a large outbreak in North America would behave differently, we can consider the planned eradication response and the structure of the industry.

Figure 4: Number of pigs exported to the USA from Manitoba by quarter in 1990-2000. In the calendar year of 2000, 1,439,872 feeder pigs (Isowean and weaner pigs) and 900,477 slaughter pigs (market hogs and cull sows and boars) were exported to the US from Manitoba. Total pig production for 2000 was 5,350,000, the preliminary estimate for 2001 hog production in Manitoba is 5.7-5.8 million head (J. Honey, MAF).



In the current Canadian draft strategy to respond to a FAD incursion, farms are declared infected upon laboratory confirmation of the disease (Anonymous, CFIA Draft CSF-1997, FMD-2001). Additional farms would be considered suspect and placed under quarantine if they were considered "trace-back" or if they fell in the infected or security zones. The initial infected zone would be a 3km radius around infected premises and the security zone a 10km wide radius around the infected zone. Manitoba is an area of low pig density by international standards and the impact of geographic based movement restrictions could be small. Some areas of Ontario may have somewhat higher hog concentration but, nothing like the European situation. With the development of multi-site production many systems are vertically integrated. With an estimated 50% of Manitoba sows currently in isowean production the impact of trace-back quarantine could be very significant. If a nursery barn was identified as infected; all feeder barns which purchased pigs from that nursery and all isowean facilities that sold pigs to that nursery in the past 90 days would probably be placed under quarantine. Quarantine would remain until clinical examination and serological testing could establish the *not infected* status of each trace out premises. Serological testing ability, ramping up to deal with volume demand and establishing confidence in serologic results would all take some time to develop.

Identifying FAD within a production chain could bring the whole chain under suspicion and therefore complete movement restriction for some time. In multi-site production there is very little holding capacity in some locations especially nursery pig production units (Bargen & Whiting 2002). The nurseries receiving piglets may be miles away and even on the other side of the US-Canadian border. Even in the case of a serious false alarm, it would be reasonable to expect a delay of at least 7 days to 2 weeks to allow testing and removal of the quarantine. A false alarm could be a Canadian herd that received pigs from or delivered pigs to US premises identified as infected. Even if the Canadian contact was eventually proven not to be infected that process would take some time. During those days of movement stand down, isowean production units would develop serious overcrowding. Isowean production facilities that could not be released from the movement restriction within a week would require veterinary intervention and welfare slaughter. In FAD contingency planning there is a need to recognize that early on in the response, veterinary resources will need to be diverted from direct disease control operations to concerns for the welfare of uninfected pigs under quarantine.

DISSECTING DUTCH SUCCESS

Despite some difficulties, the bio-security programs operating in the Netherlands were able to eradicate hog cholera in 1999 and foot and mouth disease in 2001. The evolution of funding, and the management structure for agriculture industries in the Netherlands is significantly different from the funding for the national Animal Health program delivered by the CFIA in Canada. Historically the Canadian National Animal Health Program, as represented by the bovine brucellosis and tuberculosis eradication initiatives was funded 100% from general revenue. Very few current programs in Canada other than National Security are funded in this manner. The current Canadian taxpayer may not be so willing to pay for expensive future animal health programs as was the case in the past. It is likely the current UK FMD outbreak will cost around 30 billion US$, that is 30,000 million or 10X the cost of the Netherlands CSF outbreak.

In 1840 in the Netherlands, a regional check-off program based on cattle production was introduced to fund animal health concerns, with matching government funding introduced in 1850. The fund evolved to a stable administrative structure where by 1988 the government and the livestock industry "stamping-out" fund was applied to African swine fever, hog cholera, foot-and-mouth, swine vesicular disease and Newcastle Disease of poultry. Farmers who's operation was subjected to depopulation were paid full market value for healthy animals, 50% for clinically ill animals and nothing for animals which died of a reportable disease. This compensation program is designed to encourage early reporting of a suspect FAD where a FAD is identified every couple of years. In the early 90's obligatory farm biosecurity measures were introduced such as special clothing and boots, disinfecting facilities and for growing hogs, sourcing from 3 or less suppliers with identification of all pigs to herd of origin. Producers found out of compliance with these regulations at the time of depopulation, were discounted 35% on their compensation. If herd of origin could not be identified for market hogs ordered destroyed, compensation is zero (Horst, H.S. et. al. 1999a).

