Pathways Analysis of Classical Swine Fever (CSF) Risk to the United States

Prepared by the

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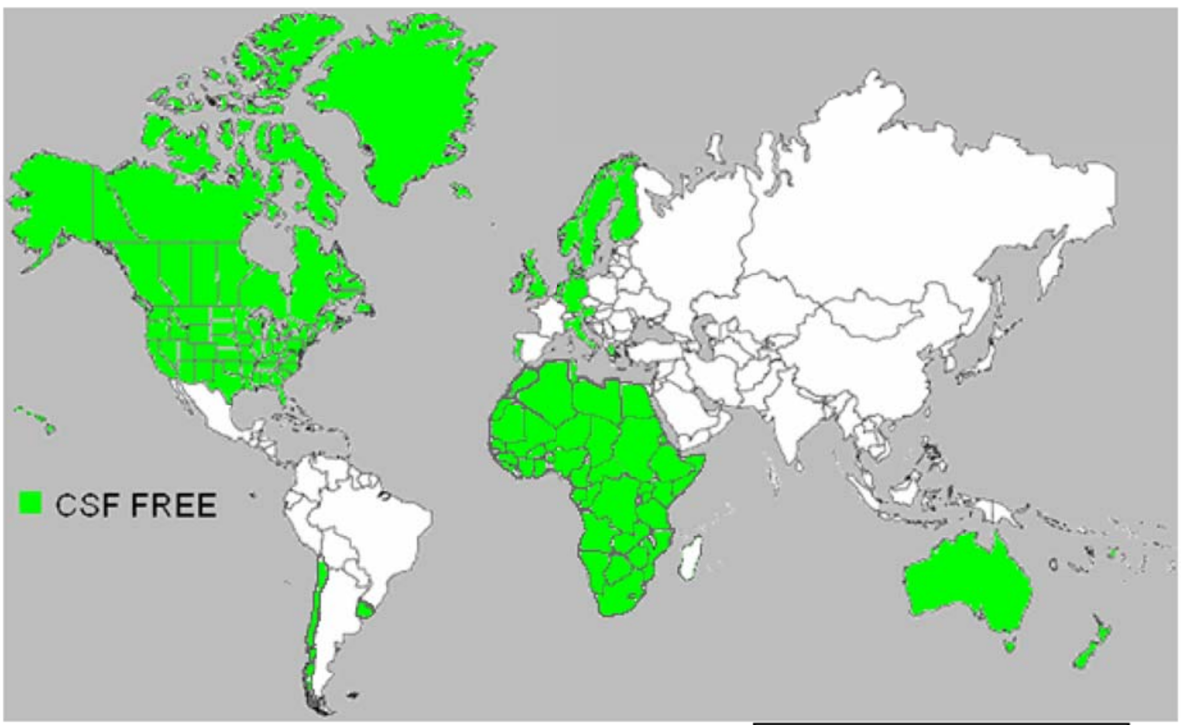
Executive Summary

The threat of agroterrorism and increased globalization of trade and travel have increased concern for either intentional or accidental introduction of a foreign animal disease to the United States (U.S.). Classic Swine Fever (CSF; Hog Cholera) was eradicated from the U.S. in 1978. However, it remains endemic in many regions of the world. As of July 2004, the only North and Central American countries not endemically infected or free from recent outbreaks were Canada, U.S., Belize and Panama. Chile and Uruguay are the only countries in South America that were CSF free. The Caribbean had three countries positive for CSF; Cuba, Haiti, and the Dominican Republic. Continental Africa and Oceana were free while Asia and Europe all had countries that were endemically infected with CSF.



Data provided by USDA

A pathways analysis of the risk of CSF to the U.S. was conducted by the National Agricultural Biosecurity Center Consortium. The report includes relevant background information on CSF (Chapters 1, 2, & 6), evaluates the pathways by which CSF could enter the U.S. (Chapter 3), describes the risks for dissemination of the virus within the U.S. (Chapter 4), and overviews detection methods and surveillance strategies (Chapter 5). An extensive review of the literature and analyses of existing data sources were conducted. Additionally, the project included several original research initiatives: a survey of swine producers to describe international travel of this potentially high-risk group, an investigation of show swine to determine our ability to track movements of these animals, a strategy for identifying and reporting clinical CSF in swine operations, and a series of qualitative surveys of government and industry stakeholders to obtain expert opinion on relevant issues. This report is intended to identify areas of high risk and to highlight knowledge gaps that should be addressed by targeted research efforts.

Classical Swine Fever is a List A animal disease according to the Office of International des Epizooties. It is a highly transmissible disease and causes significant morbidity and mortality in susceptible swine. The introduction of CSF to the U.S. would create significant trade implications. Naïve domestic swine as well as wild boar, feral swine and javelina are susceptible to infection to variable degrees. Due to similarities in disease symptoms, clinical CSF must be differentiated from endemic diseases such as Erysipelas, Salmonellosis, Eperythrozoonosis and salt poisoning.

Ingestion of garbage by swine was evaluated as a pathway of CSF introduction. Licensed waste feeding is legal in the U.S. and ninety percent of the waste fed comes from plate waste, bakery waste and produce. The risk of CSF introduction through the feeding of waste food from restaurants and institutions was low. However, the safety of waste feeding will be correlated with compliance of waste feeding regulations. Outbreaks of CSF in Europe have been attributed to improperly sanitized garbage being fed to domestic pigs.

The greater risk for CSF introduction through garbage feeding is by discarded food that is inadvertently ingested by swine. Prohibited food products arriving at U.S. ports of entry are significant and detection rates are low. This results in a large volume of prohibited product entering the U.S. each year. Europe, the Dominican Republic and Mexico account for a large portion of the legal border crossings each year. Numerous European countries, the Dominican Republic and parts of Mexico are endemic for, or have had recent outbreaks of, CSF. Much of the prohibited food product that enters the U.S. would not subsequently come into contact with swine. However, while the opportunity for smuggled food to come into contact with swine is small, the volume of contraband entering the U.S. is very large, making potential introduction by this pathway an area of concern. It would be useful to conduct a survey of individuals identified with contraband meat materials to better understand the likely dispersion of these products and to target specific education programs to prevent unintentional entry of potentially infectious materials. Smuggling of food by illegal aliens from CSF positive countries is also a concern. Illegal aliens from Mexico, which has endemic CSF in some regions, may enter the U.S. via Texas, which has a large wild swine population. Although Florida does not have a large commercial swine industry, or a large number of feral swine, illegal aliens may enter from CSF-positive countries such as Haiti and Cuba. The potential for illegal aliens from CSF positive Caribbean countries to enter Puerto Rico also is a concern. Data do not exist to quantify the volume of illegal aliens crossing U.S. borders or the amount of contraband they may be carrying.

Travelers or illegal aliens do not represent a high risk for CSF introduction independent of contraband food smuggling. Humans cannot be infected with CSF and therefore cannot transmit the virus to swine. Since the virus can live for periods of time outside of the host, it is possible for a traveler to mechanically carry the CSF virus. In order to initiate an outbreak, they would then need to come into contact with swine in the U.S. While this risk is low for the typical traveler, it may be more plausible for a swine producer or their employees that travel internationally to mechanically carry CSF virus and contact swine within a short period after arriving back in the U.S. Travel among swine producers is extensive. A survey completed as part of this report indicated twelve percent of swine producers traveled internationally within a one-year time frame. Targeting this population of travelers with educational information on foreign animal disease prevention could be prudent.

Trade of farm related equipment and swine related products were considered low risk pathways for CSF introduction. The U.S. trades extensively with countries that are infected with CSF. It is not known if imported products have been exposed to CSF or if the products will come into contact with swine once in the U.S. However, the time it takes to ship materials from other continents to the U.S. would likely surpass the survival time of CSF on most products.

Wild swine are a potential pathway for the introduction of CSF, although their importance is more as a potential reservoir for domestic swine exposure following disease introduction. Wild swine populations have been implicated as the reservoir for intermittent CSF outbreaks in Europe within domestic swine. If CSF becomes established in the wild swine population, it may serve as an endemic reservoir for domestic outbreaks. Along with natural dissemination from wild swine to local domestic herds, there is potential for wild swine to be transported from state to state or into new areas of states with existing populations by hunters seeking to improve hunting opportunities. Much of the wild swine trade or capture and release are facilitated through the use of the internet, making quantification of this risk difficult.

Despite their potential importance, wild swine in the U.S. are an enigma. An accurate estimation of the size and distribution of the wild swine population in the U.S. is not available, although indirect evidence suggests the population is growing. Research to quantify the size and location of wild boar populations and involvement of the hunting industry in foreign animal disease prevention are needed.

The domestic swine industry in the U.S. ranges from large commercial operations to backyard operations. Domestic swine movement is extensive within the U.S. and commingling is common in certain segments of the swine industry (e.g. show stock). The current lack of a national ID system and the inability to accurately track swine movements through the country is a gap in our ability to quickly contain an outbreak of CSF. The size of the backyard swine industry, the location of these operations, and the knowledge level of these producers related to foreign animal disease prevention are not know, and merit investigation.

The ability to detect CSF immediately, should it be introduced to the U.S., is of paramount importance in containment of a disease outbreak. This requires targeted surveillance, laboratory capacity, and producer and veterinarian vigilance. Enhancing our ability to prevent the introduction of CSF, to detect its presence should it occur, and to respond to its introduction will require resources, education, and communication between all stakeholders in government and the swine industry.

Components of a pathways analysis for exotic animal diseases

A pathways analysis is a systematic assessment of the ways in which an exotic disease agent might enter the US and establish an outbreak or persistent focus of disease, and an assessment of the quality and reliability of the relevant data for each arm of the pathway. An assessment of the possible ways an agent could enter the US requires a systematic knowledge of the agent biology and distribution, import source and quantity of risk products, emigration and tourist flow, and the production and distribution systems of the livestock industries at risk. A careful search of the scientific literature and government data must be undertaken to identify all available information relating to the agent and industries of interest. This information must be critically evaluated to assess its quality and reliability and this assessment must be integrated into the pathways analysis.

An additional component of pathways analysis must be the identification of knowledge gaps for assessing the risk from each arm of the path either due to a lack of data or low quality data. Critical evaluation of the available information in the context of all identified paths will identify potential high risk pathways, aid in focussing surveillance and prevention strategies, and identify knowledge gaps for decision-making and needs for future research.

In order for an outbreak of an exotic disease to occur in the US, several steps are required that highlight the issues that must be addressed in a pathways analysis.

- First the disease agent must exist somewhere else in the world with areas of higher prevalence and higher export to the US providing increased risk
- Second the agent must cross the US border, whether in imported livestock produce or other goods, inadvertent tourist introduction, environmental sources such as air or water, or intentional terrorist introduction.

- Finally the agent must reach the (livestock) host within the survival time of the organism and spread from the initial host to other animals to produce an outbreak.

Therefore, a pathways analysis for exotic animal disease should include the following components:

Biology / epidemiology of the disease and disease agent including:

- Livestock species affected including risk factors for susceptibility, species differences and their role in transmission and persistence of the disease.
- Non-livestock animal species that are susceptible (e.g. feral, wildlife) and their role in the epidemiology of infection transmission and as a potential reservoir of persistence.
- Vectors, both biological and mechanical and their role in transmission, spread and persistence of the disease. For biological vectors this must include issues of competence of local vectors, possible introduction of competent vectors and the role of the vector in geographical spread.
- The clinical signs, potential for shedding, subclinical disease, carriers, latent infections and species differences for livestock and non-livestock hosts.
- Routes of infection (direct, indirect, oral, aerosol, trans-dermal, etc.),
- Consideration of possible differential diagnoses that will need to be distinguished either clinically or with laboratory support.
- Assessment of available laboratory methods for diagnosis including available protocols, test performance (sensitivity, specificity, and predictive values), and time required for diagnostic confirmation of disease.
- The replication and shedding of the agent, and risk factors for differences between susceptible species (for example, species differences in the level of viral replication and shedding seen with FMD).
- Survival of disease agent in different mediums (livestock, biologics, meat, repro, persons, cargo / garbage of persons, fomites).
- Survival of disease agent in the environment
- Efficacy of disinfectants on the agent.

Entry into the US:

- *Source of the disease agent:*
    - Knowledge of the current distribution of the agent in the world.
    - Endemic regions and current epidemic regions.
    - Infrastructure and reporting system for negative countries should they become positive (including likely time delay).
    - Ability of national surveillance system to detect disease if present and provide confidence in negative disease status.
    - High risk countries for an outbreak (based on disease prevalence, disease presence in neighbouring countries, trading practices with US and or other high risk countries.
- *Potential routes of entry into the US:*
    - Air, sea, automobile, train, foot traffic at entry points
        - Proportion of traffic originating in disease positive countries.
    - *Legal movements*
        - Quantity of tourism
        - Quantity of risk products imported
        - Status of country of origin (and likelihood that product contacted agent at origin)
    - *Illegal movements*
        - Smuggled products
        - Illegal emigration
        - Status of country of origin for illegal products and immigrants
    - *Screening and identification at entry points*
        - High risk products for disinfection / confiscation
        - High risk persons for education

Entry into the US livestock industry:

- *Potential for agent to spread from US border to susceptible livestock host (case)*
    - Port of origin for incoming person / animal / product.
    - Port of entry for incoming person / animal / product.

  - Proximity of Port of entry to host species.
  - Destination of incoming person / animal / product (may differ from port of entry)
  - Probability of person / animal / product contacting susceptible host within the survival period of the agent.
- *Potential for epidemic*
  - Density of host livestock in the area of the initial case (requires knowledge of national and local livestock distribution)
  - Movement of host livestock, including intrastate and interstate trucking.
  - Farm to farm movements of service vehicles and industries (veterinarians, feed trucks, etc)
  - Presence and density of competent vectors, and feral or wildlife hosts (requires knowledge of national and local distribution)

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Chapter 1

Biology of CSFV

DOMESTIC SWINE

Introduction

Classical swine fever/hog cholera (CSF/HC) is classified as a List A animal disease by the Office of International des Epizooties (OIE; Paris, France). List A animal diseases are highly transmissible, have the potential for rapid spread despite national borders, and have serious socio-economic or public health consequence. List A diseases are of major importance in the international trade of animals and animal products due to the mortality and quarantines associated with them (http://www.oie.int/eng/maladies/en_classification.htm).

Classical swine fever was first described in southern Ohio along the Muskingum River in 1833 and in the Wabash River area of Indiana from 1830 to 1833 (http://www.usaha.org/history/chapter5.html). However, conflicting accounts report that the first case was seen in Tennessee in 1810 with reports coming from France in 1822, Germany in 1833, England in 1862, South America in 1899, and South Africa in 1900 (Straw et al., 1999). Classical swine fever was eradicated from the United States by quarantine and stamping out policy in 1978 after a 16-year effort. The cost was $140 million dollars for the federal, state, and local governments to implement and enforce the United States Department of Agriculture Hog Cholera Eradication Program (USDA, 1981). The $140 million spent on hog cholera eradication in the U.S. in the 1970's is equivalent to $550 million in 2003 (http://www.usda.gov/news/releases/1999/03/0114). The 1997-1998 CSF outbreaks in the Netherlands cost an estimated $2.3 billion dollars with the slaughter or cull over 8 million swine (http://www.iaem.com/index.shtml). Therefore, the estimated $550 million dollar cost to the United States in the face of an outbreak is likely greatly underestimated.

As a result of the successful eradication program CSF is currently classified as a foreign animal disease in the United States (Nettles et al., 1989). The risk of CSF re-introduction into the U.S. is a major concern due to the recent outbreaks that have occurred in Europe, South America, and the Caribbean, especially in Haiti, Cuba, and the Dominican Republic. The recent outbreaks and increased global agro-terrorism threat make the re-introduction of CSF into the United States a possibility that would have devastating impacts on swine production and economies of countries throughout the world.

Causative Agent

Classical swine fever virus is a member of the genus Pestivirus and the family Flaviviridae along with bovine viral diarrhea virus, mucosal disease of cattle, and border disease of sheep (Dahle and Liess, 1992). All members of the family *Suidae* can act as hosts or reservoirs for classical swine fever including Eurasian wild boar (see Ch.4) (Straw et al., 1999). For the sake of clarity, within chapters the terms swine and pig refer to domesticated swine and wild swine refers to feral pigs of domestic origin. Eurasian wild boar refers to swine of descent from true Eurasian wild swine genetics. Javelinas have also proven to be susceptible to CSFV but do not show the clinical manifestations and high mortality characteristic of the *Suidae* (Dardiri et al., 1969). Classical swine fever can spread from pig to pig via fecal/oral routes, oro-nasal routes, intra-uterine (from sow to fetuses), through sexual contact, and via artificial insemination with infected semen (Straw et al., 1999)

The virus is a small (40-60 nm) enveloped, single-stranded RNA virus (Moennig, 2000). The genome of CSFV has approximately 12,300 bases that encode a single polyprotein located within one open reading frame (ORF) that is co- and post-translationally processed to form viral proteins with non-coding regions at the 5' and 3' ends of the genome, and four structural and seven nonstructural proteins (DeSmit et al., 2000 and Moennig, 2000). Of the structural proteins, the E2 (gp55) and E^{rns} proteins are the two most immuno-dominant in the CSFV genome (DeSmit et al., 2000).

Genetic Typing of Classical Swine Fever

Recent advances in molecular virology have allowed for the genetic typing of viruses based on the comparison of nucleotide sequences within viral genomes. By using genetic typing, it is possible to establish the relationship of different CSFV isolates and ultimately aid in the classification and tracing of patterns of virus spread. Genetic typing has proved useful as a means of determining the source and tracing the spread of CSFV. It is generally considered superior to antigenic methods (Paton et al., 2000). Genetic typing has been used to demonstrate: (1) virus dissemination from a point source of introduction; (2) transmission between domestic swine and Eurasian wild boar; (3) transmission across national frontiers; (4) local persistence of particular viral variants, most often within infected wild boar; (5) and differentiation between field and vaccine strains (Paton et al., 2000).

Current methods allow for discrimination between isolates based on the length and variability of the target regions of the genome that are used for comparison. Although there is ongoing debate about which regions of the CSFV genome are the most suitable for characterization and classification purposes, currently the three fragments used for viral sequencing are within the 5'NTR (non-translating region), the E2 gene, and the NS5B gene (Lowing et al. 1996). The 150 nucleotide stretch of the 5' NTR and the 190 nucleotide stretch of the E2 gene (which codes for the major glycoprotein region) have been sequenced for more than 400 CSFV isolates. The 409 nucleotide stretch of the NS5B gene, which codes for the non-structural polymerase protein, has been sequenced in over 110 viral isolates to date.

Studies on the phylogenetic relationship of CSFV have divided the viruses into three main genotypes: 1, 2 and 3, (Lowing et al., 1996) which in themselves have sub-groups allowing for even more specific classification of these isolates. Phylogenetic analysis of the E2 region of the CSFV genome indicates relationships of isolates based on geographical region and time of virus isolation. Group 1.1 and 1.2, historical and vaccine strains from the Americas and Western Europe, were observed from the 1940s -1960s. Only Group 1 isolates have been isolated in the Americas, while Group 2 have been widely spread throughout Europe and Asia, and Group 3 have been confined to Asia except for the Congenital Tremor Strain isolated in the UK during the 1960s (fig. 1.1).

Since 1990, strains from Genotype 1.1 have been isolated within Mexico, areas of Europe, Russia, China, and Thailand (fig. 1.2). Since 1990, genotype 1.2 has been isolated within Cuba, portions of Eastern Europe, and Thailand (fig. 1.3), while type 1.3 has been isolated from Honduras and Thailand (fig. 1.4). Isolates that belong to Group 2.1 and 2.2 have only been found within portions of Western Europe and Asia, while Genotype 2.3 has been isolated in most regions of Europe and in China since 1990 (fig. 1.5-7). A final cluster of isolates have been placed into a separate group classified as Genotype 3. New isolates from genotype 3 have only been isolated from Asia, Korea, Thailand, and Taiwan since 1990 (fig. 1.8).

In Europe, the geographical occurrence of genotypes isolated from domestic and feral origin suggests perpetuation of infection through feral reservoirs (fig. 1.9). Wild-boar populations have been implicated in the endemic CSF infections present in Europe within domestic swine (see Ch. 4) and this data serves to augment the validity of the role wild boar play in CSF epidemiology.

Genetic epidemiology will be valuable for understanding disease spread and the proliferation and occurrence of CSF worldwide. Most of the data utilized in the genetic typing of CSF today is supplied by the CSF European Reference Library in Hannover, Germany, and is cataloged in order to allow access to strain information such as genotype, origin, year isolated, fragments sequenced, and host, whether domestic or feral (http://viro08.tiho-hannover.de/eg). To access this reference one can contact the library by email (irene.greiser-wilke@tiho-hannover.de) and request a user name and password.

Clinical Manifestations

Classical swine fever has four distinct clinical forms that include acute, chronic, congenital, and mild manifestations. The clinical manifestations that appear after infection with CSFV are dependent upon the virulence of the virus strain and host factors such as age of the infected animal (Kamolsiriprichaiporn et al., 1992). Acute CSF (fig. 1.10) involves a disease progression of two to four weeks with symptoms which include high fevers, anorexia, conjunctivitis, cyanosis of the skin, diarrhea, huddling, and uncoordination (Elbers et al., 2002; Laevens et al., 1999; & Moennig et al., 2003). Acute CSF may result in death of the infected swine in as little as 5-15 days with morbidity and mortality reaching 80-100% (Dahle and Liess, 1992). Mintiens et al. (2001) also found that higher mortality rates were observed in fattening pigs and piglets compared to breeding pigs, which was consistent with the findings of Koenen et al. (1996).

Chronic CSF involves a disease progression of 30-90 days or longer before death and usually involves older swine or congenitally infected piglets (http://viro08.tiho-hannover.de/eg/clinical.htm). Development of chronic CSF include symptoms of diarrhea, undulating fevers, retarded growth, and apparent recovery of swine followed by relapse in 50-80% and death in 90-100% of the swine that relapse (http://viro08.tiho-hannover.de/eg/clinical.htm).

Classical swine fever has many carrier states, whereby animals can harbor and shed the virus without showing clinical symptoms of the disease (http://aleffgroup.com/avisfmd). The carrier states include persistently infected piglets and carrier sows (Artois et al., 2002; DeSmit et al., 2000; Laevens et al., 1999; & Meyer et al., 1981). Piglets farrowed by carrier sows may be congenitally infected (Vannier et al., 1981). Wensvoort and Terpstra (1988) found that up to 43% of naturally infected pregnant sows in a herd might act as "carrier sows" and pass infection to their offspring. In later studies it was concluded that the most devastating carrier state of CSF is persistently infected piglets that shed virus for 4-6 months without producing an immune response or disease symptoms. This could allow infected asymptomatic piglets to be transported and introduced to naïve herds, providing a potentially important link in CSF epidemiology (Meyer et al., 1981 and Van Oirschot, and Terpstra, 1977).

The third clinical form of CSF is a congenital (late onset) disease in prenatally infected (persistently infected) piglets (fig. 1.11). Congenital CSF manifestations involve tremors, hindquarter weakness, and poor growth (pigs usually grow with a large head and small body) (Moennig et al., 2003). Many investigations have been conducted to establish the effects of CSFV on gestation. Infection in the first trimester of pregnancy results in seemingly healthy persistently infected piglets that continue to shed virus throughout their lifetime (Artois et al., 2002; Moennig et al., 2003; & Van Oirschot and Terpstra, 1977). During the second trimester, infection can result in abortion, stillbirth, and fetal mummification (Depner et al., 2001). Infection in the third trimester of pregnancy can result in fetal death due to the response of the fetal immune system to infection (DeWulf et al., 2001). Fetuses infected in-utero before the immune system is fully developed are persistently viremic and do not produce antibodies to CSF following birth (Terpstra and

Weensvort, 1997). Piglets with congenital CSF may develop symptoms consistent with chronic CSF within 3-6 months. However, many never develop symptoms but continuously shed virus. The percentage of persistently infected (PI) piglets that continuously shed virus is not known. Persistently infected piglets are perhaps the most important reservoir of CSF in areas lacking a substantial Eurasian wild boar population (Depner et al., 1996 and Van Oirschot and Terpstra, 1977). These asymptomatic pigs may be bought and sold into new herds thus spreading the disease by direct contact with naïve herds (Carbrey et al., 1984).

The final clinical form of CSF is mild CSF, which is typically seen only in sows. It is also known as “carrier sow syndrome” due to the ability of infected sows to continuously shed virus to their young and to swine they directly contact. Mild CSF is associated with the low virulence strains of classical swine fever virus (DeWulf et al., 2001). This form manifests with low reproductive rates due to abortion, fetal mummification, and stillbirth (fig. 1.12).

Although CSF has many forms that affect members of the Suidae there is no potential for this disease to spread to humans (Dahle and Liess, 1992). The threat of the disease as a potential zoonotic pathogen does not exist, therefore, the impact as a bioterrorism threat is diminished.

SUSCEPTIBILITY OF WILD BOAR TO CSF

Introduction

Eurasian wild boar can also act as a reservoir of CSF, and have been implicated in many outbreaks of CSF throughout Europe (Kern et al., 1999). In Germany CSF is not endemic in domestic swine, but is endemic in Eurasian wild boar and has caused sporadic outbreaks when Eurasian wild boars come in contact with domestic swine (Fritzemeier et al., 2000 and Kern et al., 1999).

Epidemiology in Wild Boar

In Eurasian wild boar herds CSF tends to exhibit low virulence, persisting within the population with only slightly elevated mortality rates (Artois et al., 2002 and Laddomada, 2000). The role Eurasian wild boar play in the epidemiology of CSF becomes evident in areas where domestic swine are allowed to roam on free range or where domestic pig holdings do not have secure animal containment. Examples of this can be seen in Italy, Spain, and Sardinia where domestic swine are raised unconfined, thus coming into direct contact with CSF infected Eurasian wild boar (Artois et al., 2002; Fritzmeier et al., 2000; Kern et al., 1999; Laddomada, 2000; & Schnyder et al., 2002). Eurasian wild boar may allow CSF to maintain itself in regions free of CSF in domestic swine. This may allow sporadic outbreaks to occur when Eurasian wild boar come into direct contact with domestic swine.

DIFFERENTIAL DIAGNOSIS OF CSF

The similarity of the signs and symptoms of this disease to the signs and symptoms of many other diseases that affect swine complicate the diagnosis of CSF. Delayed diagnosis due to the need for differentiation could allow the disease to be unknowingly transmitted, thus allowing an epidemic to be established at multiple foci. Some of the diseases that must be differentiated from CSF are porcine dermatitis and nephropathy syndrome (PDNS), African swine fever (OIE List A), erysipelas, salmonellosis, eperythrozoonosis, and salt poisoning (fig. 1.13).

Porcine dermatitis and nephropathy syndrome (PDNS) (fig. 1.14) is characterized by systemic vasculitis with marked tropism for the skin and kidneys. Clinical signs of PDNS include fever, anorexia, and multiple hemorrhages under the skin with predilection for the tail, hindquarters, and ears. PDNS cases may also have massively enlarged lymph nodes and glomerulonephritis (http://www.thepigsite.com). PDNS has a relatively low morbidity rate that is usually less than 1%. Mortality rate ranges from less than 1% up to 20% with severely affected swine dying within 3-5 days after infection (Morilla et al., 2002). Pigs over 3 months of age tend to suffer from higher mortality rates when infected with PDNS (Morilla et al., 2002).

African swine fever (ASF) (fig. 1.15) is another OIE list A animal disease that must be differentiated from CSF. ASF includes similar symptoms to CSF for the first four to six days post infection (dpi). At four to six dpi the highly virulent isolates of ASF result in progressively sicker pigs, with death occurring between 7 and 10 dpi (Morilla et al., 2002).

The moderately virulent ASF isolates result in high fever at 10-12 dpi, with body temperatures and leukocyte counts returning to normal levels at 12-14 dpi. At 12-14 dpi, the pigs develop cyanosis of the skin, ears, tail, extremities, and skin of the hams. Pregnant sows infected with a high, moderate, or low virulence ASF isolate may abort. Swine infected with low virulence ASFV isolates have low fevers that persist for two to three weeks with reddened, raised, necrotic areas developing on the skin during this time. Joint enlargement may also occur during early infection, particularly in the carpal and tarsal joints (Hays, 1996; Kleibocker, 2002; & Oura et al., 1998). Morbidity and mortality rates associated with ASF can reach 90-100% in infected herds and can vary from less than 30% to 100% depending on virulence of the virus strain causing infection (Morilla et al., 2002).

Erysipelas (fig. 1.16) has three apparent clinical manifestations and tends to be more prevalent in pigs from 3 months to 3 years of age (Straw et al., 1999). Acute erysipelas has a sudden onset with marked depression, high fever, and skin lesions often in the shape of a diamond. Sub-acute erysipelas has similar symptoms to the acute disease only less severe (lower temperatures, etc.). Chronic erysipelas develops three or more weeks after the initial infection. Proliferations of bacterial growth that occurs on the heart valves and in the joints cause scar tissue to develop, resulting in exercise intolerance, joint swelling and lameness (Straw et al., 1999).

Salmonellosis (fig. 1.17) is a bacterial wasting disease of swine that must be differentiated from CSF due to the high fevers, cyanotic skin, diarrhea, and nervous signs associated with both diseases. *Salmonella choleresuis*, *S. typhimurium,* and *S. derby* are the three most common strains infecting swine (www.vetmed.iastate.edu). *S. choleresuis* and *S. derby* are host-adapted to swine and can be carried for extended periods of time by sows. *S. derby* causes enteritis and *S. choleresuis* causes fever, depression, septicemia, pneumonia, meningitis, and diarrhea (http://www.thepigsite.com). *Salmonella choleresuis* is most commonly seen in pigs under five months of age and associated with septicemic pneumonia resulting in in-appetence, fever (105-107ºF), and coughing (Straw et al., 1999). *S. typhimurium* and *S. derby* along with other Salmonella species cause enteritis usually manifesting as diarrhea in swine from weaning to 4 months of age (Straw et al., 1999).

Eperythrozoonosis (EPE) is caused by *Eperythrozoonosis suis,* a rickettsia, and is associated with a lack of milk, excessive hair growth, and necrotic ears. As in CSF, swine with eperythrozoonosis have increased respiration, reddening of the skin, high fevers, and diarrhea. EPE tends to be more serious in just weaned or castrated piglets, suggesting an association with stress in younger swine (Straw et al., 1999).

Salt poisoning results in seizures, whereas CSF usually does not. Salt poisoning is usually not seen in nursing piglets. It is recognized in hot weather when water has been withheld and reintroduced followed by symptom development within 24 hours (http://www.thepigsite.com). In comparison, CSF development is not related to weather or availability of water and has at least a 72 hour incubation period.

OTHER PESTIVIRUSES IN SWINE

The discovery in 1960 of a close antigenic relationship between classical swine fever virus (CSFV) and bovine viral diarrhea virus of cattle (BVDV) (Darbyshire, 1960) prompted investigations of BVDV infection in swine. Early studies focused on the use of intentional BVDV infection as a means to immunize pigs against subsequent CSFV infection (Atkinson, 1962; Baker, 1969; Beckenhauer, 1961; & Simonyi, 1967). With the implementation of the CSFV eradication program in the United States in 1962, it became clear that BVDV infection in pigs could potentially interfere with the screening of swine herds for CSFV. With the achievement of eradication in the United States in 1976, attention has shifted to surveillance. In the United States and in other countries declared free of CSFV, it has become imperative to differentiate BVDV infection in pigs from CSFV infection in order to maintain CSFV-free status. At the present time, BVDV infection in swine has become important, as several Scandinavian countries begin the process of eradicating BVDV.

The genus *Pestivirus* is comprised of three viruses of veterinary importance, which were grouped together based upon serologic findings, suggesting that they were related (Darbyshire, 1962 and Plant, 1973). The three viruses are CSFV, BVDV, and border disease virus (BDV) of sheep and goats. The antigenic relationship between CSFV and BVDV was first reported based upon a line of identity between CSFV and BVDV in agar gel immunodiffusion tests (Darbyshire, 1960 and Darbyshire, 1962). This relationship was further supported by cross-neutralization studies (Kumagai, 1962), cross reactivity in immunofluorescence tests between CSFV and BVDV using the same antibody-fluorescein conjugates (Mengeling, 1963), agar double diffusion studies utilizing soluble antigen of CSFV and BVDV (Gutekunst, 1963), and complement fixation tests (Gutekunst, 1964). The relationship of BDV to BVDV and CSFV was discovered later (Hamilton, 1972; Osburn, 1973; & Wenswoort, 1989). In addition, pestiviruses possess the ability to replicate in cells from heterologous species (Moennig, 1990 and Roehe, 1994). Bovine viral diarrhea virus (BDV), and CSFV have been reported to replicate in cells of porcine, bovine, and ovine origin (Roehe, 1994). With the potential that BVDV or BDV infections in pigs could be confused with CSFV in the eradication program, it became important that differences between the three viruses be characterized. Monoclonal antibodies were developed and genetic analysis of BVDV and CSFV isolates has been performed (Edwards, 1988 and Wenswoort, 1989). Bovine viral diarrhea virus and BDV recovered from pigs can now be differentiated from CSFV by the use of monoclonal antibodies (Wenswoort, 1989 and Zhou, 1989) and polymerase chain reaction amplification of genomic segments (Harding, 1996; Hertig, 1991; & Katz, 1993).

Border Disease Virus Infection in Swine

Natural infections of BDV

Natural infections of pigs with BDV have been reported (Vannier, 1988 and Roehe, 1992). The use of a pseudorabies vaccine contaminated with BDV was the source of one outbreak that also involved transplacental infections (Vannier, 1988). The isolate recovered during this outbreak was determined to be BDV based upon comparative serology with the highest neutralizing antibody titers being present against BDV.

Experimental infections

Border disease virus infection in pigs has been experimentally reproduced (Chappuis, 1984; Leforban, 1990; Wrathall, 1978; & Vannier; 1988). Studies on experimental BDV infection in pigs have been done in pregnant swine in order to demonstrate transplacental infection. Three sows were infected by intramuscular inoculation at 34 days of gestation with an emulsion of tissues recovered from lambs infected with border disease virus (Wrathall, 1978). Although BDV and antibody to BDV were not recovered from fetuses, congenital defects such as cerebellar hypoplasia were recognized. In another study, two pregnant sows were intramuscularly inoculated between days 25 and 29 of gestation with the reference strain of BDV designated as the Aveyron isolate (Leforban, 1990). Transplacental infection with BDV occurred as evidenced by the birth of persistently infected piglets with BDV. Experimental reproduction of the natural outbreak involving a pseudorabies vaccine contaminated with BDV was performed by inoculating sows on day 25 of gestation by intramuscular injection of the vaccine. Transplacental infection, as evidenced by the birth of persistently infected piglets, was demonstrated in 2 of 2 sows infected (Vannier, 1988).

Clinical manifestations

Natural infections of pigs with BDV have been associated with repeat breeding, stillbirths, and mummified fetuses at birth (Vannier, 1988). Most cases of BDV infection in the dam are not apparent and the only evidence of infection is the development of neutralizing antibodies to BDV following infection (Leforban, 1990 and Vannier, 1988). In the piglets born from sows naturally infected with BDV, eyelid edema, locomotor disorders, diarrhea, and arthritis were reported (Vannier, 1988). Mortality for the first 2 days of life in litters of congenitally infected piglets varied from 30% to 70% (Vannier, 1988).

Following experimental infection of pregnant sows with BDV, clinical signs of disease in the sows were not evident (Leforban, 1990 and Wrathall, 1978). However, piglets born from experimentally infected sows with BDV demonstrate eyelid edema, pyrexia, diarrhea, and stunting, as well as an increased perinatal mortality (Leforban, 1990).

Bovine Viral Diarrhea Virus Infection in Swine

Natural infections

Bovine viral diarrhea virus infection in swine has been reported to occur under natural conditions as evidenced by the presence of specific antibodies to BVDV (Holm and Jensen, 1985 and Loken, 1991). Serological surveys have also confirmed the worldwide distribution of BVDV in swine. The first report suggesting natural BVDV infection in pigs was from Australia (Flynn, 1964). A study of breeding pigs in Germany indicated that 42% of pigs possessed neutralizing antibodies against BVDV with reciprocal titers ranging from 5 to 640 (Liess, 1976). A study conducted in the Republic of Ireland showed that 27.8% of pigs in contact with cattle possessed neutralizing antibodies to BVDV, as compared to 4% of pigs without contact (Lenihan, 1977). Serological surveys performed on pigs in the United States have shown higher neutralizing antibody titers to BVDV when compared to CSFV, indicating natural infection with BVDV (Carbrey, 1976 and Fernelius, 1973). A study performed in the

Netherlands indicated that a range of 15-20% of the pig population possessed antibodies to BVDV (Terpstra, 1988). A serological survey performed on 2,996 Danish pigs indicated that 6.4% possessed antibodies to BVDV (Holm and Jensen, 1985).

The first reported isolation of BVDV from naturally infected pigs came 12 years after it was confirmed that BVDV and CSFV were serologically related (Fernelius, 1973). The source of BVDV in this case was suggested to be a calf that was in direct contact with pigs. The virus was determined to be an isolate of BVDV based upon immunofluorescence and the production of bovine viral diarrhea and death in susceptible calves. Close contact between cattle and pigs was also the focus of another report in which natural infection of pigs with BVDV was documented (Paton, 1992). In this report, transplacental infection was reported with the birth of persistently viremic piglets. Other reports have documented natural infections of pigs with BVDV, without direct contact between cattle and pigs (Carbrey, 1976; Stewart, 1971; & Terpstra, 1988). Contaminated personnel and equipment was considered the source of infection of pigs with BVDV on a farm in Indiana where intensive production methods were employed and pigs and cattle were separated (Carbrey, 1976). The feeding of bovine offal to pigs has also been a source of natural infection with BVDV (Carbrey, 1976 and Stewart, 1971). Other origins of BVDV infection in pigs include the feeding of BVDV-contaminated whey and milk products to pigs (Terpstra, 1988) and the use of BVDV-contaminated vaccines (Wenswoort, 1988). Modified-live vaccines for CSFV (Wenswoort, 1988) that were contaminated with BVDV were responsible for outbreaks in pig herds and resulted in transplacental infection.

Transplacental infection of swine with BVDV has been reported under natural conditions, with the clinical signs in piglets closely resembling transplacental infections with CSFV (Terpstra, 1988). The sources of virus for infection of pigs were close contact with persistently infected calves (Paton, 1992 and Terpstra, 1988) or the use of vaccines contaminated with BVDV (Wenswoort, 1988). The transplacental infections were suspected by the presence of viremic piglets or the isolation of BVDV in tissues from pre-weaned piglets. The differentiation of BVDV from CSFV was achieved by determining reactivity patterns to monoclonal antibodies specific to BVDV and/or CSFV (Paton, 1992; Terpstra, 1988; & Wenswoort, 1988). When a persistently infected calf was in contact with 6 breeding gilts, transplacental infection with BVDV was confined to 1 litter of piglets with 5 of 7 piglets positive for BVDV by virus isolation at birth (Paton, 1992). In sows receiving contaminated vaccine, an examination of 232 piglets from 31 litters revealed that 135 piglets were positive for BVDV by immunofluorescent antibody testing of tissues taken at necropsy (Wenswoort, 1988).

Experimental infections

Bovine viral diarrhea virus infection has also been experimentally reproduced in pigs. Early studies utilized BVDV infection in swine as a means of immunizing pigs against CSFV challenge (Baker, 1963; Beckenhauer, 1961; Langer, 1963; Tamoglia, 1965; Sheffy, 1961; & Simonyi, 1967). Different BVDV isolates were tested, but all BVDV isolates were administered by parenteral administration (intravenous, intramuscular, subcutaneous). The results of the early experiments indicated that BVDV infection in swine had some value in protecting pigs from severe disease following challenge with CSFV (Beckenhauer, 1961 and Sheffy, 1961). In contrast, a later experiment using the same viral isolate demonstrated that no protection was offered as all pigs vaccinated with BVDV died following CSFV challenge (Simonyi, 1967). Further experimental infections of BVDV in swine utilizing different BVDV isolates and routes of inoculation were performed in order to obtain additional information on the immunologic, pathologic, serologic, and virological responses of pigs infected with BVDV and to further define the taxonomic relationship between CSFV and BVDV. An early experimental study documented the infection of pigs with BVDV by exposure of pigs to a calf (Snowdon, 1968). The report also cited that feeding of tissue from a calf infected with BVDV resulted in infection and seroconversion. Serologic responses following experimental infection were further characterized. Neutralizing antibodies following experimental intranasal BVDV infection in weaned pigs may appear as early as 14 days after infection (Stewart, 1971), but are consistently present at 3 to 4 weeks after inoculation (Dahle, 1993 and Stewart, 1971). Following experimental inoculation BVDV was isolated from peripheral blood leukocytes between days 4 and 17 after inoculation (Castrucci, 1975; Dahle, 1991; & Fernelius, 1973). Bovine viral diarrhea virus was isolated from feces and nasal mucus, thus suggesting that pigs may be involved in the transmission of BVDV to cattle (Fernelius, 1973). Intranasal inoculations of pigs with BVDV were performed to simulate natural infections. Bovine viral diarrhea virus was isolated from tissues collected at postmortem examination most consistently at 7 days after intranasal inoculation (Phillip, 1972 and Stewart, 1971).

Transplacental infection with BVDV in pigs has been experimentally reproduced (Dahle, 1987; Leforban, 1990; Paton, 1994; & Stewart, 1980). Results following experimental infection have been quite variable based upon differences in routes of inoculation, dose of inoculum, isolates used, and the stage of gestation when inoculation is performed. Routes of inoculation have included intranasal (Dahle, 1987; Paton, 1994; & Stewart, 1980), intramuscular (Leforban, 1990), and intrauterine (Paton, 1994). The titers of infecting inoculum have ranged from $10^{5.5}$ to $10^{7.5}$ $TCID_{50}$. Of 5 isolates administered by intranasal inoculation between 25 and 55 days of gestation, transplacental infection with BVDV was achieved with only 1 isolate given on day 46 of gestation (Stewart, 1980). The isolate causing transplacental infection was originally isolated from a naturally infected pig and passaged once in a calf. The isolates NY-1 and NADL, which are common reference strains, did not cause transplacental infection. Another study utilizing the NADL isolate also failed to show transplacental infection following intramuscular inoculation on day 29 of gestation (Leforban, 1990). Transplacental infection by intranasal inoculation was not achieved in a study using two pregnant gilts infected on days 34 and 79 of gestation (Dahle, 1987). The isolate used was a field strain obtained from a persistently infected heifer from a herd in which there was a history of BVDV-associated abortions. Transplacental infection was reported to occur at day 37 of gestation following intranasal inoculation and at days 35 and 42 of gestation following intrauterine inoculation of a BVDV strain originally isolated from a pig (Paton, 1994). Transplacental infection was documented by the presence of viremic piglets at birth or the presence of neutralizing antibodies to BVDV in precolostral serum samples obtained from piglets at birth. In addition, transplacental infection occurred following intrauterine inoculation at day 27 of gestation with an isolate obtained from the persistently infected steer that was thought to be the index case of the outbreak involving natural infection of pigs with BVDV (Paton, 1992).