Both the Dutch government and the organized livestock industries contribute 50% to the stamping-out fund. The industry half of the fund is met by levy on producers. In 1998 a new levy structure was introduced where management practices associated with increased risk would be accompanied by an increased levy. So a 2,000 unit feeder barn sourcing from 3 nurseries would pay a higher levy per animal produced than a 2,000 unit feeder barn with a single source of feeder pigs. This is consistent with a philosophy that those who contribute most to the overall risk should contribute most to the financial reserves required to cover the consequences of disease outbreaks.

One of the down sides of the Dutch model is that funds derived from multiple sources are generally managed in cooperative approach. Decisions made in regards to the fund have to be made in consultation with the contributors and consultation takes time, a commodity in short supply during a FAD incursion (Enserink, M. 2001).

MINIMIZING THE IMPACT

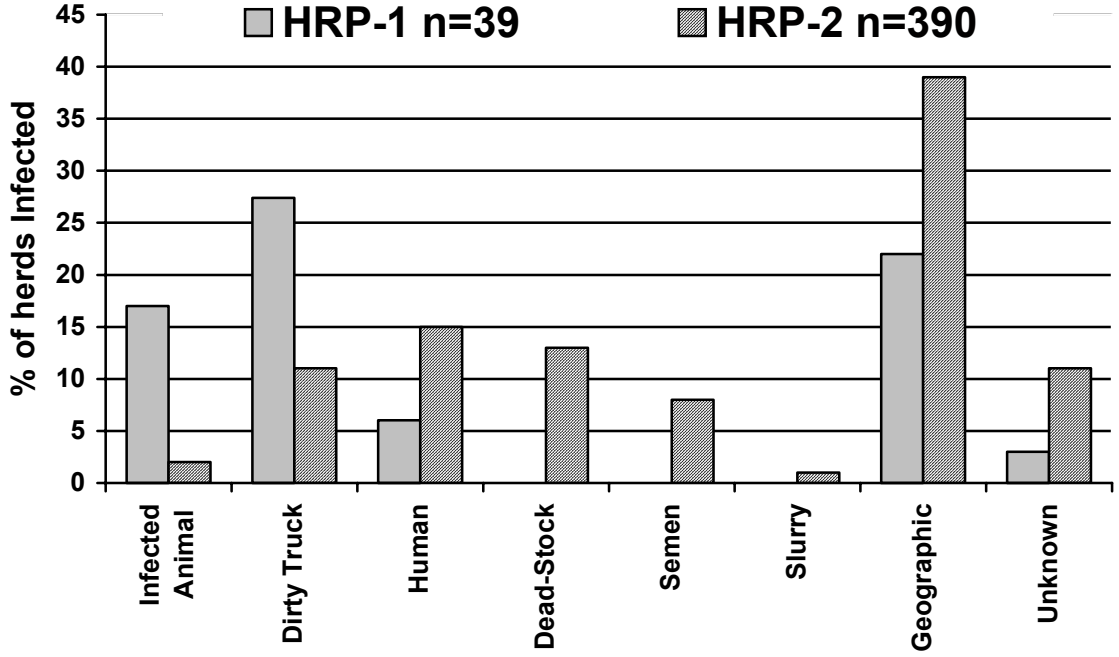
Natural Immunity

Canada is an isolated country with a single international border, fortunately, with the richest and most politically stable country in the world. As a sub arctic nation, most vector born diseases are also exotic. The risk associated with all this fortuitous animal health is complacency. The fact is security is so seductive, and insecurity is so frightening that there is a general difficulty in being objective about risks. However, security is always false, and insecurity is always real. Another hazardous by-product of our natural security is that we in Canada have not developed a culture to deal with changes in animal health risk nor have we made sufficient long term investments in preparedness. I would suggest the lack of a financial structure to compensate for losses related to FAD incursions is a risk to the sustainability of livestock production as we now know it.