Clinical manifestations

Bovine viral diarrhea virus infection in immunocompetent, nonpregnant pigs causes subclinical to mild clinical signs. Most cases of natural infection are not apparent and the only evidence of infection is the development of neutralizing antibodies to BVDV following infection (Fernelius, 1973). Experimental inoculation of nonpregnant pigs has also indicated that BVDV infection in swine is subclinical (Dahle, 1991; Fernelius, 1973; & Phillip, 1972) or causes only mild clinical disease with mild anorexia and elevated rectal temperatures being reported (Stewart, 1971). Leukopenia is the only laboratory abnormality reported following infection with BVDV in swine (Carbrey, 1976 and Stewart, 1971).

Clinical manifestations following infection of pregnant swine have been varied based upon differences in routes of inoculation and isolates of BVDV used. Bovine viral diarrhea virus infection in the pregnant pig usually results in subclinical disease, similar to the infection of nonpregnant pigs (Stewart, 1980). Some cases of natural BVDV infections have been associated with breeding problems such as poor conception, small litters, and abortions (Terpstra, 1988), similar to infection with CSFV isolates of low virulence.

Clinical manifestations following BVDV infection in pregnant swine have been reported in newborn piglets that have acquired the infection *in utero*. These clinical signs are indistinguishable from signs of congenital CSFV infection, which include elevated neonatal mortality, the birth of weak piglets with tremors, and skin hemorrhages (Dahle, 1990). Neurological signs consisting of clonic spasms or tremors have also been reported at birth following congenital BVDV infection (Stewart, 1977 and Terpstra, 1988). Viremic piglets may also appear normal at birth (Paton, 1994). Clinical manifestations of congenital BVDV infection usually develop 2 to 3 weeks after birth and include rough hair coat, growth retardation, wasting, hyperthermia, diarrhea, petechiae in the skin and mucus membranes, blue eartips, and conjunctivitis (Terpstra, 1988). In addition, elevated mortality rates in piglets congenitally infected with BVDV have been reported (Paton, 1994 and Wenswoort, 1988). Anemia and leukopenia have been reported as laboratory findings associated with congenital BVDV infection (Patton, 1992 and Terpstra, 1988).

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Chapter 2
Global Epidemiology

GLOBAL PREVELANCE OF CSF 1990-2002

Successful eradication of CSF has been achieved in many parts of the world, including North America, Australia, and parts of Northern Europe. Many countries have successfully maintained disease free status in the absence of vaccination, with a totally susceptible swine population (Edwards et al., 2000). Although eradication of classical swine fever in these geographical areas has proven feasible, other areas such as Central and South America, portions of Europe, and the Far East have been unsuccessful in their attempts to effectively control or eradicate CSF. The efficacy of control programs globally seems to depend upon the state of the national economy, and development of veterinary and laboratory infrastructure within the geographical region.

The Americas

The countries listed by the Office International des Epizooties (OIE) as CSF-free in North and Central America are Canada, the United States, Belize, and Panama. Canada and the United States have been free of CSF since 1963 and 1976, respectively; while Belize and Panama have not had an outbreak since 1988 and 1961, respectively.

Mexico can be divided into three areas with respect to CSF status. The northern states and the Yucatan Peninsula are free of the disease without the use of vaccination while the southern states have endemic infection and continue vaccination. The central part of Mexico acts as a buffer region where an eradication program has been initiated with a stamping out policy and prohibition of vaccination. In Central America, apart from Belize and Panama, CSF is endemic and vaccination is used (fig. 2.1).

Within South America, CSF is endemic or sporadic in most regions except Uruguay and Chile where free status was attained in 1991 and 1996, respectively. Brazil is divided in terms of CSF status not unlike Mexico. Area 1, which is composed of the three most southern states and is the most industrialized area in terms of pork production, is considered free of disease and vaccination is prohibited. CSF is still endemic in Area 2 and there is a large swine population that is vaccinated routinely as a means of prevention. Area 3, which is composed of the rest of the country, does not have a large swine population, therefore a vaccination program is considered unwarranted.

According to information provided to the Food and Agriculture Organization of The United Nations (FAO), programs for control of CSF are being implemented in Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador and Paraguay (fig. 2.2). The measures adopted include vaccination, laboratory testing, stamping out, quarantine, control of transit, and import restrictions (Edwards et al., 2000).

Three countries in the Caribbean have endemic CSF infections: Cuba, Haiti, and the Dominican Republic (http://www.oie.int). CSF was introduced to Cuba in the 1930's, but was kept under control through the use of vaccination until the beginning of the recent outbreaks in 1993. The first case in Haiti was reported in 1996 and may have been introduced from Cuba. The Dominican Republic is located on the same island as Haiti. Therefore, vaccination campaigns were organized and almost one million pigs in Haiti were vaccinated in an attempt to stop the spread of the disease to the Dominican Republic. However, an outbreak was reported within the Dominican Republic in June of 1997. In December of 1997, outbreaks were reported throughout the Dominican Republic and vaccination campaigns were initiated in an attempt to control disease spread within the country.

Europe

The primary objective of the EU is to establish free movement of people, capital, services, and goods between member states. Therefore, animal disease control programs are of the utmost importance to insure not only animal health throughout the entire region, but also to sustain disease-free status for international trade purposes. At the time of this writing, the member nations of the EU are: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, The Netherlands, Portugal, Spain, Sweden, and the United Kingdom. During the 1980's, the member states moved from a diversity of national control policies towards a common, community-wide approach based on the cessation of vaccination (where it had been practiced), notification of outbreaks, harmonized control measures, uniform diagnostic procedures, contingency plans, establishment of epidemiological units, and financial support in an attempt to eradicate CSF (Edwards et al., 2000).

Many regions within the European Union are endemically infected with CSF although attempts at eradication are made within domestic populations. CSF exists within populations of Eurasian wild boar that serve as natural reservoirs of the disease and perpetuate occurrence within domestic herds that come in close contact (figs. 2.3 & 2.4). In particular, Germany, Austria, Switzerland, Italy, and many eastern European states have had problems with cross-transmission from feral populations to domestic populations. Many of these countries have established control and surveillance programs to limit the occurrence of cross-transmission. Since 1995, there have been several major outbreaks in domestic swine and wild boar. The 1997/8 Netherlands outbreak and the 2000 East Anglia outbreak in the U.K. resulted in the culling of millions of pigs to control the epidemics. According to the OIE, the only countries in Europe that have successfully eradicated CSF since 1990 are Ireland, Portugal, Denmark, Norway, Sweden, Finland, and Greece (fig. 2.5).

Africa

According to the Office International des Epizooties (OIE), continental Africa has been historically free of CSF. The exception is Namibia and South Africa, where isolated cases were reported in 1917 and 1918, respectively. Madagascar and Mauritius, two islands off the southeast coast of mainland Africa, have endemic CSF infections and are currently using vaccination as a means of control (figs. 2.6 & 2.7).

Asia

The presence of classical swine fever within Asia is still a problem in many regions, but is absent in most areas of the middle-east. Within the far-east, and in particular Southeast Asia, CSF outbreaks occur regularly in most countries except Japan (fig. 2.8). The last known CSF epidemic in Japan occurred in 1992 and a three-phase eradication program was initiated in 1996. The first phase took 2 years and consisted of vaccination of nearly 100% of the swine population. The next phase established a CSF-free zone without vaccination while the third and final phase (1 year) was the suspension of vaccination completely and confirmation of the region as free of CSF. While Japan has made strides at eradication the rest of the region has not initiated such a proactive plan. This could be due to economic situations, general infrastructural problems, lack of trained personnel, or non-prioritization of CSF eradication programs. The status of the CSF eradication program in N. Korea is currently unknown.

Oceania

Oceania, according to the OIE, is free of CSF as a region (fig. 2.9). The last known occurrences within this region occurred in Australia and New Zealand in 1962 and 1953, respectively.

OIE REQUIREMENTS FOR CSF (-) STATUS

The OIE requirements for CSF-free status, as defined at (http://www.oie.int/eng/normes/mcode/a_00042.htm), are as follows (OIE, 2003):

1. Historically Free Status

A country or zone may be considered free from the disease in domestic and wild swine after conducting a risk assessment as referred to in Article 2.1.13.2. but without formally applying a specific surveillance program (historical freedom) if the country or zone complies with the provisions of Article 3.8.1.2.

2. Free status as a result of an eradication program A country or zone which does not meet the conditions of point 1 above may be considered free from CSF in domestic and wild swine after conducting a risk assessment as referred to in Article 2.1.13.2. and if:

A) it is a notifiable disease;

B) domestic pigs are properly identified when leaving their *establishment* of origin with an indelible mark giving the identification number of the herd of origin; and a reliable trace back procedure is in place for all pigs leaving the farm of origin;

C) the feeding of swill is forbidden, unless the swill has been treated to destroy any CSF virus that may be present, in conformity with one of the procedures referred to in Article 3.6.4.1

D) animal health regulations to control the movement of *commodities* listed in Article 2.1.13.8. have been in place for at least 2 years to minimize the risk of introduction of the infection into the *establishments* of the country or zone;

E) where a *stamping-out policy* without vaccination has been practiced for CSF control, and no *outbreak* has been observed in domestic pigs for at least 6 months; or

F) where a *stamping-out policy* combined with vaccination has been practiced, vaccination against CSF should have been banned for all domestic pigs in the country or zone for at least one year. If vaccination has occurred in the last 5 years, a serological monitoring system should have been in place for at least 6 months to demonstrate absence of infection within the population of domestic pigs 6 months to one year old, and no outbreak can have been observed in domestic pigs for at least 12 months; or

G) where a vaccination strategy has been adopted without a *stamping-out policy*, vaccination against CSF should have been banned for all domestic pigs in the country or zone for at least one year. If vaccination has occurred in the last 5 years, a serological monitoring system should have been in place for at least 6 months to demonstrate absence of infection within the population of domestic pigs 6 months to one year old, and no *outbreak* has been observed in domestic pigs for at least 12 months;

H) CSF infection is not known to occur in the Eurasian wild swine population.

CHARACTERISTICS OF CSF OUTBREAKS

The OIE provides data pertaining to epidemiological details of CSF and other animal disease occurrence in two methods. One method is the multi-annual disease status website

(Handistatus II) which allows access to information such as a nation's disease status for a particular year and the total numbers of animals affected by country/year (fig. 2.10) (http://www.oie.int/hs2/report.asp?lang=en). This database is compiled by the OIE through the aid of the member countries that report information on disease activity/country such as: number of outbreaks, cases, and deaths due to specific disease as well as number of animals destroyed, slaughtered, or vaccinated in attempts to curb disease transmission. Appointed OIE delegates from member countries gather information on outbreaks concerning notifiable diseases from state and local veterinarians. This information is then reported to the OIE in a standardized manner so that it can be entered into the database and compared with the current disease situation world-wide.

The second method the OIE uses to provide information is through weekly updated reports that provide more in-depth, herd-level, information on an outbreak (fig. 2.11 or http://www.oie.int/eng/info/hebdo/A_INFO.HTM). Details on estimated date of infection and date of outbreak as well as number of animals susceptible and descriptions of the affected populations are provided (note: OIE definitions for terms used in this data set are provided in appendix). Through comparison of these databases we can make some rational conjectures about disease occurrence, prevention, and reporting world-wide.

According to data provided by the OIE online (Handistatus II) multi-annual disease status website (http://www.oie.int/hs2/report.asp?lang=en), since 1998 there have been at least 4,940 outbreaks of CSF in 59 countries world-wide. Affected regions of the world include countries within Europe, Asia, and the Americas. (figs. 2.12 & 2.13). It is apparent that reporting is more likely to take place on a yearly basis rather than on a weekly basis. This is evident by the discrepancies between the numbers provided yearly and weekly during the period 1998-2002. The total number of outbreaks reported to OIE yearly (1998-2002) is more than ten fold the total number of outbreaks reported within the weekly (1998-2002) database. Because the number of outbreaks and cases recorded within the yearly database were greater in number than those of the weekly database, these numbers characterize the nature of CSF activity in a global manner. The weekly reports, which are more "real-time", focus more on herd-level outbreak information and provide additional epidemiological details not included within the yearly database. These reports, although extremely helpful because of their "real-time" reporting do not include information on all outbreaks throughout the world. This manner of reporting is confined to countries that have better economic resources, or were thought to be free from CSF prior to the outbreak.

In both databases, a consistent case fatality rate of around 40% is seen throughout the 5 geographic regions, with only the Central-America / Caribbean region higher at 56.04%. This region also reported the lowest number of animals destroyed per outbreak, which could lengthen the time of clinical infection and thereby result in more deaths. This low number of animals destroyed per outbreak may reflect a less aggressive approach towards eradication of outbreaks. The Central America / Caribbean region also reported the highest average percentages for morbidity and mortality at 59.27% and 31.85% respectively. Morbidity and mortality can be altered by eradication campaigns and are not entirely due to virulence factors associated with differing strain types. Since most clinically infected animals are destroyed before disease resolution, morbidity and mortality also are suggestive of the intensity of aggressiveness and vigilance within prevention and eradication programs. However, vigilance and aggressiveness of an eradication program are not the only factors determining the apparent morbidity and mortality of an outbreak. Differences in approach to eradication (e.g. vaccination vs. preemptive slaughter), as well as differences within industrial practices such as numbers of swine per holding and the swine density of particular regions act as morbidity and mortality determinants.

The European Union, though among the lowest with regards to morbidity and mortality percentages of swine within the affected herd, has the highest numbers of animals destroyed both overall and per outbreak, as well as the highest number of cases/outbreak (a case refers to an individual animal affected while an outbreak refers to the herd level). This could be attributed to the strict non-vaccination policy in effect within these nation-states but could also reflect the production practices of larger operations, as illustrated by the EU's number of susceptible animals/outbreak being nearly 1958 hogs (fig. 2.13).

The European Union and Asia had an increase in the occurrence of CSF from 1998-1999, then a decrease in 2000, and an increase again in 2001 (figs 2.15 & 2.16). The Central American/Caribbean countries and South American countries had a gradual decrease in the number of outbreaks reported over the years 1998 (400 outbreaks) to 2001(133 outbreaks), while the European Non-EU countries exhibited a gradual increase in occurrence from 179 outbreaks in 1998 to 268 outbreaks within the year 2001. The numbers for 2002 and 2003 were not complete and therefore are not fully representative of the yearly situations. Other than a noticeable spike in occurrence within Asia during the year 1999 to over 800 reported cases, the range for the averaged annual reported cases of CSF falls between 27 outbreaks within S. America, and 428 outbreaks per year within Asia.

European countries, both EU and Non-EU, and countries located within the Central America/Caribbean region all had averages slightly above 200 outbreaks per year.

The OIE weekly reported data set was summarized to describe trends in monthly incidence (figs. 2.16 & 2.17). Peaks and troughs observed within the year may be indicative of seasonality. An overall peak in occurrence can be noted within the months of July, August, September, and October. A trough was seen February, March, April, and May, aside from a peak that occurred in April within European Non-EU countries. While these apparent trends seem to exhibit seasonality, reporting distribution within the monthly database could in itself also be seasonally biased. Although there is not enough data to investigate seasonality, it would be interesting to see a study of occurrence that covered a broader frame of time and range of outbreaks. More robust surveillance to assess the temporal distribution of outbreaks would aid in understanding both the etiology of the disease and the months that may represent a higher risk for the possible introduction into the United States.

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Chapter 3
Potential Pathways

INTRODUCTION

Definition of Pathway Analysis: A list of weak spots and how to fill them (Anon)

A pathway is any means by which the CSF virus could cross our borders and infiltrate our domestic swine industry. A pathway in one country may not be a significant pathway into the United States. In terms of response, the U. S. should not necessarily mimic other countries without having sufficient pathways analyses to deem it necessary. It is important to stay aware of other country's experiences with diseases such as CSF, especially if those diseases are foreign to our country. However, this should not be the only strategy for disease prevention.

Understanding how other countries have dealt with various emerging disease outbreaks helps us to identify possible pathways of a disease into our country. As an example, most of our live swine and swine products are imported from Canada and a select few other countries that have a negative CSF status. Germany and the Netherlands on the other hand, have trucks bringing live pigs across the border and into their countries from CSF countries. So, the latter would be a pathway identified by knowing their experiences with CSF, but an insignificant one in the United States. However, the risk of introduction would greatly increase if Canada's CSF status changed.

A recent risk analysis of the introduction of Foot and Mouth Disease (FMD) into Europe suggested that 50% of the risk could be attributed to three pathways: illegal movement of livestock or animal products, food carried by tourists or immigrants, and legal trade in animal products (International Conference on Control and Prevention of FMD). The risk of many of these pathways in the United States is minimized due to current regulations and actions taken by state and national agencies concerned with food animal health. However, since an estimated 2 million people cross our borders every day, the food carried by tourists and immigrants, and the illegal movement of people and products become a major concern. For example, we must be very concerned about CSF contaminated meat coming in on small boats and possibly infecting feral swine, thereby establishing a natural reservoir for disease propagation.

An important point to highlight is that our knowledge of the movement of people, as well as the trade of animals and products, stops at the point of entry into the United States. Estimates of the volume of products and people entering illegally can be made by considering both the amount of product confiscated and the number of people apprehended. But, without information regarding the dispersion of people and products once within the United States it is difficult to determine where the eventual CSF outbreak could occur.

We approached the CSF pathway analysis using two methods; available data sources and scientific literature were used to describe the possible pathways of entry into the U.S. and to ascribe a qualitative risk; a qualitative survey was used to complement this information and to obtain expert opinion on both legal and illegal modes of entry.

The first element of the pathway analysis considered all products ("mediums") that were of swine origin or industry related that could come into direct contact with hog operations or other parts of the industry. To identify high-risk areas or practices for CSF virus introduction to the United States, we considered both the volume (number) entering the country and the respective survival time of CSF within each medium. The year 2000 was used to illustrate these pathways because there were significant amounts of data readily available on product importation, occurrence of CSF (OIE data), and immigration and transportation of people.

Due to the existence of knowledge gaps related to survival period in many mediums other than live swine and processed meats, all were considered. These mediums include live swine, hog products for human consumption and not for human consumption, industry related products, humans, and environmental sources. Hog products for human consumption consist of any hog products that are normally utilized within the human food chain including meats in varying preparation styles. Hog products not for human consumption mainly consist of any portion of swine that are not normally used within the human food chain (i.e. glands and extracts) or swine products that are processed for companion pets (i.e. dog and cat food). Industry related products include all swine industry products that could potentially come in contact with swine before entering the United States. Additionally, a survey was developed and sent to swine producers to describe the travel patterns of this potentially high-risk group.

The second element of the pathway analysis utilized survey techniques to gather expert opinion on the concept of pathway analysis from a variety of stakeholders, as well as to obtain expert opinion on host-agent-environment interactions related to CSF entry into the United States and additional information on the role of feral swine. We concentrated our efforts on high-risk pathways from both national and international perspectives, gathered opinion on so-called "low pathogenic" CSF, and identified pathways where targeted surveillance could be the most proactive method for disease prevention.

LIVE SWINE, BIOLOGICS, SEMEN & OVA

Survival within Live Swine and Biologics

Survival and shedding of CSFV within live swine is dependent upon factors such as virulence, age of the infected animal and the general clinical manifestation of the disease. The ability for live swine to act as a possible medium of introduction is dependent on the course of clinical disease and the length of period shedding of the virus occurs. Classical swine fever has four distinct clinical forms that include acute, chronic, congenital, and mild manifestations.

Acute CSF (fig. 1.10) involves a disease progression of two to four weeks (Moennig et al., 2003, Elbers et al., 2002, & Laevens et al., 1999). Acute CSF may result in death of the infected swine in as little as 5-15 days with morbidity and mortality reaching 80-100% (Dahle and Liess, 1992).

Chronic CSF involves a disease progression of 30-90 days or longer before death and usually involves older swine or congenitally infected piglets (http://viro08.tiho-hannover.de/eg/clinical.htm). Development of chronic CSF includes: symptoms of diarrhea, undulating fevers, retarded growth, and apparent recovery of swine followed by relapse and death in 90-100% of the swine that relapse (http://viro08.tiho-hannover.de/eg/clinical.htm). The average percent mortality in chronic CSF must be established through further research.

The third clinical form of CSF is a congenital (late onset) disease in prenatally infected piglets (fig. 1.11). Fetuses infected in-utero before the immune system is fully developed are persistently viremic and do not produce antibodies to CSF following birth (Terpstra and Weensvort 1997). Piglets with congenital CSF may develop symptoms consistent with chronic CSF within 3-6 months. However, many never develop symptoms but continuously shed virus and the percentage of persistenly infected (PI) piglets that continuously shed virus is not known.

The final clinical form of CSF is mild CSF, which is typically seen only in sows. It is also known as "carrier sow syndrome" due to the ability of infected sows to continuously shed virus to their young and to swine they directly contact. Mild CSF is associated with the low virulence strains of classical swine fever virus (DeWulf et al., 2001).

During acute and chronic courses of infection virus shedding occurs mainly during the clinical phase of disease, since young animals are clinically sick much more often than adults, they play a major role in the spread of CSF virus (European Commission, 1999). In postnatally acutely infected animals the period of virus shedding lasts only a few days until they either die or recover, chronically infected animals shed virus intermittently until they die. Persistently infected animals that became infected trans-placentally or early in postnatal life usually shed virus for several weeks or even months before they die (European Commission, 1999). By considering the length of time shedding occurs during the different clinical manifestations of disease we are more able to assess the likelihood of live swine acting as mediums of introduction.

The swine biological products considered within this pathway analysis were limited to swine vaccines and swine serum antibodies for purposes of clarity. Semen and ova, although sometimes considered swine biological products in other readings, were analyzed as an autonomous pathway. The current research available on the survival of CSF in swine biological products such as vaccines and serum antibodies is limited but some survival studies have been performed on swine semen. Although we found no studies focusing on the survival of CSFV within swine biologics such as vaccines; studies have indicated that there is a possibility of contamination of vaccines with related pestiviruses such as bovine viral diarrhea virus (Wensvoort and Terpstra. 1988). Survival of CSFV in semen has been estimated in experimental studies to be between 12-72 hrs at 20°C but at 4°C or below survival ranges from 1 month to years depending on temperature (Floegel et al., 2000). Survival in ova and embryos is unknown (Floegel et al., 2000 and Glossup and Cameron, 2002).

Data Sources

All data regarding the international movement of live swine into the U.S. was obtained from two datasets. The first set of data, which was provided by USDA-APHIS in Microsoft Access ® format, was gathered at ports of entry by U.S. Customs personnel and was submitted to the database on a monthly basis. This database includes fields of information such as: country of origin, entry port name, inspection date, importing state, destination state, breed, purpose, unit of measurement and date of import. This information is part of a larger database called the World Trade Atlas (WTA) that includes all commodities that enter the U.S. Every commodity in the WTA database is given a 10-digit harmony code for organizational purposes. The purpose of this dataset is to keep track of the large amounts of commodities that enter the U.S. for security purposes and to provide information that can be later utilized for economic purposes.

The World Agricultural Trade Flows system (WATF) provided by UN-FAO on a publicly accessible website is another source of information on live swine importation numbers to the U.S. (http://www.fao.org/es/ess/watf.asp). The WATF is an interactive map that displays the trade flows between countries/territories and provides basic trade data. It has been designed to provide the user with quick, graphically-oriented information regarding trading partners, volume and value as well as bilateral percentage shares. Although the WATF does not contain information on individual import accounts and other details found within the dataset provided by USDA-APHIS, it provides an easy way to summarize world trade figures. Updated yearly, these databases have been made possible by the cooperation of governments that supplied most of the information. In general, information is supplied by governments through magnetic tapes, national publications and FAO questionnaires.

Live Swine, Swine Biologics, Semen & Ova Data

During the year 2000, the importation of live swine, semen, and ova were limited to a few countries. The USDA currently does not allow importation of swine biological products such as vaccines and serum antibodies from international markets (Dr. Donna Gatewood, APHIS-VS, personal communication, 2003). These biologics can be imported for research purposes but the direct import into the consumer market is prohibited. According to the USDA-APHIS dataset, the only country from which live swine were imported was Canada. The U.S. reportedly imported 4,346,494 head of swine for commercial, slaughter, feeder, breeding, in-bond (animals shipped into the U.S. and held for some time before being shipped back to their country of origin), and pet purposes, (figs. 3.1-3.6) and 22,115 semen straws for artificial insemination (AI) purposes. Over 20,000 of the semen straws were listed as having Canadian origin, while the rest came from the U.K. and Australia.

U.S. swine imports from 1994-2002 had similar trading patterns to the year 2000. U.S. imports of live swine for feeder and slaughter purposes were only of Canadian origin, and AI imports were primarily Canadian. Overall, only eleven countries, in addition to Canada, exported swine or swine semen and ova to the U.S. during the years 1994-2002 (fig. 3.7). Of these imports, 13,596 straws for breeding purposes were imported from Australia, U.K., Germany, Denmark, France and Ireland. The U.S. only imported 27 live swine from countries other than Canada from 1994-2002. This small number of live imports from countries such as Australia, Barbados, Denmark, Fiji, Germany, Netherlands, Poland and Spain were for research and diagnostic purposes only.

The U.S. swine import numbers for the year 2000 provided by the UN-FAO are similar to those provided by USDA-APHIS, with almost 99.9% of the live swine imports coming from Canada. However, the rest of the imports (0.1%) came from the U.K. and Denmark. The UN-FAO WATF dataset reported 4,358,626 head of swine imported from Canada while only 724 head and 5 head were imported from Denmark and the U.K., respectively. Information on trade of swine ova and semen was not available in the WATF dataset. It is interesting to note that the UN-FAO reported the U.S. imported live swine from countries other than Canada while USDA-APHIS data sets did not. This disparity is somewhat concerning because the data that the UN-FAO have in their possession were provided by individual member states.

Live Swine Import Regulations

Live swine may only be imported to the U.S. from countries or regions of countries certified by the OIE to be free of CSF, foot and mouth disease, African swine fever, and other foreign animal diseases as reported in "title 9 chapter 1 part 94" of the code of federal regulations. However, wild swine may be imported into the U.S. from areas where CSF is present, when in accordance with Sec. 93.504(c) or Sec. 93.501 of "chapter 1 title 9" of the code of federal regulations (http://www.access.gpo.gov/nara/cfr/). These sections of the CFR state that all live swine imported into the U.S. must be held in USDA approved and inspected quarantine facilities or be inspected at border crossings with Mexico or Canada in order to be certified free of disease (fig 3.8). This applies to all live swine unless they are being brought in for diagnostic or specimen purposes, in which case they may be transported directly to their destination with the proper reservations and documents. In addition, no litter, manure, fodder, or equipment that is associated with or been in contact with swine can be offloaded without undergoing disinfection procedures supervised by a Plant, Pest and Quarantine (PPQ) officer at the port of entry. Manure from quarantined swine shall not be removed from the quarantine premises until the release of the swine (http://frwebgate3.access.gpo.gov).

One of the regulations regarding live swine pertains to exhibition swine. It states that "swine from the U.S. which have been exhibited at the Royal Agricultural Winter Fair at Toronto, Ontario, or other publicly recognized expositions in Canada, including racing, rodeo, circus, or stage exhibitions in Canada, and have not been in that region for more than 90 days are eligible for return to the U.S. without Canadian health or test certificates, if they are accompanied by copies of the U.S. health certificates and issued and endorsed in accordance with chapter 91 of the C.F.R." (http://frwebgate3.access.gpo.gov). This allowance could provide a loophole for an agro-terrorist to infect swine with CSF intentionally at a Canadian exhibition and import it back into the U.S. within a short time frame without being detected.

Swine Biologics Import Regulations

The policies concerning the importation of animal biological products from countries where foreign animal disease exist or have high risk for development can be viewed at http://www.aphis.usda.gov/vs/cvb/lpd/sifs/vbimp.html and involve strict regulation of production procedures, testing of seed microorganisms, and containment facilities where the product is being produced. This document outlines the need for the USDA to know where the products are going, whether the destination has proper bio-containment facilities, other organisms present at the facility, characterization of the vaccine microorganism (i.e. parental strain source and possible contaminants), production procedures and capabilities of the production facility, testing/validation procedures for vaccine, packing/shipping procedures, and any other procedures used to detect, inactivate or reduce the presence of potential contaminant microorganisms exotic to the U.S.

Live Swine, Semen & Ova as a Pathway

Potential for the legal importation of live swine to act as a pathway of introduction was assessed by taking into account current international trading patterns and the survivability of CSFV within live swine. Since the survival period of CSFV within live swine, or period of infectivity ranges from one week to greater than six months depending on various host-pathogen factors, this potential pathway of introduction has an inherently higher risk than other mediums. However, due to the U.S.' selective trading with countries that are listed as CSF negative by the OIE, the risk of introduction has been minimized. Because more than 99% of all U.S. live swine imports originate in Canada, which is currently free of CSF, the risk of introduction is further minimized.

The broad range of estimates of survival time in semen represents a potentially important gap in our knowledge. The importation of biologics such as semen and ova for breeding purposes is the only pathway that could be considered multi-national with the U.S. importing from countries other than Canada, most of which are located within the European Union. Although the U.S. importation of semen and ova is multi-national, the trade with Canada accounts for more than 90% of the total. With the overwhelming majority of live swine and swine biologics imported from Canada the risk from the imports that fall within these categories is minimal. This risk is greatly dependant on the CSF status of Canada. If there were to be a change in CSF status within Canada, the U.S. risk would be greatly affected.

The illegal importation of live animals can also serve as a pathway of introduction, as was seen in the most recent outbreak of Exotic Newcastle Disease (http://www.aphis.usda.gov/lpa/issues/enc/vnd.html). This disease was thought to be introduced to California by the illegal importation of fighting game cocks. No numbers are available to describe the number of illegal swine importations to the U.S. However, Mexico and several Caribbean nations have CSF. Therefore, the illegal importation of live swine is a possibility, but the precise magnitude of this risk cannot be estimated with current data sources.

SWINE PRODUCTS

CSF Survival within Swine Products

The overall survival times of classical swine fever in selected products were reported by APHIS in the 1985 Hog Cholera Eradication Guide (fig 3.9). CSFV has been shown to persist in meat and meat products at a variety of temperatures, moisture levels, and pH values.

In cured and smoked meats CSFV has been shown to survive between 17 and 188 days depending on the time and temperature at which the products were stored (Edwards, 2000). McKercher et al., (1987) recovered CSFV from samples of Parma ham from 12 experimentally infected pigs (2 hams processed from each animal) at 188 days. However, CSFV was not recovered in Parma ham sampled at 313 or 377 days from the same group of hams. Mebus et al., (1993) showed that CSFV was not recoverable after 168 days by in vitro assay using dry salt curing of Iberian hams. In the following in vivo assay, swine were intramuscularly injected with recovered CSFV from the assorted hams to establish a time frame in which the ham could potentially be infective. The Iberian hams showed CSFV infectivity up to 252 days after curing. In contrast, Serrano hams from swine experimentally infected with CSFV by the intramuscular route were not infective at 140 days after curing began. These results indicate that the minimum commercial salt curing period of 365 days for Iberian cured hams and 190 days for Serrano hams is likely sufficient to inactivate CSFV. However, this research did not indicate an exact survival time of CSFV in these products, because sampling was done at periodic intervals throughout the experimental duration. Therefore, there is a need for more definitive research on exact survival times of CSFV in meat products. This discrepancy of CSFV survival may be attributed to differences in the curing methods to reach the desired taste for that product. For example, two of the most popular hams that are legal for importation into the U.S. are Parma and Serrano hams.

These hams undergo a curing process of at least 14 months under strict temperature, pH, and moisture control (http://www.jrnet.com/ham/). Through this extensive process of time and environmental controls the survival of CSFV is no longer possible.

Helwing and Keast (1966) conducted a study in which 1 mL of a 10^{-3} dilution of infective definbrinated blood from the 1961 New South Wales outbreak was intramuscularly injected into 3 healthy 4-5 month old pigs from CSF free herds. The pigs were slaughtered and processed 6 days after they were infected. A feeding trial was conducted with hams and sausage casings from these pigs. The hams were prepared by being injected and soaked in brine (NaCL and KNO3) for 7 days at 39F then rubbed with salt and stored 10 days at 39F, soaked in water 24 hours then smoked for 24 hours. The hams were then either stored at 39F or heat treated at 180F for variable times in 1 and 6lb units. The salt content in hams from one of the trials was established at 8.3% to ensure proper curing. The casings were prepared by (1) soaking in brine, (2) soaking in water then rubbing with salt, and (3) soaking in water then rubbing with salt and then soaking in salt water. No infectivity was recorded from feeding the cooked (heat treated) hams. However, uncooked smoked and cured ham that was held at 39F was infective for 34-85 days. The same product stored at room temperature, was not infective when fed at 26 and 43 days. Casings prepared using method (1) and fed immediately after curing were non-infective. Casings prepared using method (2) retained infectivity through 86 days when they ran out of material to feed. Casings prepared using method (3) were infective at day 8, but not at day 17 or 31. In the same study it was concluded that CSFV was destroyed in cooked ham when the core temperature of the ham reached a temperature above 150ºF for at least 30 minutes.

Stewart et al. (1979) isolated CSF from canned hams subjected to temperatures of 50ºC and 55ºC for 90 minutes, and occasionally from hams heated to 60ºC, but not at 65ºC. In addition, they found that CSFV could not be isolated from ham held at 71ºC for 1 minute. This study was based on hams that were derived from swine that were experimentally inoculated with CSFV prior to slaughter.

One method of virus destruction used to prevent disease transmission is pasteurization, which is the partial sterilization of a substance at a specific temperature for a specific period of time that destroys objectionable organisms without major chemical alteration of the substance (http://www.merriam-webster.com). Pasteurization is an effective method of destroying CSFV in hams from swine infected experimentally by the intramuscular route.

Pasteurization inactivated CSFV after 30 minutes at 65ºC or 1 minute at 71ºC but not after 30 minutes at 62.5ºC (Terpstra and Krol, 1976 as cited in Edwards, 2000).

Kubin (1967) found that CSFV was stable over a wide pH range, but was inactivated below pH 4 and above pH 11 (reviewed in Terpstra, 1991). *In vitro* CSFV survival has been shown to be dependent on pH levels in many studies. At a pH of 5-10 the virus is stable, while it is rapidly inactivated at pH of 3 or below and above 10 (reviewed in Edwards et al., 2000; Kubin, 1967; Trawinski and Trawinska, 1949; & Terpstra, 1991). Low pH combined with low temperatures is more effective than if combined with higher temperatures for virus inactivation (Trawinski and Trawinska, 1949 and Edwards, 2000). CSFV half life values increase at low temperatures and neutral pH's, thus establishing a relationship between temperature and pH (Depner et al., 1992). Depner et al. (1992) found that at 4ºC, the half-lives of CSFV varied between pH 3-4, but did not vary at 21ºC. At 21ºC the decrease in infectivity was dependent on the increased temperature and the half-lives at 37ºC at pH 4 were even shorter than half lives at 4ºC and 21ºC. These results indicate that there are finite times, temperature ranges, pH ranges, and environmental parameters that must be reached in order for CSFV to be reliably inactivated in contaminated meat and meat products.

Downing et al. (1977) determined the ability of high temperature to inactivate CSFV. Tonsil, lymph node, muscle and viscera were collected from swine showing symptoms of CSFV and emulsified in blood collected from the infected swine at a virus titer of 10^7 plaque forming units per gram (PFU/g) and stored at -80ºC. Inactivation was reached by dipping a thermometer probe coated with emulsified tissue into a hot oil bath for varying time periods. The results indicated that CSFV was inactivated by 5 seconds at 160ºC, 30 seconds at 110ºC, 45 seconds at 100ºC, and survived heat treatment at 80ºC for over a minute. These results indicated that high temperatures are very effective at inactivating CSFV. However, more research must be conducted to determine CSFV survival specific temperature required to inactivate CSFV in tissue.

The USDA has developed a list of recommendations for the destruction of CSFV in meat and meat products that have the potential for importation into the U.S. These recommendations include heat treatment in a hermetically (air tight) sealed container with a F_o value of 3.0 or more (energy value of 1 F_o is the equivalent of energy accumulated if exposed to a cycle of 1 minute at 121ºC with saturated steam in an autoclave) (http://www.thebrownegroup.co.uk/pages/questiondetail.asp?ID=5), heat treatment at a minimum temperature of 70ºC throughout the meat, or treatment in an air tight container at a temperature of at least 80ºC for a minimum of four hours with a core temperature of 70ºC for 30 minutes.

Recommendations for natural fermentation and maturation of not less than nine months included an available water value of ≤ 0.93, and pH ≤ 6.0. For dry cured pork the USDA recommends that Italian hams with the bone-in should be cured with salt and dried for a minimum of 313 days. Spanish style bone-in hams should be cured with salt and dried for a minimum of 252 days, and for Iberian hams, 140 days for Iberian shoulders, 126 days for Iberian loin, and 140 days for Serrano hams (http://www.aphis.usda.gov/vs).

CSFV survival in hides or carcasses ranged from 7 days in summer to many months in winter (temperature dependent) in buried carcasses. The virus can survive in hides for 3-6 months in frozen carcasses and 14-90 days in refrigerated carcasses (USDA-APHIS: Federal Emergency Management Association, 1985 and Doyle, 1933). In hides, the virus can survive for 33 days if prepared by smoking and at least 80-100 days if salt preserved and chilled (USDA-APHIS: Federal Emergency Management Association, 1985; Doyle, 1933; Farez & Morley, 1997) (fig 3.9). The pH levels attained during tanning are sufficient to inactivate the virus. Fully tanned and fully processed porcine hides and skins do not need to be quarantined at their port of entry. However, the wide pH range in which the virus is stable means that partial processing of hides cannot be relied upon to completely inactivate all viruses. Partially processed (liming or acid pickling only) hides from affected countries represent a lower risk than hides which have not been processed at all, but additional control such as further processing at a quarantine approved tannery is warranted (http://www.affa.gov.au/corporate_docs/publications/pdf/market_access/biosecurity/animal/2001/2001-24a.pdf).

Data Sources

The amount (volume) and origin of products legally entering the U.S. corresponding to the predetermined list of products and harmony codes were ascertained by using the information online 10 digit harmony code online dataset: (http://www.fas.usda.gov/ustrade/USTImHS10.asp?QI=).

The database can be accessed by anyone interested in information about the international trade of commodities. The data are originally collected on site by U.S. Customs Services, who then pass it on to the U.S. Census Bureau. The database is updated monthly and the schedule of updates can be found on the opening page of the application by clicking on "Other" and then Release Dates. Additionally, each year the Department of Commerce, U.S. Census Bureau, Foreign Trade Division releases a 13th month file three months after the December release of the data. The 13th Month file includes corrections (ERRATA) made at the request of outside sources and verified with exporters or importers by the Foreign Trade Division. The 13th month data also includes late shipments. Late shipments are Shippers Export Declarations or Import Entry Summary Forms that are received too late to be included within the normal monthly trade release (personal communication, U.S. Trade Web Team).

Swine Products Data

To describe the U.S. importation of hog products, a complete list of harmony codes for the year 2000 was provided by USDA-APHIS. From all of the harmony codes available, we selected codes that included all U.S. imported products that could serve as possible vectors for CSF (fig. 3.10). These harmony codes were subsequently grouped as follows: hog products for human consumption (FHC), hog products not for human consumption (NFHC), hog hides and their derivatives, hog feed and other feed related materials, and farm equipment.

During the year 2000, according to FAS-ONLINE, the U.S. imported products (fig. 3.11) found on our predetermined list of harmony codes from a total of 53 countries. Based on OIE data for 2000, 18 of those countries were CSF positive. The products imported from countries which were CSF positive, are summarized by country and product grouping (hog products for human consumption, hog products not for human consumption etc.) (figs. 3.12-3.16).

Hog Products: For and Not for Human Consumption

The data in figure 3.16 show that hog products not for human consumption imported into the U.S. were mainly imported from Canada at 178,223 Metric Tons, followed by New Zealand and Australia at 36,780 MT and 17,527 MT respectively. Thailand, Brazil, Germany, and Mexico accounted for 28,530 MT of the total 29,897 MT that were imported from CSF positive countries. The majority of hog products imported by the U.S. for human consumption were from Canada (294,805 MT), while Denmark controlled most of the remaining market with nearly 45,000 MT exported to the U.S. (fig. 3.14). The main exporters of hog products for human consumption from CSF positive countries in the year 2000 were the U.K., Italy, Mexico, Brazil, and Germany, accounting for 7,175 MT of product.