How Big an Outbreak is Likely?

The major determinates of the final size of a FAD outbreak are described by the High-Risk-Period-1 (HRP-1), and HRP-2 (Horst HS et al 1998). HRP-1 is defined as the time period from when the infective agent is first introduced into a region and the first detection of infection. HRP-2 is the time from the detection of the agent until all herd to herd transmission has stopped subsequent to implementation of control measures. The Canadian HRP-1, for the CSF virus (time present in the country but not yet detected), would probably exceed the 1997 Netherlands HRP-1 which is accepted as between 21 and 42 days; introduced late Dec-Early Jan and identified on to Feb 4th 1997 (Horst et al 1999b). The HRP-1 for CSF is known to vary widely even within the EC (Horst et al 1999b). The Dutch veterinary infrastructure has a long history with CSF and considerable sensitivity in field and laboratory diagnosis. Prior to diagnosis, CSF will probably have been in Canada for at least 6-10 weeks. The Canadian HRP-2 for CSF, the time from identification to successful stoppage of herd-herd transmission is anyone's guess, as we have no data on which to base a speculation.

Figure 5: Method of introduction of CSF into 429 swine herds in the 97-89 Netherlands outbreak (From Elbers, A.R.W. et. al. 1999). Prior to identification of the emergency, HRP-1, movement of infected animals and dirty trucks were largely responsible for herd to herd transmission with some early geographic spread. Once the disease is identified these risks for transmission are addressed by animal movement controls. In this swine production area animals are at a very high land based stocking density of up to 3000 market hog equivalents per km^2. In North America only parts of North Carolina approach these stocking densities. It is unlikely that the geographic spread of CSF to neighboring farms as seen in the Netherlands would be repeated in Canada or in most pork production areas of the US.



The relative contribution of different forms of herd-herd transmission is well documented for the Dutch CSF outbreak (Figure 5). There are however significant differences in structure of production in North America and Europe. A major sector of the Canadian swine industry is organized as multi-site production and our concentration of swine per square kilometer is generally at least a log unit less than the Netherlands pork production zone. A strict geocentric model to predict CSF spread/control in Canada is probably inappropriate. So, the transmission of CSF by infected vehicles, fairly common in the Netherlands would be rare here. CSF transmission by geographic spread would be rare due to low stocking density in most Canadian production areas. CSF transmission by infected animal movement would probably be at least as important and proportionally greater than ND especially if the index herd was a weanling production unit. Multi-site production results in more swine movement and our relative lack of veterinary diagnostic sensitivity would result in a longer HRP-1. If first introduction was into an isolated finish facility and was detected early, there may be no spread at all.

In the EU experience, if more than 10 herds are infected the cost of humane slaughter always exceeds the cost of stamping out infected herds (Saatkamp HW et al 2000). It is hard to imagine a scenario in North America where CSF or FMD would be detected prior to the infection of more than 10 herds (Author may lack imagination).

There are three basic scenarios that one can imagine in the US-Canada swine market place in relation to FAD. Those are; a limited (1-2 state) or widespread (Multi-state) outbreak confined to the US, a limited outbreak confined to Canada, and an outbreak involving both Canada and US. Because the flow of live animals is predominantly from Canada to the US, it is hard to imagine a widespread outbreak in Canada, which did not involve the US systems. In North America the USA has roughly 10-times the human and animal population as Canada which would suggest 10-fold risk for the index herd in a FMD/CSF outbreak to be located in the US over Canada. The US has thousands of garbage feeding operations (Corso, B. 1997) compared with less than 100 in Canada. The Oklahoma City bombing and other recent incidents would suggest that the US might not have to shop internationally to find individuals capable of terrorist actions. It is therefore likely in a Canada-USA FAD outbreak that the index infected swineherd will be in the US. Paradoxically; with Canadian veterinary infrastructure and emergency planning resources focused on eradication of the disease in Canada, we are currently most prepared for the scenario least likely to happen.