Hog Hides and Their Derivatives

Over 85% (26,889 M^2) of the total hide imports in 2000 came from countries which were listed as CSF+ by OIE during 2000, with the top 5 countries of import reportedly CSF endemic (fig. 3.15). The hides were classified according to processing technique as follows:

1) SWINE RAW SKINS, (NOT PRETANNED), FRESH, OR SALTED, DRIED, LIMED, PICKLED OR OTHERWISE PRESERVED, BUT NOT TANNED, PARCHMENT DRESSED, FURTHER PREPARED (221,322.00 pieces imported in 2000)

2) SWINE RAW SKINS, PRETANNED, FRESH OR SALTED, DRIED, LIMED, PICKLED OR OTHERWISE PRESERVED BUT NOT PARCHMENT DRESSED OR FURTHER PREPARED (9,878.00 pieces imported in 2000)

3) SWINE TANNED SKINS, IN THE WET STATE, WET-BLUE, WITHOUT WOOL ON, WHETHER OR NOT SPLIT, BUT NOT FURTHER PREPARED (16,444.00 square meters imported in 2000)

4) SWINE TANNED SKINS, IN THE WET STATE OTHER THAN WET BLUE, WITHOUT WOOL ON, WHETHER OR NOT SPLIT, BUT NOT FURTHER PREPARED (169,308.00 square meters imported in 2000)

5) SWINE CRUST SKINS, IN THE DRY STATE, WITHOUT WOOL ON, WHETHER OR NOT SPLIT, BUT NOT FURTHER PRPEPARED. (95,167.00 square meters imported in 2000)

6) PARINGS/WASTE OF RAW HIDES/SKINS, GLUE STOCK (48,221.5 metric tons imported in 2000)

Although many of the imported hides were prepared in a way that should have effectively inactivated CSFV, some hides and skins were either not pre-tanned or were only partially processed before entering the U.S. These hides represented the greatest risk of CSFV introduction. The U.S. imported a total of 221,322 pieces (pcs) of swine raw skins in 2000 according to the first processing technique listed above and 9,878 pieces according to the second processing technique. The data indicate that 221,322 swine raw skins (not pretanned) were imported that year, and that 87,700 of those came from the Czech Republic and 154 from China.. Both countries have reported CSF outbreaks in recent years, and therefore such hides represent a risk of CSFV introduction. The remaining majority (133,465 pcs) of unprocessed pieces according to technique 1 were imported from Canada. Techniques 3&4 are pre-tanned and present little risk for introduction. The majority of the 16,444 square meters (M^2) of hides processed according to technique 3 were from Slovenia (94%) and the remainder from Italy (6%). As above, both of these countries have reported CSF outbreaks in recent years. The majority of 169,308 M^2 imported that were processed using technique 4 were from Slovenia (52.4%), Taiwan (32.9%), Poland (7.3%), Korea (5.5%), and Italy (0.9%). Hides that fall within category five are not specified as "to be tanned" and therefore present a risk of introduction even though they are dried. U.S. imports that fell into category five during the year 2000 came from Poland (34.3%), S. Korea (23.1%), Taiwan (21.5%), and Mexico (20.1%). These are also countries that have reported recent CSF outbreaks or are considered countires with a CSF positive status. Unlike the other categories, the importation of hides that fell into category 6 was broad and incorporated 27 different countries. Brazil (32.9%), China (18.3%), Thailand (16.6%), Mexico (8.9%), and Colombia (8.16%) exported the majority of hides falling into this category to the U.S. These countries are also considered to have a CSF positive status by the OIE. Therefore these unprepared hides/skins (specifically techniques 1, 5 & 6) represent the greatest risk of CSF introduction within this particular category of swine products. Unprepared hides that originate from a CSF positive country present a possible pathway for introduction. Although we are able to look at what types of hides enter the U.S., we are not able to tell what amount of hides come in contact with the swine industry after crossing the border and where the possible points of contact exist. It is these informational gaps that present problems when trying to assess this possible pathway of introduction.

Swine Products Import Regulations

According to regulations set by USDA-APHIS and enforced by the U.S. Bureau of Customs and Border Protection, "No pork or pork product may be imported into the U.S. from any region where hog cholera is known to exist unless it complies with the following requirements:

(1) Such pork or pork product has been treated in accordance with one of the following procedures:

(i) Such pork and pork product has been fully cooked by a commercial method in a container hermetically sealed promptly after filling but before such cooking, so that such cooking and sealing produced a fully sterilized product which is shelf-stable without refrigeration;

(ii) Such pork or pork product is in compliance with the following requirements:

(A) All bones were completely removed prior to cooking; and

(B) Such pork or pork product was heated by other than a flash-heating method to an internal temperature of 69ºC. (156 ºF) throughout; or

(iii) Such pork or pork product is in compliance with the following requirements:

(A) All bones have been completely removed in the region of origin, and

(B) The meat has been held in an unfrozen, fresh condition for at least 3 days immediately following the slaughter of the animals from which it was derived

(C) The meat has been thoroughly cured and fully dried for a period of not less than 90 days so that the product is shelf stable without refrigeration. Provided, that the period of curing and drying shall be 45 days if the pork or pork product is accompanied to the processing establishment by a certificate of an official of the national government of a hog cholera free region which specifies that:

(2) The pork involved originated in that region and the pork or pork product was consigned to a processing establishment in a region free of CSF, in a closed container sealed by the

national veterinary authorities of the hog cholera free region by seals of a serially numbered type; and

(3) The numbers of the seals used were entered on the meat inspection certificate of the hog cholera free region that accompanied the shipment from such free region;

(4) Small amounts of pork or pork product, subject to the restrictions in this section, may in specific cases be imported for purposes of examination, testing, or analysis if the importer applies for and receives written approval for such importation from the Administrator. Approval will be granted only when the Administrator determines that the articles have been processed by heat in a manner so that such importation will not endanger the livestock of the U.S." (http://frwebgate3.access.gpo.gov).

The code of federal regulations can be viewed at (http://frwebgate3.access.gpo.gov) and further describes the regulations governing import of pork and pork products into the U.S. from foreign countries.

Swine Products as a Pathway

As with live swine, the U.S. import market of FHC and NFHC products is dominated by products of Canadian origin. Any change in the CSF status of Canada would undoubtedly have the largest impact on the risk of introduction via this medium. Other countries that share a significant portion of the swine products market and are of potential concern are Denmark, New Zealand and Australia. These countries have been free from CSF for a significant amount of time. But, if their status in regards to CSF were to change the risk associated with this pathway would also increase. If Mexico, Brazil and Germany were to be successful in their CSF eradication campaign, the risk of introduction via swine products would be significantly less. As noted above, an accurate assessment of the likelihood of CSFV introduction will depend on information about how these products might come into contact with domestic swine. The information summarized in this report indicates the amounts of products imported from countries with CSF but does not distinguish products destined for swine farms. Data were not available to describe product movement beyond the point of entry into the U.S. Therefore a gap remains in the information available to accurately assess the probability of this potential pathway of introduction.

During 2000, the top five countries contributing to the U.S. hog hides import market were positive for CSF (fig. 3.15). While the import market for hog hides is composed of many countries that are endemic for CSF, and CSFV survives in hog hides from 33 to 100 days, the likelihood of these products contacting live swine is not as high as other products related to the swine industry. It is likely that CSF virus could be present on the skins of pigs slaughtered in countries where the disease occurs and is likely that the disease could become established in U.S. pigs, if it were introduced on skins and hides. (http://www.affa.gov.au/corporate_docs/publications/pdf/market_access/biosecurity/animal/2001/2001-24a.pdf). Although we failed to find an instance where introduction of CSFV occurred in this manner it would be beneficial to further investigate this possible route of introduction.

SWINE AND PIG MEAT TRADING MODELS

Using the information provided by the UN-FAO WATF, a live swine trading grid and swine product trading grid were developed to relate the trade flow of swine and swine products to the occurrence of CSF during the year 2000 (figs. 3.17 & 3.18). These grids were organized in such a manner that it is possible to describe the movement of live swine and swine products on the following four tiers:

1° ~ Countries from which the U.S. imports live swine/pig meat directly

2° ~ Countries from which U.S. 1° trade partners import live swine/pig meat

3° ~ Countries from which U.S. 2° trade partners import live swine/pig meat

4° ~ Countries with outbreaks of Classical Swine Fever in the year 2000

With countries located on the y-axis assuming an importing role and countries on the x-axis assuming the exporting role, these grids are fashioned similar to a mileage chart located on a road atlas. Volumes of trade along with the bilateral percentage of trade are included within these grids.

Based on this model, the largest concern for the introduction of CSF into the U.S. during the year 2000 through the medium of live swine was by direct import from the U.K. The U.K., being one of three countries from which the U.S. directly imported (based on FAO data), was listed as being CSF positive during the year 2000. It is probable that the largest threat of introduction, aside from the U.S.' direct import of live swine from the U.K., is the importation from Canada which imports directly from the U.K. Apart from the direct import of swine from the U.K., and through secondary importing associated with Canada, there were no other pathways of introduction through legal importation of live swine in 2000 (fig. 3.19).

Canada does not have regulations that pertain specifically to swine or CSF, but does have regulations that are more generalized. The Canadian Health of Animals Act gives Canada the authority to control the introduction of foreign animal diseases. The import regulations state that an animal may be imported either under an import permit or under the provisions of the Import Reference Document (IRD) and that they must meet all of the conditions on the import permit or all of the applicable provisions of the IRD. All animals from countries other than the U.S. except dogs and cats require an import permit, as do some U.S. animals (e.g. slaughter swine). Dogs and cats from anywhere and most U.S. livestock (including breeding swine) do not require an import permit but the export certificate must show that the animals meet the provisions of the IRD (Dr. Debbie Barr, CFIA, personal communication). The Act, Regulations and the IRD can be found at http://www.inspection.gc.ca/english/reg/rege.shtml.

The pig meat trade is more complex and involves more countries (fig. 3.18). The U.S.' main pathways of potential introduction are by the direct import of pig meat from the U.K., Germany, and Italy but these countries provided less than 1% of the total imports for the year 2000. Canada, with 85% of the U.S. import market, imported only from the U.S. and New Zealand. Thus, the importation of pig meat from Canada is an unlikely pathway of introduction.

An example of a secondary pathway is encountered with the U.S. import of Danish swine meat. Although Denmark has been reportedly free from CSF since 1933, the Danish imported a substantial amount of pig meat from countries where CSF was endemic in the year 2000. The Danish imported almost 54.5% of their total pig meat imports from the U.K., Germany, and Italy, all of which were CSF positive during that time frame. Danish pig meat accounted for more than 13% of all U.S. imports of pig meat within the year 2000. Countries from which the U.S. directly imports such as Ireland, the Netherlands, Sweden, and

Switzerland import substantial amounts of product from countries reported to be CSF positive (fig. 3.20).

Although this model provides a better perspective on the trade of live swine and swine products worldwide, there are some gaps in the information. For example, it is not stated within the database whether live swine or products are imported to Denmark for only domestic consumption or are subsequently shipped to the U.S. with or without being quarantined for an allotted amount of time. This lack of information regarding the final destination and travel of live swine and swine products are obstacles that hinder an assessment of the potential pathway of introduction.

SWINE INDUSTRY RELATED PRODUCTS

Survival of CSFV in Swine Industry Related Products

The survival of CSFV within feed, veterinary and farm equipment is unknown. What is known is that survival is highly dependant on environmental factors such as temperature, pH, moisture and protein content of the particular medium (Crump, et al., 2002; Kramer et al., 1995; Terpstra, 1988; & Terpstra, 1991). Classical swine fever virus was shown to survive for 10 days in liquid slurry manure, 15-20 days in solid state manure, and 6-24 days in water at 20ºC (Have, 1984). Contaminated masonry bricks and hay, exposed to air but protected from sunlight and rain, maintained infective doses of CSFV for 7 days but were no longer infective at 14 days when CSF free swine were exposed to the contaminated material (Edwards, 2000; Kubin, 1967; & Slavin, 1938). In the same studies a portion of the contaminated material was exposed to sunlight and was not infectious at the 7 day interval, illustrating that CSFV inactivation may be facilitated by exposure to UV light.

Data Sources

The data sources used for the examination of Swine Industry Related Products as pathways were the same as the sources described in the Swine Products section.

Farm Equipment Import Regulations

Importation of farm equipment is regulated by USDA-APHIS. The current regulations state that "Importation of any used farm equipment originating from areas where rinderpest, foot and mouth disease, swine vesicular disease, ASF, or CSF are present is prohibited unless the equipment is accompanied by an original certificate signed by an authorized official of the national animal health service of the exporting region that states the equipment was steam-cleaned free of all exposed dirt and other particulate matter. Such machinery is subject to inspection by APHIS personnel and shall be denied entry to the U.S. if all regulations are not met, if the contamination is minimal the inspector may deem that the equipment can be thoroughly cleaned at the port and allowed entrance after re-inspection" (http://frwebgate3.access.gpo.gov).

Swine Feed Import Regulations

Materials derived from any animal, or produced with animal-origin ingredients, are potentially subject to USDA regulations, and must be cleared by U.S. Customs and Border Protection officials at the port of arrival before entry into the U.S. is authorized. This includes animal feeds, feed supplements, and pre-mixes containing vitamins and/or minerals (including vitamins coated with porcine gelatin) as the only animal-origin ingredients. A USDA-APHIS-VS import permit is required for animal material that may pose a risk of introducing epizootic livestock or poultry diseases exotic to the U.S. However, animal feeds that contain vitamins and/or minerals as their ONLY animal-origin ingredients may be imported without a USDA-APHIS-VS permit provided the conditions of this guideline are met (http://www.aphis.usda.gov/vs/ncie/ifeed.html).

Swine Industry Related Products as a Pathway

In 2000, the U.S. imported over 50,000 MT of farm equipment from countries that were considered CSF positive. Mexico exported over 30,000 MT in that year. Other notable countries with a share in the U.S. farm equipment import market during the year 2000 were: France, Canada, India, and Italy. While France and Canada were free from CSF, India and Italy were considered positive. With survival of CSFV in contaminated soil/manure extending to 24 days the pathway of introduction is limited to products shipped from countries closer to the U.S. Also, the risk depends on methods used to disinfect used farm equipment. Although we have collected information on volume of swine industry related products entering U.S. ports, it is not known what portion of these products were in contact with swine within the country of origin, or how many of these farm related products will be in direct contact with swine after importation. The data provided does not distinguish between new farm products sent directly from foreign manufacturers and older equipment that had been previously used in a swine operation. The risk for introduction via this potential pathway involving farm equipment is therefore unknown, but is likely to be minimal due to the short-term survival of CSFV within the environment.

Of the 22,404 MT of feed imported into the U.S. from countries positive for CSF, Mexico exported 905 MT to the U.S. while England and Germany exported 14,663 and 5,662 MT, respectively. While the U.S. imported feed from Mexico, England, and Germany, the data did not distinguish whether or not the feed originated from regions endemic for CSF. The majority (around 75%) of U.S. imported feed originated from Canada with more than 116,000 MT during 2000. Once again, if the status of Canada with regards to CSF were to change, the risk for introduction via feed would increase. Although much is not known about the survivability of CSFV within feed, this pathway of introduction likely has a minimal risk due to the fact the U.S. does not import much feed from countries other than Canada. Nonetheless, a study on the survivability of CSFV within swine feed would be beneficial to determine what risk is actually presented with this particular pathway.

ENVIRONMENT

Vectors and Fomites

The relationship between fomites and vectors in the transmission of CSF is not fully understood. House and stable flies have been linked to the spread of CSFV by mechanical transmission (Bram, 1977). In experimental studies it has been demonstrated that stable flies can harbor CSFV for at least 72 hours and transmit the virus after 24 hours (Miller et al. 1975, Morgan and Miller, 1976). In the same study it was concluded that house flies could harbor the virus for 24 hours and transmit the virus for within 2 hours after contact with infected swine. The face fly (*Musca autumnalis*) harbored CSFV for 168 hours and could transmit the virus for 2 hours after exposure to an infected swine (Miller et al. 1975, Morgan and Miller, 1976). The transmission of CSFV by mosquitoes is not fully understood. Stewart et al., (1975) found that 2 of 8 mosquitoes in North Dakota and Maryland field observations could harbor and transmit CSFV for 3 days. However, Tidwell et al., (1972) found that horseflies (*Tabanidae* sp.) were able but mosquitoes were unable to transmit CSFV. Ten susceptible pigs (as defined by negative results when blood was tested by the fluorescent-antibody tissue section technique (FATST) and tonsillar biopsies were tested by the fluorescent-antibody serum neutralization test (FASNT) were obtained from herds free of CSF, and 3 infected pigs were acquired from CSF positive herds in the area. Female horseflies were collected using the Manitoba trap technique and maintained individually in 155-Gm vials with gauze lids, and mosquitoes were collected with an aspirator and transferred to a 450-ml freezer carton. The insects were maintained in a cooler at 24ºC. For the feeding trials, a positive source pig was tied on a restraining table and the insect (within its container) was placed on the skin of the animal and allowed to feed. After feeding, the insects were allocated into 3 groups. Group 1: the immediate transfer group where insects were interrupted during a blood meal on a source pig and within 2 hours allowed to feed on susceptible pig (4 pigs exposed to horseflies, 1 to mosquitoes). Group 2: 24 hour delayed feeding group treated as group 1 but feeding on susceptible pig was delayed 24 hours (3 pigs exposed to horseflies). Group 3: Post-oviposition feeding group; insects in this group were allowed to take a full blood meal on a source pig then placed in chambers for egg deposition, once oviposition had occurred the insects were allowed to bite a susceptible pig. Four pigs where maintained as controls. Results of the feeding experiment indicate that all four pigs in group one bitten by horseflies contracted CSF (positive tonsillar tissue using FATST). The pig bitten by the mosquitoes did not display clinical signs of CSF (negative using FATST and FASNT) and was susceptible upon challenge with Ames strain virus. Pigs from group 2 did not show symptoms of CSF. However, the FATST and FASNT tonsillar tissues were positive for CSF 5 dpi. Within group 3 no pigs displayed symptoms or tested positive for CSF using FATST or FASNT. This confirmed the ability of horseflies to transmit CSF immediately after feeding on an infected source. However, more research must be conducted in order to establish the role horseflies play in CSF transmission 24 hours or longer after feeding on infected pigs.

Many studies have been conducted to evaluate the survival of CSFV on fomites in the environment. Classical swine fever virus was shown to survive for 10 days in liquid slurry manure, 15-20 days in solid state manure, and 6-24 days in water at 20ºC (Have, 1984).

DeWulf et al. (2002) conducted an experiment to determine the transmission of CSF by excretions of infected pigs. Five pairs of pigs were experimentally infected with the "souche Lorraine" strain of CSFV at 10^3 $TCID_{50}$/ml by intramuscular injection and intranasal inoculation. After the pigs exhibited clinical signs of disease for at least 3 days, the pens housing the infected pigs were depopulated and five pairs of susceptible pigs were placed in the un-sterilized pen for 35 days. The pens were not cleaned or sterilized for the first 3 weeks during the observation period and none of the susceptible pigs became infected based on clinical signs. The results of this experiment suggest that excretions from infected pigs do not play an important role in transmission to swine moved into an area with previously infected animals. Although CSFV is not thought to exhibit aerosol spread over long distances (http://www.vetmed.iastate.edu/services/institutes/cfsph/FactSheets/classical_swine_fever.pdf), it has been shown to spread within confined spaces (Dewulf et al., 2000).

Garbage Regulations for Vehicles Entering the U.S.

The USDA-APHIS PPQ and Customs and Border Protection services control garbage and waste from airplanes and maritime vessels entering the U.S. from a foreign country, Hawaii, and U.S. possessions and territories. Both services approve contractors to remove the waste by using compliance agreements, monitoring the contractors, and supervising the off-loading of garbage to an approved facility for sterilization or incineration. Garbage from these ships or planes must be handled at an USDA approved airport or military base for handling garbage and galley refuse disposal (fig. 3.21). At the approved facility the waste products must be disposed of by USDA-APHIS approved methods which are:

1. Incineration of the garbage/waste to ash
2. Sterilization (cooking at 212ºF for 30 minutes) and burial in a landfill
3. Grinding and discharge into an approved sewage system (http://www.aphis.usda.gov/ppq/manuals/pdf_files/AMOM_Chapters.htm)

Cleaning and Disinfection of ships and airplanes after unloading cargo:

Any article or surface that has been in contact with animal material or regulated garbage must be thoroughly cleaned and disinfected before being returned to normal use. The disinfectants required by USDA-APHIS are 4% sodium carbonate solution and/or Virkon S®

(http://www.antecint.com) disinfectant at a 1-2% solution. For more specifics on disinfection efficacy see section entitled "Disinfection and Destruction".

Many of the recent outbreaks of CSF in Europe have been attributed to improperly sanitized garbage being fed to domestic pigs and to persistently infected Eurasian wild boar herds that come in direct contact with domestic swine (Williams and Matthews, 1988, Griot et al., 1999, Kern et al., 1999, Laddomada, 2000, and Moennig, 2000). An example is the 1986 outbreak in Great Britain where the source of infected pig meat fed in untreated swill was traced to three meat packing plants, 14 importers, 13 wholesalers, six retailers, a restaurant, and a bar and grill (Williams and Matthews, 1988). In this outbreak, three primary outbreak sites were identified. In one site, untreated meat products were fed to swine and another site received pigs transported from a market using trucks that had previously hauled infected pigs. The third site was a licensed waste food processor where pigs had gained access to areas where unprocessed food was handled (Williams and Matthews, 1988). The outbreak affected approximately 50,000 pigs on 300 farms (Williams and Matthews, 1988). Swill feeding has been in the spotlight for many years as a potential route of transmission for foreign animal diseases. Regulations have been established to limit the risks associated with swill feeding (http://www.aphis.usda.gov/lpa/news/1995/RAWWASTE.HTM).

The Swine Health Protection Act of 1980 prohibits feeding raw garbage to swine in the U.S. and Puerto Rico (http://www.aphis.usda.gov/lpa/news/1995/RAWWASTE.HTM). The USDA-APHIS requires licensure of all garbage feeding swine operations and heat treatment of raw garbage fed to swine (212ºF for 30 minutes). However, some small holdings (backyard producers) feed household waste to their swine disregarding the necessary precautions to prevent disease introduction. For instance, it has been estimated that 50% of the household waste fed to swine in Puerto Rico has been improperly sanitized (http://www.aphis.usda.gov/lpa/news/1995/RAWWASTE.HTM). The practice of garbage feeding is an area of concern for the potential introduction of CSF into the commercial and feral swine populations of the U. S. because of this disregard for regulations by "backyard" operations (http://www.aphis.usda.gov/lpa/news/1995/RAWWASTE.HTM).

A 1995 risk analysis by the USDA Centers for Epidemiology and Animal Health (CEAH) estimated the risk of foreign animal disease introduction into the continental U.S. swine population through 1,175 USDA licensed waste feeders. The risk assessment took into account the probability of contaminated food waste that originated from a foreign source. They also considered the type of food waste that is fed to swine, since partially cooked, cured, and dried meat may still contain live CSF virus while meat or other products that are fully cooked cannot harbor the virus. In addition, they compared different types of waste and their source (i.e. household or institutional waste) and whether they were meat products or products with a plant origin (i.e. breads, etc.). The risk to the swine population of introductions of CSF was estimated at 6.7% annually, higher than ASF (0.5%), FMD (4.1%), and SVD (0.5%) (http://www.aphis.usda.gov/vs/ceah/cadia/fadfact.htm). The annual risk of CSF introduction to Puerto Rico was calculated separately and estimated at approximately 24%.

The regulations that govern feeding of garbage to swine in the U.S. allow licensed facilities to be monitored closely. In a 2001 survey of licensed garbage feeding facilities in 13 states and Puerto Rico, 87% of the garbage fed to swine at licensed facilities was produced by bakeries and institutions (i.e. schools, prisons, etc.), with 13% coming from household waste in the 13 states surveyed and 50% coming from household waste in the Puerto Rico study (APHIS, PC, 2003). The 2001 survey illustrates that the proportions and types of garbage being fed to swine in the U.S. and Puerto Rico has not changed in the 20-some years since implementation of the Swine Health Protection Act.

MOVEMENT OF PEOPLE AS A PATHWAY

Introduction

The movement of people across borders presents a possible pathway for disease entry via themselves, the products they carry, or contaminated clothing and shoes. With people entering by land, air, or sea, there are many pathways in which classical swine fever could possibly enter the U.S. While people entering the U.S. by air and sea are limited to the modes of plane and ship, many modes of entry such as train, bus, truck, personal vehicle and pedestrians need to be accounted for at land borders.

Data Sources

A statistical database provided by the Bureau of Transportation Statistics (BTS) was used to evaluate the movement of people across the U.S. land borders with Canada and

Mexico. The data include monthly incoming border crossing/entry data for vehicles, containers, passengers and pedestrians. The data represents activity at the port level on the U.S.-Canadian and U.S.-Mexican borders. The data are provided to the Bureau by Customs and Border Protection reports.

The database provided by BTS regarding people entering the U.S. via air travel contain information collected by personnel of U.S. and foreign air carriers. For the U.S. air carriers, at least one point has to be outside the U.S. or in one of its territories. All foreign air carrier data must have at least one point in the U.S. or in one of its territories. These data are often referred to as either Market or On-Flight Origin-Destination (O&D) records. The data fields contain information on passengers; freight and/or mail enplaned at the origin airport of the flight, and deplaned at the destination airport of the flight (http://www.transtats.bts.gov/TableInfo.asp?Table_ID=260&DB_Short_Name=Air%20Carriers&Info_Only=0). This database has almost a million records, is updated monthly, and is available from 1990 to present. The major weakness associated with the use of this database is that the actual origin of the passenger is not necessarily the flight origin. Because this database only lists the non-stop direct flights into the country, any passenger that originated from another country but caught a connecting flight into the U.S. will not be listed from their actual origin. Thus, reported numbers may not precisely reflect the movement of people from countries positive for CSF to the U.S.

The Agricultural Quarantine Inspection Monitoring (AQIM) Dataset provided by APHIS-PPQ was utilized to better estimate the number of people entering the U.S. by air that visited foreign farms and / or returned to domestic farms. This dataset includes all types of farms and is not limited to that of swine operations. Although it does not solely encompass swine operations we felt that it represents the possible pathway of CSF introduction via international travel of people better than other datasets that accounted for all people crossing the border. AQI Monitoring is a structured sampling activity (random, non-biased) that occurs at 24 major U.S. airports that have arriving commercial foreign passengers, and account for approximately 92% of the foreign air passengers. The total samples listed in the dataset are not the total number of foreign passengers arriving in that fiscal year, but are sample totals taken from the entire arriving foreign passenger population at the 24 airports. In this dataset, the fiscal Year (FY) is defined as starting October 1 and ending the following September 30. The AQIM sampled population of people who had traveled to foreign farms and returned to domestic farms was utilized to estimate the total amount of people entering the U.S. via air travel that visited a foreign farm and returned to a domestic farm. The sampling unit was the customs declaration filled out upon entrance to the U.S. (Ron Komsa, APHIS, personal communication). The dataset was broken into files according to fiscal year (2001-2003) and the travel status of the passengers (1) visited foreign farm, (2) returning to domestic farm, or (3) visited foreign farm and returned to domestic farm. Since a far greater risk of introduction of CSFV exists via people that have visited foreign farms and are returning to domestic farms, it was felt that this dataset would represent the pathway of introduction via international travelers most accurately.

Land Travel

The data in figures 3.22 and 3.23 are representative of the flow across the borders by passengers legally crossing in various modes. The largest form of trans-border traffic into the U.S. from Canada is by personal vehicle with more than 90 million people entering yearly (fig. 3.24). The states with the largest incoming traffic are Michigan, New York, and Washington with a combined total of 72,012,382 passengers or roughly 80% of the total amount of passengers crossing by personal vehicle. The next largest mode of transportation from Canada was by bus that accounted for nearly 5 million passengers (fig. 3.25). The states with the largest number of passengers entering by bus were also Michigan, New York, and Washington. Only a little over a half million people entered the U.S. from Canada as pedestrians, while only 269,502 people entered by train (figs. 3.26 & 3.27). The most heavily traveled ports on the U.S.-Canadian border are: Buffalo-Niagara, NY, Blaine, WA, and Detroit, MI.

The number of people legally entering the U.S. from Mexico is far greater than from Canada. During the year 2000, nearly 240 million people entered the U.S. from Mexico by personal vehicle, while more than 47 million entered as pedestrians, over 3.5 million in buses, and 18,254 by train (figs. 3.28-3.31). California and Texas had the largest amounts of traffic with similar numbers in regards to pedestrians, passengers by train, and passengers by bus. However, Texas had nearly twice the number of passengers entering the U.S. by personal vehicle compared with California. The most heavily traveled ports on the U.S.-Mexican border are El Paso, TX, Otay Mesa/San Ysidro, CA, Laredo, TX, and Calexico, CA.

The illegal immigration of people into the U.S. by way of land should also be considered as a possible pathway of introduction. According to statistics released by U.S. Citizenship and Immigration Services (USCIS), in the year 2000 there were a total of 1,643,679 apprehensions of illegal immigrants, by U.S. border patrol agents along the southwest border (http://uscis.gov/graphics/shared/aboutus/statistics/msrsep01/SWBORD.HTM). In 2001, the number had decreased 25% to 1,235,717, and in 2002 decreased another 25% to a total of 929,809 apprehensions along the southwest border. In 2002, the Immigration and Naturalization Service (INS) apprehended a total of 1,062,279 aliens of this total 97% were from the southwest border and the U.S. Border Patrol made 955,310 apprehensions. In the year 2000 there were 185,731 total removals and 85,836 expedited removals of undocumented aliens by INS, and there were an estimated 1,675,625 voluntary departures (http://uscis.gov/graphics/shared/aboutus/statistics/msrsep01/SWBORD.HTM). Seasonal highs of apprehension tend to be in early spring. Apprehensions then decrease but remain relatively high through the summer months before beginning their autumn decline and reaching a low in December (fig. 3.32). There were 23,092 apprehensions of people originating from Central America during the year 2000 and 22,515 apprehensions of Central Americans made in 2001. Of the 22,515 apprehensions in 2001, 39% were Honduran, 38% were El Salvadoran, 20% were Guatemalan, and 3% were of Nicaraguan origin (http://uscis.gov/graphics/shared/aboutus/statistics/msrsep01/SWBORD.HTM). Numbers regarding the apprehension of people crossing the northern U.S. border were not available. The seasonality of migration suggested within these apprehension figures should be taken into consideration when analyzing this possible pathway of CSF introduction. If an increase in numbers apprehended accurately represents an increase in total numbers crossing the U.S.-Mexico border illegally, then the most likely point of CSF introduction by this pathway would be within the spring when traffic across the border is greatest. Most of these migrants come to the U.S. in search of work, and many find employment within agriculture. Although we found no data regarding the estimated number of illegal migrants working within the U.S. swine industry, it would be prudent to further investigate this issue as a possible pathway of CSF introduction.

According to the estimates of the U.S. Immigration and Naturalization Services during the year 2000, Mexico had contributed the greatest number of unauthorized residents within the U.S. at 4,808,000 people. These illegal immigrants from Mexico accounted for 68.7% of the total unauthorized resident population (Office of Policy and Planning, U.S. Immigration and Naturalization Service, 2000). El Salvador (189,000), Guatemala (144,000), Colombia (141,000) and Honduras (138,000) followed Mexico in the number of unauthorized residents within the U.S. Of the top 15 countries of origin that contributed to the estimated unauthorized resident population within the U.S., 13 were considered to have CSF positive status (Office of Policy and Planning, U.S. Immigration and Naturalization Service, 2000). The countries that were not CSF positive were Canada and Korea and they had estimated unauthorized resident populations of 47,000 and 55,000. The states claiming the largest number of unauthorized residents were California (2,209,000), Texas (1,041,000), New York (489,000), Illinois (432,000) and Florida (337,000). These states were followed by Arizona (283,000), Georgia (282,000), New Jersey (221,000), North Carolina (206,000), and Colorado (144,000). With the population of unauthorized residents in large swine producing states such as Illinois and North Carolina at more than half a million there exists a risk of introduction. This risk exists only if these undocumented immigrants are in contact with swine or swine products previous to entering the U.S. and subsequently have contact with U.S. swine industry.

Air Travel

In the year 2000, it was estimated that more than 50 million people entered the U.S. via air travel. According to the BTS dataset during the year 2000, there were 26,098,520 that visited the U.S. (fig. 3.33) from 21 countries that were CSF positive. Because the BTS dataset does not include information on connecting flights or passengers which "hub" within a country other than their origin before entering the U.S., 21 countries is likely an underestimate. The U.K., Germany, and Italy had a combined total of more than 18 million people enter the U.S. (approximately 70% of the total number of people entering from CSF positive countries), while 4,566,741 passengers or 17.5% of the total came from countries within Central America/Caribbean and South America. The rest of the passengers were from China, Malaysia, the Philippines or India. In the dataset provided by BTS a comprehensive log of all flights entering the U.S. with an origin outside the U.S. and its territories were recorded. These logs provide not only information about the origin of flights but also the destination city. The dataset showed that 103 U.S. cities were the final destination of flights originating within countries that reportedly had a CSF positive status according to OIE (fig. 3.34).

Miami had the largest volume of passengers arriving from CSF positive countries (3,643,962). Most of the passengers (83.5%) that arrived in Miami were from countries in the regions of Central America/Caribbean and South America, but approximately 16.5% were from the U.K., Germany, and Italy. The city with the second largest number of passengers coming from CSF positive countries was New York with a total of 3,282,421 passengers. Passengers from Central America/Caribbean and South America accounted for 1,105,427 passengers (33.7%), while 1,884,793 European passengers accounted for 57.4% of the total and Asian passengers accounted for 292,201 (9.0%) of the total. Los Angeles was the city with the third largest number of incoming passengers from countries positive for CSF. A total of 2,949,066 passengers from CSF positive countries arrived in Los Angeles during the year 2000 with 1,561,038 (52.9%) coming from Central America/Caribbean and South America, 541,902 passengers (18.3%) came from Asia while 846,126 (28.6%) came from Europe.

Of particular interest are the passengers arriving from Haiti, the Dominican Republic, and Cuba due to current outbreaks in those nations. While it is not listed within the dataset how many people arrive within the U.S. from Cuba; the Dominican Republic and Haiti were the origin of 998,444 and 329,096 passengers, respectively. Passengers arriving from the Dominican Republic landed in 28 U.S. cities. New York, NY (410,878), Miami, FL (317,202), Newburgh, NY (124,647), Boston, MA (41,700), and Philadelphia, PA (27,253) were the cities with the largest volume of passengers from the Dominican Republic. Only six cities were listed as the final destination of passengers arriving within the U.S. from Haiti. The cities and respective volume of passengers were Miami, FL (233,498), New York, NY (90,209), Boston, MA (5,315), Indianapolis, IN (54), Alexandria, LA (14), and Fort Lauderdale, FL (6). While we do know the arrival destinations and volume of travel from these countries, we do not know how many people were in contact with the swine industry prior to their arrival in the U.S. or whether they were in contact with swine during their stay in the U.S.

In order to more accurately assess the pathway of introduction of CSFV via international travel of people, the AQIM dataset provided by APHIS-PPQ was utilized. A potentially high-risk group for the accidental introduction of CSF were individuals that had contact with both foreign and U.S. farms. These data were therefore queried to determine the number of people, of those sampled in the AQIM dataset, who visited foreign farms or were returning to American farms (fig. 3.35). For the years 2002 and 2003, we have broken down the AQIM data by country of origin of the person sampled, and have included the number of persons sampled who were going to a farm in the U.S (as stated on the customs declaration), the state where that farm was located (when known), and the CSF status of the country of origin at that time (based on OIE data) (figs. 3.36 and 3.37 for 2002 and 2003, respectively). It is possible to derive 'proportionate risk' statistics for the country of origin of the passenger (PAX), but there are essentially no denominators with regards to other passengers from the same countries included who had not been or were not planning farm visits. If this sample is truly representative of the population of travelers for the entire country for a year then the 'absolute' number of high-risk farm visits (without regard to type of farm (e.g., beef, dairy, pork, poultry, grains, etc) can be estimated from the proportion sampled.

Maritime Travel

According to U.S. Customs Services, 11 million people arrived in the U.S. by means of ship in fiscal year (FY) 2000. In total, about 489 million passengers/pedestrians were processed in FY 2002, so about 2.25% of all incoming passengers were attributed by the maritime industry (http://www.customs.gov/ImageCache/cgov/content/publications/ar2000_2epdf/v1/ar2000.pdf). A vast majority of these numbers are linked to the cruise ship industry which primarily operates within the Caribbean and Central American regions. Many countries within this region such as Cuba, the Dominican Republic, Haiti, Mexico and most Central American countries other than Belize and Panama are considered to have a CSF positive status. The disposal of garbage from cruise ships is regulated in a manner consistent with USDA-APHIS regulations, but there still exists a chance people could transport foreign agricultural products or food back to the U.S. Therefore this mode of travel to the U.S. should be considered a possible pathway of CSF introduction to the U.S..

The illegal immigration of people to the U.S. by maritime means should also be considered as a possible means of CSF introduction. According to the U.S. Department of Transportation, the U.S. Coast Guard, and the Office of Law Enforcement there were 4,217 U.S. Coast Guard Migrant Interdictions at Sea during FY 2000. Of those interdictions 1,394 originated from Haiti, 1,029 from Ecuador, 928 from Cuba, 781 from the Dominican Republic, 37 from Mexico and 2 from China (http://www.uscg.mil/hq/g-o/g-opl/mle/amiostats1.html#cy). Nearly all of the people who were interdicted at sea before entering the U.S. were from countries that were considered to have a CSF positive status. While we do not have an estimate on the number of people successfully entering the U.S. via this illegal mode of travel, this should be considered a concerning pathway because of the origin of the illegal immigrants that are captured.

Swine Producer and Employee Travel

As part of this pathway analysis, a survey was developed by the National Agriculture Biosecurity Center Consortium at Kansas State University with cooperation by the National Pork Board to evaluate the role pork producers in the U.S. could play in the introduction and/or prevention of a Foreign Animal Disease (FAD). In addition, producer concerns pertaining to FAD introduction, travel precautions, and border security issues were evaluated.

In 2004, the survey was distributed to members of the National Pork Board. (Appendix 3.1) The survey was conducted to better understand producer and employee views of foreign animal disease and international travel patterns of this population. Of the 970 producers responding, 12% (119/970) had traveled internationally to 52 different countries during the past year (December 2002 – December 2003). Of producers who traveled internationally, 44% (52/119) visited a farm on their travels and 75% (39/52) of the producers who traveled and visited a farm had contact with livestock. Of the producers who traveled internationally, visited a farm, and had contact with livestock on their farm visit, only 26% (10/39) responded that footbaths were provided at their point-of-entry to the U.S. Swine producers that traveled internationally were asked if they underwent an inspection of their luggage or person for agricultural products at their point of entry. Forty-nine percent (58/119) of international travelers replied that their luggage was inspected. However, only 36% (43/119) of travelers were provided with information on the proper precautions to take if they planned to visit a farm upon their return to the U. S.

When producers were asked if any of their employees had traveled internationally in the past year (December 2002 – December 2003), 6% (60) said they knew that at least one of their employees had traveled internationally. Employees visited twenty-two countries. Twenty-four (40%) respondents indicated having knowledge of at least one of their employees visiting a farm during their travel.

Human to Animal Transmission

There are a series of events that must occur to enable human travelers to transmit CSFV to swine. First, the human traveler must come into contact with CSFV. Second, the virus must infect the human traveler or use the human traveler as a mechanical vector. Third, the virus must survive until the human traveler comes into contact with naïve swine. It should be recognized that not all human travelers would come into contact with swine. Finally, if the virus survives it must be presented to the naïve swine at a dose and route that can cause infection.

There is no evidence that CSFV can cause infection in humans therefore human travelers represent no risk as biological carriers of CSFV (USDA, 1998). It is possible that human travelers could serve as mechanical vectors since CSFV can survive outside the host. While possible, it is not very likely that the previously stated course of events would occur for a majority of the traveling population therefore the risk of humans serving as mechanical vectors is negligible (USDA, 1998).

ENTRY OF CSF VIA CONTRABAND MEAT PRODUCTS

A recent risk analysis of the introduction of FMD into Europe suggested that food carried by tourists or immigrants was a potentially important pathway of entry (International Conference on Control and Prevention of FMD). In 2001, APHIS conducted an analysis of contraband interceptions at international ports of entry as a component of a pathways analysis of FMD (USDA: APHIS, 2001). Using the Work Accomplishments Data System (WADS) and AQIM they estimated the total volume of prohibited products entering the ports and the proportion of prohibited products detected. APHIS estimated that 30% of all prohibited materials arriving at U.S. ports are animal products. The report concluded that total prohibited products arriving at U.S. ports of entry are significant and detection rates are low. This results in a large volume of prohibited product entering the U.S. each year.

Europe (particularly the U.K.), the Dominican Republic, and Mexico have the highest estimated totals of prohibited animal materials arriving at U.S. ports by air. Numerous European countries and the Dominican Republic are endemic for or have had recent outbreaks of CSF. The USDA estimated that approximately 1 million prohibited and undetected animal-related products got into the country with arriving passengers in 2000 at the 10 busiest U.S. airports.

Prohibited animal products may also arrive via sea or land. Vehicle and pedestrian traffic from Mexico alone included approximately 3 million passengers and pedestrians in 2001. The USDA estimated that about 3 million undetected and prohibited products came in with passengers and pedestrians from Mexico in 2001.

The USDA FMD report does not take account of illegal border crossings by any route. However, not all undetected contraband materials have the potential to reach a susceptible swine host. Thus, it also is important to consider the volume of contraband that could result in transmission to a U.S. swine, either through subsequent arrival at the farm or via improperly disposed of garbage. Estimates of this percentage are not available. It would be useful to conduct a survey of individuals identified with contraband meat materials to better understand the likely dispersion of these products and to target specific education programs to prevent unintentional entry of potentially infectious materials.

The Data Management Analysis (DMA, APHIS: PPQ) provided additional information on contraband materials entering the U.S. The DMA group uses the WADs data to::

a. Analyze agricultural inspection and import information captured by various databases that PPQ maintains.

b. Support the Smuggling Interdiction and Trade Compliance (SITC) field ops.

c. Conduct pathway evaluation and provide advice, coordination and analytical reports as needed.

Example reports on meat interceptions were provided by DMA for California for October, November, and December, 2002 and for Texas from October 2002 to January 2003 (figs. 3.38 to 3.41). Some of the issues when interpreting these reports include:

a. APHIS-PPQ data are for meat and by-products but are not divided into beef, pork, or poultry

b. These reports are derived from 'WADS' data that typically run 15-30 days behind schedule

c. For some data (e.g. see Texas interceptions) it appears that either there is no checking for contraband during certain months (unlikely) or else reporting is 'lumped' bimonthly (more likely).

d. No denominator information is available (that is, are these all self-reports from PAX, are they from random checks, are they from targeted checks and or blitzes?). This makes it difficult to estimate risks proportionate to traffic volumes and/or country of origin. It is likely that targeted surveillance would be needed to determine appropriate denominators.

e. Quantity is assumed to be 'confiscations' rather than weight (this isn't clear from information provided).

f. However, it is subdivided by Baggage (accompanied by PAX) versus Aircraft versus Cargo (unaccompanied) so we can likely assume that the latter two are detected actively whereas the first category may involve some voluntary representation by PAX. Again, this is not clear.

g. Data are also divided by airport code (e.g., LAX vs DFW). Land crossings and maritime ports are likewise provided.

h. Country of origin of these confiscations are not explicitly presented but could readily be achieved through targeted blitz surveillance

i. Disposition of product is not tied to passenger destination (e.g., farm vs city)

j. Comments on this dataset from DMA personnel included the following: "Our personal knowledge of the small volume (1-2 pounds of each meat per PAX) carried across land and air by non-commercial couriers indicates most persons intend to use the meat for personal consumption. [Whether this happens is unknown, as is the disposition of leftovers].

These reports provide some indication of the magnitude of the problem of contraband meat products entering the U.S. However, not all undetected contraband materials have the potential to reach a susceptible swine host. Thus, it also is important to consider the volume of contraband that could result in transmission to a U.S. swine, either through subsequent arrival at the farm or via improper disposal of garbage. Estimates of this percentage are not available. It would be useful to conduct a survey of individuals identified with contraband meat materials to better understand the likely dispersion of these products and to target specific education programs to prevent unintentional entry of potentially infectious materials.