Response

Control of a FAD in Canada-US would probably use the same tools as have proven effective elsewhere, which are the mechanisms of stamping out and movement restriction (Pluimers, F.H. et. al. 1999). We can be confident the initial response to a FAD introduction into either Canada or the USA or both, would include closure of the US-Canadian border. The border would remain closed until sufficient time had passed to assure regions were free of the disease and it was safe to move animals. In a limited distant outbreak, such as hog cholera in Florida, the border could open in 4-6 weeks based on what has occurred in the European Union under regionalization rules of international trade. If there was a multi-centered, outbreak or if both countries were involved, it would take longer to sort things out and return to normal. Manitoba is particularly sensitive to access to the US market for live animals, as we have about 6,000 pigs a day weaned in Manitoba with the nursery barn located in the United states (based on 1.5 million exported weanlings in 2000 and 260 business days).

CANADIAN ANIMAL HEALTH BIOSECURITY PROGRAM

A complete National or Regional bio-security program involves prevention, preparedness, response and recovery. Recognizing the importance of the "war against terror" it is important that nations and regions concerned must take adequate steps to protect their agriculture. In Canada the CFIA describes bio-security protocol at border crossings which is largely delivered by the Canada Customs and Revenue Agency (CCRA). CFIA also directly negotiates health certification requirements for the international trade in products of animal origin and live animals. Both of these systems work exceedingly well.

Some producers may feel confident that we are fully prepared to respond to a FAD outbreak. CFIA has a commitment to responding to eradicate a FAD identified in Canada, however; we can have a very substantial emergency in Canada without ever having FAD identified here. A US border closure does not currently trigger a federal response. The 2000 tripartate exercise would also suggest that even for eradication our North American partners and we are ill prepared (Speers, R. et. al. 2000). Many provinces are generating Foreign Animal Disease Eradication Plans (FADES). These plans are essentially designed to assist the CFIA in the stamping out of infected herds. Currently our "Preparedness" extends only to being able to respond to a limited outbreak (8-10 herds). Response has never been field tested in North America and there has been little effort into preparation for the recovery phase.

There is an ongoing need to educate our farmers and veterinarians about FAD recognition to increase the probability of early detection and early regulatory intervention to avoid spread to other areas. The provision of veterinary diagnostic capability has changed in much of Canada in the past 10 years, from Provincially supported central diagnostic laboratories to private laboratory services. Manitoba may be the only province in Canada with has retained a central veterinary diagnostic service. The impact of privatization of veterinary diagnostics on the ability to early detect an outbreak of FMD has not been evaluated to my knowledge.

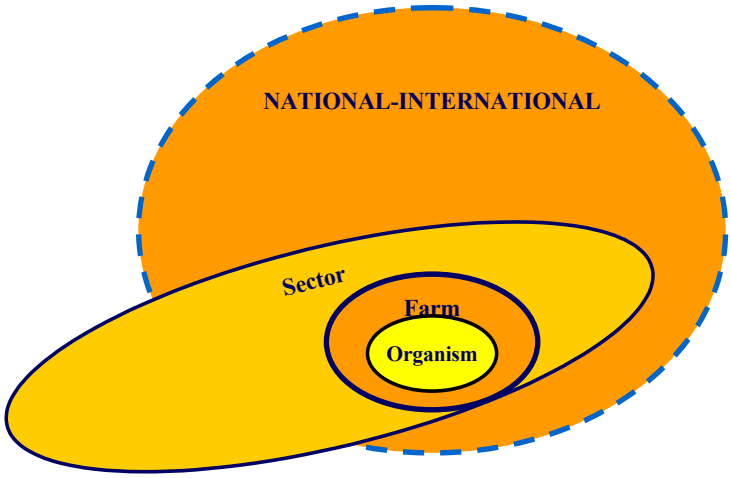
CFIA is the lead agency recognized as responsible for the eradication of a FAD identified in Canada (Bowman & Arldni 1999). Currently the CFIA has authority to pay compensation for animals ordered destroyed because they are infected or have been in close contact with animals infected with a FAD. On February 5, 2001 Prime Minister Jean Chrétien announced the creation of the OCIPEP, the Office of Critical Infrastructure Protection and Emergency Preparedness. While the response structure for stamping-out infected herds is organized from Ottawa, all other emergency response models (fire, floods, tornado, earthquake) are organized at the sub-provincial level through provincial Emergency Measures Management Organization and Nationally through OCIPEP. The Minister of National Defense is the Minister responsible for OCIPEP, which will also encompass the previous functions of Emergency Preparedness Canada.