PATHWAYS ANALYSIS: SURVEY RESULTS

We used a qualitative survey to gather expert opinion on the concept of pathway analysis from a variety of stakeholders, as shown in Figure 5.1. The survey instruments used are attached as Appendix 3.1. We analyzed 91 responses, from state (18) and national (7) regulatory officials, veterinary diagnostic laboratory directors (24), international animal health experts (10), farmers and ranchers (6), and veterinary practitioners in previously CSF endemic areas (6); and from industry (5), and other experts such as USDA inspectors, game wardens and wildlife biologists (11). While many of the responses obtained are somewhat anecdotal in nature, the responses to this survey represent expert opinion and include ideas, insights, and concepts that cannot be gleaned from published sources. Anonymity of individuals' responses allowed for frank discussion of some controversial topics. Because of the richness of the replies, the results are presented as near verbatim responses. Separate headings with separate bullets and lower case numerals are comments or summary of responses from different individuals about the same topic.

High Risk Pathways – International Perspectives

A) Caribbean

- Underreporting of diseases to OIE by countries
    - ***i.*** There was an incident when there was CSF in the Dominican Republic (DR) and Haiti, but it remained unreported to the OIE. Due to infrastructure, there are a number of countries that do not report FAD outbreaks.
- Low virulent strains in Caribbean/Central America right now

i. There are a lot of low virulent CSF strains out there. The virulence of the strains right now in Central America/Caribbean is low.

- Small boat traffic from Caribbean to Puerto Rico (PR) and the U.S. coastal mainland
    i. As emphasized by the 2004 CSF surveillance program, PR is considered the highest risk area for CSF virus entry into the U.S. There is already a clear threat for CSF virus introduction from the CSF endemic DR, which is enhanced by small boat traffic originating in the DR and coming to PR. Puerto Rico is very vulnerable due to the potential for illegal immigration because people will bring food, usually improperly processed sausage that may carry viable CSF virus. Unused food could then be fed with garbage to swine in Puerto Rico. The passage from the DR to PR is short. The border patrol in PR works night and day to impede illegal immigration; however, there is intense pressure for impoverished people to seek better opportunities in places such as PR and other locations within the U.S., such as Florida. Because of this threat, a great amount of surveillance goes on here. It should also be noted that there are no swine practitioners in PR High immigration activity to PR is correlated with seasons of calm water for boats to cross the Mona Passage from the DR to PR.

    ii. Many agree that it is amazing that PR is CSF-free today due to the impossible task of protecting its borders; this is an enormous problem that is not comprehended until people see firsthand what protecting PR's borders entails.

    iii. CSF virus will likely come into PR by sausage that is improperly cooked and included into improperly cooked garbage that is fed to pigs.

    iv. Small boat traffic throughout the Caribbean is uncontrollable. There is great potential for small boats from the Caribbean to end up in Mississippi, Alabama, Florida, Texas, or other parts of the U.S. mainland.

    v. Refugees originating from countries in the Caribbean often will bring all that they can with them aboard their small boats, including animals such as pigs. Illegal immigrants from Haiti will bring with them smuggled feeder pigs or pork. Feeder pigs brought in illegally from the DR or PR and then contraband meat spreading the disease to the continental U.S. is a very high risk and a way that many feel CSF will come into the U.S.

vi. Authorities will routinely find numerous small boats all along the coasts of PR; there is a lack of personnel to stop all small boat traffic from around the Caribbean

vii. There are no restrictions for Puerto Ricans coming to the U.S. PR is easy to enter from anywhere in the Caribbean. CSF is not in PR yet; it could be possible that it is there or that it has been there, but it has not spread into the U.S. due to the virus not having access to the right channels.

viii. Another issue is small boat traffic instigated by dope runners that bring in contraband. These individuals will go to remote areas in the U.S. by small plane or boat, which increases the likelihood that trash they throw out could be contaminated, which is a potential source for feral swine to become infected with CSF. In Florida and Georgia, it has been reported that trash was often found at unloading sights. There is a decreased incidence of reports of such activities, or perhaps violated pastures are not being reported by cattlemen as often as they once were. However, a possibility that must also be contemplated is maybe we are not looking as hard.

ix. Due to their culture, Cubans and Haitians coming to the U.S. via boats do not just come with suitcases; they will bring everything they can fit on the boat: pigs, chickens, family, etc. It is easy to get into Southwestern Florida; there are many spots for illegal entry through the Everglades or the Florida Keys.

x. Once you legally enter PR, your entry into the U.S. is not international. A shipment of cattle from PR to Florida or vice versa is interstate commerce, not international.

xi. U.S. territories are a risk: PR, Guam

xii. High potential for movement of people/animal products from the Caribbean

xiii. The island of Hispaniola has low virulent CSF right now; everyday there are immigrants originating from this island that land on the shores of PR.

xiv. The high-risk area in PR is the southwest to northwest coasts. CSF will most likely come into PR from small boat traffic that brings in homemade products, such as sausage or pork meat, which has not been cooked at the appropriate time/temperature to kill the CSF virus.

xv. When boats are not intercepted, the immigrants will hide in the brush. Most immigrants originate from the DR, but there has been an increase in immigrants from Cuba.

xvi. There are no seasons where there are more boats found as compared to other seasons.

- Route from PR into New Jersey, New York, and other states
  - *i.* If CSF gets into PR, the virus could end up in New Jersey (NJ) and/or New York (NY); there are more Puerto Ricans in NJ/NY than are actually on the island. This is a significant risk due to the large volume of family visits either to the mainland or relatives from the mainland coming for a visit to the U.S. It is a cultural tradition to take homemade food from relatives.
  - *ii.* Most people from PR travel to NY, NJ, Florida and California.
- Navigable inland waterways
  - *i.* The waterway from Cuba to Florida is a short travel distance, so it is less likely immigrants would be carrying food. Immigrants caught trying to come into the U.S. via this waterway are turned back with what they are carrying. People in Cuba do eat a lot of pork. However, it is doubtful they would bring pork meat on such a (usually) short crossing.
  - *ii.* Due to easy access and the close proximity of feral swine to the Caribbean, the southeastern part of the Inland Waterway is considered a risk for CSF introduction. Some of Florida's rivers are navigable inland for hundreds of miles. It is said that the Mississippi and its tributaries contain navigable waterways of over 14,000 miles.
  - *iii.* The inland waterways in Florida and some of the states coursed by the Mississippi river have feral swine, and so meat tossed overboard could easily end up in the mouths of feral swine. (NB: This will be discussed in more detail in the section on Meat/Contraband.)
- Political leadership issues and the U.S. relationship with Cuba
  - *i.* Due to political issues with Cuba, the U.S. does not know what is in Cuba. An issue that must always be considered is the impact of what would happen if Fidel Castro dies. Most likely, the doors would open within 10 days or less because many Cubans in the U.S. have a desire to return to Cuba to reclaim their land. Castro's death would likely cause mass movement of people between the U.S., Cuba, and Hispaniola.
  - *ii.* CSF is probably in Cuba, but this is not known for sure.
- States with large immigrant communities; immigrants maintaining physical ties with native country

i. Georgia, Florida, Alabama, and Arkansas have relatively larger communities of immigrants/residents from the Caribbean. NY/NJ may be of concern as well.

ii. The Caribbean ethnic population in Florida is large and is increasing rapidly, especially in the suburban populations located outside Florida's major cities in the south, such as Miami. The population is most concentrated in the south, and then scatters all over as you move north. There are a lot of Haitians and Cubans in the south; there are not a lot of Puerto Ricans. The major ethnic groups in Florida come from the Caribbean.

iii. Those with strong family ties to the Caribbean often will have backyard pig operations. They have a heritage they are proud of; therefore, they maintain cultural traditions. Many of the greater than 600 backyard pig operations in Florida have such origins. Pigs are an important part of their culture, especially during celebrations, and they are an important part of life. If a hog gets sick, they will eat it before it gets too sick. These ethnic groups also do not trust or understand our government due to a basic mistrust of government from the old country. There are numerous operations like this, and it is hard to know where exactly they are located and how many there. This is because a) you have to go looking for them, b) these ethnic groups do not want the government in their business, and c) you have to be able to communicate with these individuals. These operations have poor biosecurity, so there is commingling between domestic and feral swine. This will be discussed in more detail in the section on Pathways within the U.S.

iv. There is a significant population of Caribbean immigrants who maintain physical ties with their old country due to relatives still living there. Tainted meat scraps could find their way into the swill bucket when travelers arrive at their relatives' residence or other locations where the travelers might stay. "One of the hot items confiscated by PPQ is food from the old country brought to the USA to share with relatives. High on the confiscated piles are sausages and cheeses. How much of this gets through and into the wrong place when the recipient of this good gesture is less than appreciative of the old world cuisine isn't really known. But, can't you just see it now…'Gee, Mommy, this stuff tastes worse than Grandpa's oyster chili', and out to the pigs it goes."

v. There is a man in Iowa who has a pig operation and has an adopted little girl from Haiti. They go back to Haiti frequently to visit the little girl's relatives.

What is the likelihood that he could bring something back with him to the U.S. unintentionally, or that the little girl's relatives might put some meat in her luggage or pockets for her to take back with her to the U.S. as a gesture of courtesy? And in the meantime, everyone is worried about Texas or Florida.

vi. Half of the billboards in Miami, Florida are in Spanish.

vii. "They say that from the Caribbean to the backyard hog to its feral or wild neighbor is just a food scrap away."

- Current U.S. laws/regulations regarding contraband confiscations

  i. If a person brings goods into the U.S. that are normally allowed, a customs tax is paid. People smuggle in goods as a way to avoid paying taxes on those goods. Illegal contraband brought into the U.S. needs to be focused on more. Confiscated contraband is disposed of. Meats are disposed of in an industrial strength grinder, and this waste, like most international food wastes from ports, is autoclaved. This makes it sterile garbage, which then is not a risk and can be transported anywhere. Animal contraband is not inspected or tested for possible disease agents.

  ii. Plants are inspected more than animal products because it is easier to cut the plant open and inspect for larvae or to inspect using a microscope which inspectors have access to.

B) Mexico (see Feral Swine in national pathways section)

- Movement of people across the Texas (TX) – Mexico (MX) border

  i. "People, especially veterinarians, are excellent vehicles for CSF virus, as mobile fomites."

  ii. There are reports of Mexican veterinarians practicing in the U.S. illegally; they mostly do large animal work. They will try to bring their own equipment with them, but if they are caught by customs, they will put the equipment they need in the U.S.

  iii. Customs inspectors are more lenient with people they see crossing frequently

  iv. Migrant workers:

    1. There is some seasonal flow of migrant workers - most are going more north in the U.S. to make money picking fruit, etc. Most migrant movements are during the summer and fall.

    2. The flow of migrant workers is still year round.

v. The housewives of illegal immigrants are a big threat for CSF entry into the U.S. Illegal immigrants hide in the brush creating a high potential for tossed meat that could be CSF infected to end up in the feral pig population.

vi. There are Mexicans who have ranches in the U.S., and vice versa; but, due to fever tick controls, there is controlled movement of animals.

vii. It is likely there are people, animals, and products that come across the border everyday illegally.

viii. It would be easy to move product back-and-forth across the border

- Feral swine population (see also Pathways within the U.S.)

  i. Texas is a threat for CSF introduction into the U.S. because of the feral swine population and due to the interaction between feral and domestic swine.

  ii. Due to the large population in Texas, if CSF got into the feral swine the virus would be hard to control.

  iii. Feral swine, unprocessed sausage and swill feeding are ways CSF is most likely to come into the U.S.

  iv. If the feral population is such a high risk, then why has CSF not gotten into that population yet?

- Lack of biosecurity on noncommercial operations in TX

  v. There is a lack of biosecurity, especially at waste feeder and backyard pig operations.

- No CSF testing on the border; should we?

  vi. We have good import and export regulations, but the problem is our sampling. We cannot sample everything, and so we only look at a certain percentage. There are more samples which come into the U.S. that could be contaminated, but are not sampled.

  vii. Semen/embryos that come into the U.S. must have international certificates. Meat product importation from other countries is generally not allowed.

  viii. There are not any major hog producers along the Texas/Mexico border anymore

- Naïve areas unaware of Hispanic culture customs

  ix. This is true in Texas and elsewhere in the U.S. People in some areas are unaware of Hispanic population activities, such as that they will bring meat with them from Mexico.

x. There are ranchers in Mexico that also have ranches in the U.S., and vice versa. Three years ago there was a *Brucella mellitensis* problem on a sheep and goat ranch in Texas. The owner of the ranch also had a ranch in Mexico. It was concluded that the rancher had smuggled animals in from his ranch in Mexico.

- Ethnicity at slaughterhouses becoming more Hispanic

xi. It is also not uncommon to find one or two Hispanic workers on small swine farms. Most of these operations are family-owned. Corporate producer operations are also mostly Hispanic workers.

xii. There is increasingly more Hispanic labor used in the swine industry. There has been documentation of Hispanics eating native meats in employee lunchrooms of pig production facilities. Although this is not common or representative of all productions facilities, it is a source of vulnerability that needs to be kept in mind.

- Consumer preferences driven by economic forces between TX/MX

xiii. Mexico, the Monterrey port especially, imports products from Australia, such as cattle. There are a lot of buyers in Texas, New Mexico, and Arizona who would like to buy cheap cattle; there is always this economic pull.

xiv. Economists do not talk to public health officials until they need disease cost estimates.

xv. High import tariffs drive smuggling from Mexico into the U.S. There are professional smugglers.

- Stray pig across Mexican border – likelihood?

xvi. It could be possible for feral swine to come across the Texas/Mexico border because they can swim or they could cross when the river is low. Feral swine are nocturnal animals so they are hard to see at night. It is hard to control the movement of feral swine; they are intelligent and they will go where they want. You cannot tell the difference between American and Mexican feral swine. The brush is very thick along the border, so it would be difficult for the Tick Force riders to see if there are feral swine in their area. They also do not patrol 24 hours a day. The Tick Force does not patrol at night or on weekends. There are about 120 stray animals caught per year by the Tick Force, primarily bovine and equine. The river is not a barrier to wildlife coming across the border. Currently, there are 61 inspectors working as part of the Tick Force.

xvii. During certain times of the year when the river is low, it is not a barrier to anything. There is no end to the type of exotic animals that can be found along the border, and most of these animals have come from Mexico. It would be difficult to have full control of the river and what comes across the border from Mexico. It has been proposed that a fence be built along the Rio Grande River. However, this is not feasible and would be too costly to put up a game-proof fence along 900 miles of river. If a fence were built, it would eventually be breached, first by people, and then by animals. There is just too much river and too much going on.

xviii. People smuggle animals across the border, and this probably happens more often than we know. If swine are smuggled, it is probably for personal consumption or sale. Since pigs are not known to carry fever ticks on them, they are not examined as closely at sale barns as others animals are, such as cattle.

xix. The Border Patrol, which is now part of the Department of Homeland Security (DHS) does not patrol the border like the Tick Force does; the Border Patrol sits farther off the border and do not actually patrol the river. If Border Patrol does see animals coming across the border at night or on weekends, they will usually leave the animals there and let the Tick Force riders find them later (i.e. on Monday morning) because they do not have the capabilities to handle the animals. There was one instance where frozen chickens were being smuggled into Mexico and the Border Patrol did not deal with them because it is not their business. The Border Patrol and the Tick Force do cooperate with each other as much as possible, and this relationship needs to be fostered. There are issues with the U.S. Fish and Wildlife Agency about maintaining patrol status on refuge property. There are laws that are preventing the Tick Force riders from maintaining their trails along the river even though the riders have the legal authority to go anywhere along the river.

xx. There is not much live movement of illegal animals into the U.S. Live swine coming across the border is not common – very spotty. This is due to the strong presence of the Tick Force, DHS, immigration, as well as the TAHC in Texas.

xxi. Pork is more of an important commodity in Mexico than in the U.S. There is a potential for feral hogs to move across the river because the river is shallow in many places and pigs can swim. You cannot regulate a wild population in which the animals can swim.

- Why Mexican border is NOT a risk

xxii. Mexican border not a high risk area

xxiii. Since Mexico has had CSF for 40 years, there is not much reason to increase surveillance. The border is ok with the measures in place now to keep CSF out of the U.S. Programmatic decisions affecting the border are ok; we are doing well with our inspections.

xxiv. There are no hogs coming across the border legally – no swine, sheep or chickens are allowed into the U.S.

C) Canada

i. Canada exports a greater percent of their pork than does the U.S. If CSF came into the U.S. by way of Canada, it would be a by-product coming through Vancouver or Toronto.

ii. There is lack of security at the Canadian/U.S. border – it is nowhere close to being protected.

D) Meat / contraband carried by travelers / common carriers / private carrier (see section on garbage feeders below)

- Via international airports (see section on 'airplanes' below)

i. Accidentally; from the Caribbean/Central America going into Newark, JFK, and Florida

ii. International garbage at airports is not fed to pigs. Occasionally something might get through, but the likelihood of sausage from Europe getting into pig operations is very low.

- Travelers/immigrants dumping along roads, etc.

i. This is a high risk; the infected meat could get dumped into backyards or on the side of roads where feral swine could eat it or the meat could have direct contact with backyard pigs, which could then infect the feral pig population.

ii. Vulnerability is greatest with illegal immigrants carrying sausage that is improperly prepared and is CSF infected into PR. There is constant pressure for people originating from underdeveloped areas to find a better way of life in another area, and this incentive will pull people into PR and the U.S. mainland, such as Florida.

iii. In Europe, there is a problem with ethnic foods not being cooked and the proximity of people. The U.S. does not have as big of ethnic culture that eats ethnic foods as Europe does. In the U.S., people that have ethnic foods, such as raw pork, are mostly located in cities.

iv. Meat scraps can be discarded at numerous locations from travelers/immigrants. Food tossed out car windows or along roads of Southeastern states. Migrant workers travel along these roads and feral swine could eat the scraps that are tossed.

- Intentional dumping (cruise ships, pleasure crafts visiting foreign ports, private aircrafts)

  i. International waste off planes or boats anywhere in the U.S. is a risk for CSF introduction. Ranchers used to receive incentives from drug runners to leave their back pasture gates open. Runways lit up by candles would be made in the pastures, and ranchers would find garbage that had been dumped. This is rare now.

  ii. Although illegal, it still happens. The garbage dumped can wash up onto shores. In some southern states, feral swine have access to these shores.

  iii. Feral swine have been known to line the beaches of certain Southern coastal lines and wait for the tide to bring in garbage that is dumped from passing ships.

- Contraband not tested/inspected

  i. Almost a repeat of above: If a person is bringing goods into the U.S. that are normally allowed in, a customs tax is paid. People smuggle in goods as a way to avoid paying taxes on those goods. Illegal contraband brought into the U.S. needs to be focused on more. Confiscated contraband is disposed of. Meats are disposed of in an industrial strength grinder, and this waste, like most international food wastes from ports, is autoclaved. This makes it sterile garbage, which then is not a risk to be transported anywhere. Animal contraband is not inspected or tested for possible disease.

- Landfills receiving garbage from cities/international airports (see Landfills in national pathways section)

  i. Feral swine may eat the raw garbage.

ii. Some landfills receive garbage from cities that have a significant immigrant population that maintain ties with relatives who reside in CSF infected countries

- Airplanes at international ports/airports: will agent find host?
  i. Miami international airport – it is impossible to screen everyone, even since 9-11-01, due to the volume of airline traffic. PPQ does well with inspection, but there is still the risk of illegal products entering the U.S. There are not enough resources to screen everything. Example: Incidence of anesthetized baby parrots being found inside hair rollers of individuals coming into the international airports.
  ii. If CSF virus was able to get through the Miami airport, then what is the probability that the agent would find a host?
  iii. Product coming through the more popular international airports for South/Central Americans (i.e. Houston, NY, Miami) is a risk. Due to cultural influences, it is more likely that pork is the animal product that comes through.
  iv. Licensed garbage feeders pose less of a threat than in the past because much of the garbage is cooked before it is given to the swine. However, the source of the garbage must always be considered. There is always the scenario of the ethnic restaurant improperly cooking the meat brought in illegally from travelers from the orient and subsequently starting an FAD outbreak.
  v. A lot of flights will come in all at once and leave all at once. There will be three different planes coming in from Europe at the same time, each carrying 500 or more passengers – this swamps Customs. This is a risk factor since you cannot inspect everything and so a person could get through without being screened. Example: (1998) Incidence at the San Juan Airport in PR where U.S. Customs threw open the gates due to passengers being backed up as several planes had arrived all at once. "Weary passengers…get angry when held up too long and converse with their politicians." In a situation like this, it would be easy to smuggle "anything smaller than a baby elephant" into the U.S. Just "pick an airport that did the same thing and…get on a U.S. flight and [you would] not have to go through customs or PPQ inspection." However, this practice is most likely not done anymore since 9-11-01.

vi. Food can be smuggled either in luggage or on the travelers themselves. Food smuggled in baggage is likely to be caught by PPQ during normal hours and conditions– they do an incredible job with inspection, but they do not claim to be perfect.

vii. A significant concern is a traveling person that is headed to a U.S. swine operation who has live CSF virus in mud in their boot/shoe crevices.

viii. States with international airports are a risk; any port of entry is a risk. Illegal goods enter the U.S.: PPQ once found boxes in FL marked as fruit that originated from Asia – when opened, chicken remains where inside.

ix. There is not 100% intervention at airports – it is likely that some of the product that comes in has the agent in it; it is just a matter of whether the agent will find a host.