Foreign Animal Disease is a special type of emergency, which may stand outside current national emergency response structure. This may have been a good design feature when agriculture producers could count on national funding from General Revenue to provide for program delivery. Since our last FMD response in Saskatchewan in 1952 the Federal government has stepped back from program delivery in many areas. Even if a guarantee of central comprehensive funding was present, currently problems like welfare slaughter are not addressed in the National Plans. There is currently no pre-authorized funding for other losses, which would reasonably be expected consequential to the identification of a FAD emergency. Canada is a world leader in not subsidizing agriculture. At the provincial level Manitoba Agriculture and Food is working with the Emergency Measures Organization (EMO) to explore all options for a FAD emergency. Manitoba has a proven track record in responding to natural disasters like the periodic flooding of the Red River. EMO administers the Disaster Financial Assistance (DFA) Program. DFA may be available for eligible costs when a disaster creates an unreasonable financial burden. Assistance is generally provided to help local governments, individuals, full-time farmers, small business and some non-profit

organizations. Government on an event approves provincial emergency programs and assistance is not available for loss of income and opportunity or inconveniences.

Biosecurity (Anti-bioterrorism) is a multidimensional program involving a wide range of participants. Experts suggest that such a program could be maintained and bioterrorism countered at four levels (Figure 6) namely: National, Sector, Farm, and the Organism.

Figure 6: Biosecurity can be assured at four levels:
1. at the **organism** level by breeding disease resistance eg. Scrapie in sheep, biotechnology in crops at this time;
2. at the **farm** level, by management techniques that prevent disease introduction and transmission;
3. at the agriculture **sector** level through early disease detection and response preparedness including funding for consequential losses;
4. and at the **national** level**,** through policies designed to minimize the societal and economic impacts of a catastrophic disease outbreak and minimize the risk of foreign animal disease introduction.
Modified From Kohnen A. 2000. She considered a sector to be clustered within a country. In Canada only supply-managed industries can be considered to be clustered within the country.



CONCLUSIONS

Biosecurity encompasses your farm, your region, the country and international risk management. In all, the challenge is to anticipate the threat, identify it early and counter it while the damage can be minimized. If a FAD were identified in Continental North America, it would be possible to have a significant impact in Manitoba and Ontario without the disease actually being in Canada. Very little preparation has been done to mitigate the risk of business interruption related to a FAD in North America. The pork industry at all levels - farmer, financier, and food processor - must have enhanced participation in all aspects of

biosecurity assurance. With heightened efforts we can hope to effectively protect animal agriculture, one of the economy's critical infrastructures

LITERATURE CITED

Anonymous. May 2001. Foot-And-Mouth Disease Strategy. (Draft) Canadian Food Inspection Agency. Available from Dr. D. Geale, CFIA, Ottawa.

Anonymous. Feb. 1997. Classic Swine Fever Strategy. (Draft) Canadian Food Inspection Agency. Available from Dr. D. Geale CFIA, Ottawa.

Bargen, L.E. and Whiting, T.L. 2002. Time to critical overcrowding in isolated nursery barns placed under quarantine. Proceedings of the American Association of Swine Veterinarians Annual Meeting, Kansas City.

Bowman, Q.P. and Arnldi M. 1999. Management of animal health emergencies in North America: prevention, preparedness, response and recovery. *Rev. Sci. Tech. Off. Int. Epiz.* 18(1):76-103.

Bridges, V.E. and Cummings, D.J. 1998. The potential for international travelers to transmit foreign animal diseases to US livestock and poultry. USDA:APHIS:VS, Centers for Epidemiology and Animal Health, 555 South Howes Fort Collins, CO 80521.

Callis, J.J. 1996. Evaluation of the presence and the risk of foot and mouth disease virus by commodity in international trade *Rev. Sci. Tech. Off. Int. Epiz.*15:1075-1085.

Corso, B. 1997. Likelihood of introducing selected exotic diseases to domestic swine in the continental United States of America through uncooked swill. *Rev. Sci. Tech. Off. Int. Epiz.*16(1):199-206.

Council Directive 80/217/EEC of 22 January 1980 introducing Community measures for the control of classical swine fever (with amendments from: 08/07/1993 last updated: 07/08/2000) available from http://europa.eu.int/eur-lex/en/consleg/main/1980/en_1980L0217_index.html

Council Directive 85/511/EEC of 18 November 1985 introducing Community measures for the control of foot- and-mouth disease (with amendments) Available from http://europa.eu.int/eur-lex/en/lif/dat/1985/en_385L0511.html

Elbers, A.R.W., Stegman, A., Moser, H., Ekker, H.M., Smak, J.A., and Pluimers, F.H. 1999. The classic swine fever epidemic 1997-1998 in the Netherlands: descriptive epidemiology. *Prev. Vet. Med.*42:157-184.

Enserink, M. 2001. Infectious diseases. Rapid response could have curbed foot-and-mouth epidemic. *Science* Oct 5, 294(5540):26-27.

Harris, D.L. and Turney-Harris I. 1999. One site and multi-site swine rearing systems: Standardized nomenclature and alphaumeric notation. Proc. 7th Iowa State Univ. Swine Dis. Conf. pp. 135-147 .

Honey, J. 2000. Manitoba livestock industry profiles 2000 Market Analysis and Statistics Section. Manitoba Agriculture and Food .

Horst, H.S., Hurine, R.B.M., and Dijkhuizen, A.A. 1996. Eliciting the relative importance of risk factors concerning contagious animal diseases using conjoint analysis: a preliminary survey report. *Prev. Vet. Med.* 27:183-195.

Horst, H.S., Dijkhuizen, A.A., Hurine, R.B.M., and de Leeuw, P.W. 1998. Introduction of contagious animal diseases into The Netherlands: elicitation of expert opinions. *Livest. Prod. Sci.*53:253-264.

Horst, H.S., Meuwissen, M.P., Smak, J.A., and Van der Meijs, C.C. 1999a. 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.*18(1):30-37.

Horst, H.S., Dijkhuizen, A.A., Hurine, R.B.M., and Meuwissen, M.P.M. 1999b. Monte Carlo simulation of virus introduction into the Netherlands. *Prev. Vet. Med.* 41, 209-229.

Kellar, J., Lees, W., and Power, C. 2001. Protecting Canadian export markets of livestock and animal products through zoning. Canadian Animal Health Network, Canadian Food Inspection Agency, 3851 Fallowfield Rd., Nepean, Ontario K2H 8P9.

Kohnen, A. 2000. Responding to the threat of agroterrorism: Specific recommendations for the United States Department of Agriculture. BCSIA Discussion Paper 2000-29, ESPD Discussion Paper ESPD-2000-04, John F. Kennedy School of government, Harvard University.

Metcalf, H.E., Blackwell, J.H., and Acree, J.A. 1996. Application of risk assessment to international trade in animals and animal products. *Annal. N.Y. Acad. Sci.* 791:280-295.

Meuwissen, M.P.M., Horst, S.H., Huirne, R.B.M., and Dijkhuizen, A.A. 1999. A model to estimate the financial consequences of classical swine fever outbreaks: principals and outcomes. *Prev. Vet. Med.* 42:249-270.

O'Keefe, J.S., Tempero, J.E., Motha, M.X., Hansen, M.F., and Atkinsona, P.H. 1999. Serology of rabbit haemorrhagic disease virus in wild rabbits before and after release of the virus in New Zealand. *Vet. Microbiol.* 66(1):29-40.

Pluimers, F.H., de Leeuw, P.W., Smak, J.A., Elbers, A.R.W., and Stegeman, J.A. 1999. Classical swine fever in the Netherlands 1997-1998: a description of organization and measures to eradicate the disease. *Prev. Vet. Med.*42:139-155.

Saatkamp, H.W., Berentsen, P.B.M, and Host, H.S. 2000. Economic aspects of the control of classical swine fever outbreaks in the European Union. *Vet. Microbiol.* 73:221-237.

Speers, R., Robinson, M., and Webb, M. 2000. Tripartite 2000 Exercise observations, comments and lessons learned. Operations Evaluation Group CNA Corporation. Available from http://www.humanitarian.net/eidnet/fmd

Tucker, J.B. 1999. Historical Trends Related to Bioterrorism: An Empirical Analysis. *Emerg. Infec. Dis.5:*498-504.

Other Reading

Brown, C.C and Slenning, B.D. 1996. Impact and risk of foreign animal disease. *J. Amer. Vet. Med. Assn.*208(7):1038-1040.

Horst, H.S., DeVos, C.J., Tomassen, F.H.M., and Stelwahen, J. 1999. The economic evaluation of control and eradication of epidemic livestock diseases. *Rev. Sci. Tech. Off. Int. Epiz.* 18(2):367-379.

Knowles, N.J., Samuel, A.R., Davies, P.R., Kitching, R.P. and, Donaldson, A.I. 2001. Outbreak of foot-and-mouth disease virus serotype O in the UK caused by a pandemic strain. *Vet. Rec.*148(9):258-9.

Krystynak, R.H.E. and Charlebois, P.A. 1987. The potential economic impact of an outbreak of foot-and-mouth-disease in Canada. *Can. Vet. J.*28: 8 523-527.

Ramsay, G.C., Philip, P., and Riethmuller, P. 1999. The economic implications of animal diseases and disease control at the national level. *Rev. Sci. Tech. Off. Int. Epiz.*18(2):343-356.

Electronic Sources

Cain, S. Agroterrorism: A Purdue Extension backgrounder September 24, 2001 http://www.humanitarian.net/eidnet/fmd/tripartite2000.html

Pate, J. and Cameron, G. "Covert Biological Weapons Attacks against Agricultural Targets: Assessing the Impact the Impact against U.S. Agriculture." BCSIA Discussion Paper 2001-9, ESDP Discussion Paper ESDP-2001-05, John F. Kennedy School of Government, Harvard University, August 2001. Available at http://ksgnotes1.harvard.edu/BCSIA/Library.nsf/pubs/ESDP01Cameron.

Horn, F.P. Statement by Floyd P. Horn, Ph.D., Administrator, Agricultural Research Service U.S. Department of Agriculture Before the United States Senate Emerging Threats and Capabilities Subcommittee of the Armed Services Committee, October 27, 1999. Available at http://www.senate.gov/~armed_services/statemnt/1999/991027fh.pdf.

National Emergency Response to a Highly Contagious Animal Disease, U.S. Department of Agriculture, Animal and Plant Health Inspection Service. Available at http://www.aphis.usda.gov/oa/pubs/fco412.pdf.

National Association of State Departments of Agriculture FMD Resource Page. Available at http://www.nasda-hq.org/FMD/index.htm.