- Customs/PPQ relationship

i. PPQ has dogs that will sit by individuals trying to sneak in meat. There was one instance where a man was caught coming into the U.S. with a sausage belt around his waist; his reason for trying to sneak in the meat was that there is no good sausage in the U.S.

ii. PPQ spot-checks and inspects people based on percentages, and dogs are not used all of the time. It seems almost a certainty that meat products do come across U.S. borders.

iii. There are veterinarians present at some of the larger international airports. More are not employed so as to prevent those staffed from being complacent or bored.

iv. Customs must refer individuals to PPQ; if individuals do not get referred, PPQ will not see them.

v. Customs is trained in security issues and they do not have a scientific background. It could be possible for someone to get through Customs with CSF.

E) Mail

i. Repeat: illegal goods enter the U.S. PPQ once found boxes in FL marked as fruit that originated from Asia – when opened, chicken remains were inside.

ii. Food that is mailed internationally often makes it into the U.S.

iii. U.S. mailing facilities are a weak link in trying to monitor international mail coming into the U.S. There are PPQ representatives that talk with the U.S. Postal Services, but PPQ is not physically there trying to detect mislabeled boxes or food coming in internationally. There was an instance where a Federal Veterinary Medical Office (VMO) went to FedEx to pick something up and caught eight full semen tanks that were being shipped in from Germany. These tanks would have gotten through if the VMO did not notice them. How many times does a shipment like this gets through and into the U.S.? You can get things mis-manifested in another country if you have the right money and connections.

F) Necessary conditions: the 'epidemiological triad'

- For disease to spread, you must have the agent, host and environment. In NY, it is more difficult to have these three factors interact as compared to Miami. Because the CSF virus is more stable than FMD, you can infect pork jerky with it and it is viable. Therefore, the probability of CSF coming through airports is questionable; it is more of a matter of whether the agent can find the susceptible host.
- CSF is not in PR yet; it could be possible that it is there or that it has been there, but it has not spread into the U.S. due to the virus not having access to the right channels.
- CSF has most likely entered the U.S., but has just not had access to sustainable pathways. Most likely, the virus has come in with individuals from infected product, but this product was probably eaten, thrown out in a dump, a yard, the woods, etc. It is possible that CSF has gotten into the feral swine population, but the virus just did not establish. It would be shocking if CSF has not come into the U.S. at all since its eradication. Things come into the U.S., and due to increases in trade and free movement, there are added possibilities of ways CSF could come in and become more established.
- "How many times has CSF been introduced into the U.S. in the last 25 years and it either failed to find a suitable host or the infected host(s) never spread the disease outside of its isolated population?"
- It is likely CSF has come into the U.S. but has not spread; probably has come in with product from the Gulf Coast. This has probably been the case with many diseases.

- CSF most likely been in the U.S. unrecognized. “Leading authorities on CSF are amazed that PR remains CSF-free today.”

G) Bioterrorism (targeting feral vs. domestic swine)

i. CSF could definitely be used in this manner

ii. CSF is not that contagious in the field, so it does not seem it would be an agent of choice

iii. Possible, although CSF is more limiting economically as compared to FMD

iv. CSF could come into the U.S. this way. It would be more devastating if terrorists used the agent with a mixture of other agents, such as combining CSF with Foot and Mouth Disease (FMD) and African Swine Fever (ASF).

v. DHS puts a lower priority on animal problems as compared to human; agriculture is at the bottom.

vi. CSF could be used in this manner; this is probably the most likely way CSF will come into the U.S. It is likely CSF will appear first in domestic hogs of corporate operations, especially the large corporations located in the midwest that would hurt the U.S. the most.

vii. People who are willing to blow themselves up to kill a few would likely risk trying to smuggle in disease agents or attempt to be biological carriers.

H) Special topics: garbage feeders – see also the section on pathways within the U.S.

- Location
  - *i.* Garbage feeders are a risk if feral swine are nearby
- Regulations
  - *i.* Garbage feeding cannot be outlawed for fear it might drive this practice underground, and therefore make it even more impossible and difficult to supervise and regulate the process than it is now.
  - *ii.* Remote pathway because garbage feeding has been done for so many years since CSF was eradicated; there is a large amount of control at our international ports for cooking garbage; and people must cook their garbage. It may not always be cooked to regulation, but USDA has the opportunity to observe these operations.

I) Weather Events

i. During hurricane season, what is the likelihood that a CSF infected dead pig from the Caribbean will wash up onto the Gulf Coast and start an outbreak?

J) Trade

i. Trade is always a risk; trade increases the possibilities of CSF entrance into the U.S.

The risks and threats for CSF entry were hard to rank in order of probability by many of the people interviewed due to the fluctuations of incidence and prevalence of the disease and outbreaks around the world. One comment: "Few of us Foreign Animal Disease Diagnosticians (FADD) take the time to stay current where the reported FADs are at all times or the subtle shifts of world politics."

High Risk Pathways – National Perspectives:

A) Illegal movement of swine (see Movement under Feral Swine section below)

i. 98% of infectivity of disease comes from animal movement

ii. Owners would take their animals to slaughter immediately if animal movement was about to be prohibited

iii. Movements of animals within states is controlled AFTER the dust settles because so much movement happens first during outbreak situations

iv. Stopping movement of animals is a state problem first

v. There are people called "traders" that can be anywhere from someone with a pickup truck to someone with a semi. A trader buys swine from anyone and from anywhere and sells the swine in his/her own name or in someone else's name. Swine identity is lost. There are many of these "traders" around.

vi. Even though we have law enforcement, it is hard to catch everyone that is moving swine illegally, especially between states; It is not absolute that everyone has health certificates or that everyone moving animals is checked

vii. Some states probably check for illegal movements of animals more often than other states

viii. There is not someone at every road checking for illegal movements of animals *ix.* You cannot implement animal movement controls without proper facilities; there are thousands of animal movements everyday, you do not have control points with the current state and federal budgets, and you might have control points on major roads, but not on back roads.

B) Unapproved/unregulated animal market sales

x. These types of markets, such as flea markets, operate outside of standard operating methods. They have increased in number over the past 10-15 years, are found all over the U.S., and there is no surveillance at these types of operations.

xi. These types of markets are A-bombs; they trade everything and anything. If you try to regulate them at the market, then they will sell on the side of the road.

xii. It would be helpful to have regulations on these markets.

xiii. If you stop one market, another will popup somewhere else. They are hard to control.

C) Feral Swine

- Access to infected meat scraps (see section on Meat/Contraband in international pathways section)
  - *i.* In some SE states, feral swine have access to miles of coastal beaches, intercoastal waterway shorelines, and navigable inland river shores. Feral swine have been known to line beaches and wait for the tide to bring in garbage from passing ships that washes ashore. Feral swine populate some of the states coursed by inland rivers.
- Domestic and feral swine interaction
  - *i.* The interaction between feral and domestic swine is increasing
  - *ii.* There are overall numerous opportunities for feral swine to make it into regular market channels
  - *iii.* Feral swine can get into slaughterhouses because they are not dependably recognized by appearance
  - *iv.* Some backyard swine producers see feral swine as extra income
  - *v.* It is common for backyard operations to trap and eat feral swine.

vi. To prevent chasing away potential customers, small auctions/sale yards do not exclude feral swine

vii. There is commingling between the domestic swine of backyard operations and feral swine. Physical contact is made between the fencing.

viii. It is more common for feral swine to break into backyard operations than for domestic swine to break out

ix. Feral swine can easily intermix with backyard swine operations. “They can climb trees.”

x. There is frequent interaction of feral and domestic swine in some markets.

xi. It would be hard for feral swine to intermix with corporate domestic swine. There could still be intermixing, but this is not as likely now. The feral swine are not causing corporate industry much problem.

xii. Swine destined for international trade are highly unlikely to intermingle with feral swine.

xiii. There is no disease that feral swine have that domestic swine cannot get.

xiv. According to one state, there is feral and domestic swine interaction because although Pseudorabies was eradicated in domestic swine, is still present in feral swine, and every year there will be 10-20 cases that show up in the domestic swine population.

xv. Some states have dropped trying to stop feral swine from entering sale barns and have stopped testing because nobody cared. Owners do not like testing at sale barns because it causes the swine to have bloody necks, and therefore bad appearances as they go through the rings. Testing will be done only if they owner asks. Testing at sale barns is not sustainable or productive. One SE state examined the destination of animals going through sale barns and found that most of the animals end up in slaughterhouses.

xvi. Some states have been unable to enforce a separate market for feral swine.

xvii. It is not illegal to bring feral swine through sale barns in some SE states.

xviii. Until the feral swine and backyard animals are truly addressed, such as by bolstering biosecurity, it is just a matter of luck we are keeping CSF out of the U.S.

xix. In some SE states, garbage feeding operations are located in rural areas by streams where feral swine have easy interface with domestic swine

- Cultural implications (see section on Caribbean and Mexico in international pathways section)
    - ***i.*** Feral swine are a part of some cultures in the U.S.
    - ***ii.*** Feral swine meat is a must-have for some Hispanic and other cultural groups
- Movement (see section on Illegal movement of swine above and Mexico in international pathways section)
    - ***i.*** We lack knowledge on how to better control interstate movements of feral swine.
    - ***ii.*** Feral swine are moved frequently between states for many reasons, especially for hunting purposes, in the back of canopied pick-ups. It is difficult for highway patrol in any state to control such movements unless there are traffic violations. The illegal movement of feral swine between states parallels illegal movement of drugs, firearms, contraband, etc.
    - ***iii.*** Feral swine are getting used to the smell of diesel fumes because they are transported around so much.
    - ***iv.*** Feral pigs are moved fairly often. People will move them in the dead of the night. It is hard to quantify how much this happens.
    - ***v.*** Swine can be smuggled between states in the back of certain vehicles, such as station wagons, that are not required to stop at Agricultural Law Enforcement Inspection Stations. Swine can be brought into states where inspection stations are not located.
    - ***vi.*** There are few states that have check stations to check for illegal movements of animals. There used to be cases of feral swine being smuggled across state lines in UHAUL trailers. At points where vehicles are inspected, there were instances of empty semi trucks being used to divert law enforcement attention so that people could get by without being inspected.
    - ***vii.*** Even though there is law enforcement, it is hard to catch everyone.
    - ***viii.*** It is not absolute that everyone has health certificates or that everyone moving animals is checked.
    - ***ix.*** Some states probably check for illegal movements of animals more often than other states.
    - ***x.*** There is not someone at every road checking for illegal movements of animals.
    - ***xi.*** You cannot implement animal movement controls without proper facilities. There are thousands of animal movements everyday. You do not have control

points with state and federal budgets like they are. You might have control points on major roads, but not on back roads.

xii. Feral swine are moved between states for hunting purposes regularly. These swine are non-permitted and non-tested. The feral swine can interact with backyard swine and spread disease between state lines whose origin is untraceable.

xiii. Most feral swine caught by farmers go to hunting areas. The desire for better game drives the movement of feral swine between states. Pig hunters will do whatever to make better game.

xiv. Unregulated markets spread diseases and feral swine across state lines

xv. Possible ways to control movement of feral swine: Licensing and checks on feral involvement, police and border agency education, public education about disease, technology concerning reproductive controls, double fencing, and hunter harvest allowances

xvi. Swine can cross state borders of certain SE states by natural movements

xvii. There is poor compliance with moving feral hogs that are not going directly to slaughter; it would be good to test these pigs

xviii. 98% of infectivity of disease comes from animal movement

- Targeting feral swine

i. There would be no way to tell the state of origin of a feral pig from the Devine slaughter plant if there was a CSF outbreak

ii. It would be helpful to test the pigs that are going from Florida to the Devine slaughterhouse in Texas.

iii. There are few veterinarians in Florida, if any, who would be willing to routinely bleed feral swine.

iv. Very seldom are sick feral swine reported

v. Sick feral swine reported are usually swine that have been found with backyard swine operations.

vi. The U.S. needs to target feral swine not only for CSF but for other public health reasons as well

vii. There is rare interaction between feral swine and veterinarians

viii. FADD rarely work with feral swine

ix. There are not many livestock shows anymore where feral swine move through; feral swine are not show animals.

x. Feral swine are hard to handle, so it is difficult to get samples from them unless they are hunted.

xi. It would not be in the feral swine population that you would want to target surveillance.

xii. There may need to be additional regulations implemented to create an effective disease surveillance and preventative program so that if we get disease in the feral population, our domestic population would still be considered by other countries as disease-free.

xiii. The U.S. needs to see if feral swine are even susceptible to CSF. Instead of being afraid of them, we need to use the feral swine population to our advantage. Feral swine could serve as border sentinel herds.

- Population control

i. There is no national control program for feral swine due to costs. It is more logical to localize population control programs to areas that are high risk or where the feral swine are a nuisance.

ii. It would be helpful to convince people to hunt feral swine more often to help control the population

iii. Feral swine is a good meat source for barbeque, outdoor parties, and cultural gatherings. In some SE states, feral swine meat is used exclusively over domestic markets.

iv. A market for feral swine would be very limited due to lack of control of swine brucellosis. Until there is dependable oral vaccine for brucellosis and Pseudorabies (PRV), controlling disease in feral swine is problematic.

v. It would be beneficial to have a separate marking strategy for feral swine. There may need to be additional regulations implemented to create an effective disease surveillance and preventative program so that if we get disease in the feral population, other countries would still consider our domestic population disease-free.

vi. It is doubtful there will ever be an industry for feral swine in the U.S., but maybe more packing plants will develop to ship more feral swine meat to Europe.

vii. It would be helpful to limit the marketability of feral swine to just slaughter.

viii. The marketability of feral swine will only be for hunting or slaughter

ix. Feral swine are hunted throughout the year in many states, especially when they are a nuisance and cause landscape or crop damage.

x. When a feral pig is hunted, hunters will either kill and eat it, kill and leave it there, kill and throw it into the water for alligators to eat, trap and raise it for fattening, or trap and turn it lose in another state for hunting purposes

xi. The domestic swine population is becoming more and more separate; this is not the case for the feral swine population

xii. When discussing issues concerning feral swine, you have to look at topography; half of South Florida is underwater.

xiii. Feral swine are hunted in areas in which their population needs to be controlled

xiv. Due to the inability to completely remove the feral population, CSF in this population could become endemic and non-eradicable.

xv. Eradicating CSF from the feral population seems like an impossible task; this is why disease prevention is crucial

xvi. Biggest complaint of people about feral swine is the nuisance factor; they will come onto pastures, golf courses, and orange groves. Private trappers will be hired in order to control the damage caused by the feral swine. There have been military jet crashes due to feral swine running across runways. People complain about feral swine rooting, running through pastures, destroying land, and the feral swine rubbing on pine trees. Feral swine will rub tree trunks bare. On some ranches visited in South Texas, the feral swine come onto the ranches so often that trench-like paths have been left in the fields and across gravel roads. Some of the paths seen were so deep that owners have to fill them so that the roads could still be travelable.

xvii. Since it is currently not possible to rid the feral swine population of swine brucellosis and PRV, you could say the same if we ever got CSF in the feral population.

xviii. It has been commented by numerous people interviewed that the U.S. got part of its swine population from owners setting their pigs free when the market dropped. Most believe that if we had a CSF outbreak today, marginal producers would likely turn their animals loose. This is unlikely to be the case for the larger, commercial producers.

xix. In ten years, our feral swine population will:

- Increase, until technology enables population control

- Most swine are in areas that are not urbanized. There is more of a problem with the expansion of feral swine than with the feral swine population being encroached upon by urbanization.
- The feral swine population is likely to habitat states that before did not have a population

In 20 years, our feral swine population will:

- Be stable or decrease once technology kicks in
- The population will continue to increase unless we do something about it.

- Comments on current knowledge we have regarding feral swine:
  i. Due to response to natural food supplies, the feral swine population peaks in late fall and late spring
  ii. The normal range for feral sows, gilts and piglets is 2-4 kilometers; for boars it is 4-8 kilometers.
  iii. Feral swine will compete with deer for a significant amount of the same foods.
  iv. Feral swine are very adaptable
  v. Feral swine can climb trees
  vi. Feral swine can swim and they are nocturnal animals.
- Poor understanding of biological characteristics of feral swine; we lack knowledge regarding:
  i. If you have disease in an animal population, you need to know where they are, how many in the population, if you can get to them and how, and what to do about stopping the spread and eradicating the disease. The problem with feral swine is knowing where they are exactly, their distribution, and how this changes day-to-day.
  ii. How they move, what causes them to move
  iii. How they interact with each other [feral to feral interaction]
  iv. Feral swine have territorial issues; they will run in microgroups of around 2-4 sows, their young, and the boars will come in and out when they want to breed.
  v. How they behave in their environment, where they go
  vi. How their range will expand over the next few years
  vii. How often they interact with domestic swine
  viii. Info regarding the prevalence of diseases within different populations

ix. Feral swine stay in groups, but there is little knowledge on their behavior in micro-groups and their interactions with other swine [domestic, other feral swine, etc.]. For example, there were two different groups of feral swine that populated the Seminole County Landfill. One group populated the landfill while the other group stayed in the woods around the landfill. The two groups did not interact. Only when the feral swine that populated the landfill were killed off due to Swine Bruecellosis (SB) and PRV did the other group of feral swine populating the surrounding woods move onto the landfill.

x. How feral swine respond to drought, lack of food, etc.

xi. How far will feral swine go if there is water but no food?

xii. Role of Javelinas in CSF virus transmission

xiii. How far they will travel? How much will their range expand over the next few years?

xiv. How to control their population and movement

xv. How to vaccinate orally to reduce disease prevalence

xvi. It is tough to define just exactly what a feral pigs is.

D) Commercial operations

i. Commercial operations are largely responsible for outbreaks, especially due to poor biosecurity practices, and they expect government to bail them out.

ii. Mortalities are considered normal at the level of 8-10%. If samples are not submitted and analyzed, there is the possibility of missing CSF for 11 months.

iii. It would be easy to perform surveillance at corporate swine operations because of vertical integration. We should also do surveillance in packinghouses.

E) Garbage feeding (see section on Garbage feeding in international pathways)

- Lack of interaction with veterinarians

  i. Veterinary practitioners rarely visit these operations, if at all.

  ii. It is likely for CSF to show up in these operations. Hopefully, the owners will call USDA if there were dying pigs. It was commented that if the owners are sent to the state lab, the humane society would be called instead of USDA.

iii. The national swine health protection program that deals with garbage feeders is very important because it allows interaction of regulatory agencies with the swine on garbage feeding operations

iv. Clinical reporting and visual inspection is important and needs to continue to be part of surveillance. There needs to be encouragement to garbage feeder owners to call if there is something wrong.

v. We need them to communicate with us if they have sick pigs so we can get a diagnosis.

vi. In PR, the swine population receives their veterinary support from government salaried veterinarians. Common clinical signs seen are fever, poor doers due to internal parasites, diarrhea and respiratory problems. Since 100% of the swine veterinary care is under government salaried veterinarians, a close surveillance of the swine population is always ongoing.

- Location

i. There are garbage feeder complexes whose owners will buy, rent or lease around 10 acres of cheap real estate together and then line up their pig operations in a row on the property. There is no biosecurity on these complexes. The complexes are usually located along rivers and/or in rural areas, so there is a lot of feral and domestic swine interaction.

ii. Garbage feeders are also located around major cities

iii. It is likely there are illegal garbage feeding operations in the U.S. There are thousands of places where these illegal operations could be located. It is not very logical that there are no illegal garbage feeding operations.

iv. The number of garbage feeding operations is going down. This may not be the case if the economy went sour.

- Herd health (see section on Backyard swine operations below)

i. It is common for the swine at some of these operations to be culled or inferior show pigs.

ii. Some swine at these operations come from wild boars that accidentally got in and mated with the sows

- Education (see section on Backyard swine operations below) *i.* Education of backyard and transitional swine owners, especially those owners that are unable to read, is important in order to convey the effects FADs would have not only on their operations, but also on the U.S. agricultural economy

- Infected meat scraps fed to pigs/scraps not cooked at appropriate time/length (see section on Meat/Contraband in international pathways section)
    - *i.* Garbage feeding regulations cannot be outlawed for fear it would drive this practice underground
    - *ii.* More effective enforcement and education with public relations kept in mind is crucial.
    - *iii.* Licensed garbage feeders pose less of a threat than in the past because much of the garbage is cooked before it is given to the swine. However, the source of the garbage must always be considered. There is always the scenario of the ethnic restaurant improperly cooking the meat brought in illegally from travelers from the orient and subsequently starting an FAD outbreak.
    - *iv.* Licensed garbage feeders do not always cook their meat properly before feeding it to swine. Unlicensed garbage feeders that obtain waste food from any source available rarely, if ever, cook the garbage before feeding it to swine.
    - *v.* It is likely there are garbage feeding operations that only half cook their garbage or do not cook it at all.
    - *vi.* One garbage feeder inspector commented that one would have to be there 7 days a week to make sure operations were following regulations all the time.
    - *vii.* There are some garbage feeders that make money by using their pigs as a way of getting rid of trash. Some people will go around to schools and restaurants collecting trash and then throw it over the fence to swine to get rid of it.
    - *viii.* In one SE state, there is 1-2 illegal garbage feeding operations that are identified and quarantined every quarter. The true number of illegal operations is unknown.
    - *ix.* The number of garbage feeding operations in some states is decreasing.
    - *x.* In Texas, garbage feeders are not allowed to use meat scraps
    - *xi.* In PR, Animal Health Technicians visit their assigned premise at least once every 45 days to assure regulations are being followed. VMOs bleed premises at random (10% of the population is bled of selected premises) and the

samples are sent to the Plum Island Animal Disease Center. Turnover time is about 7 days.

xii. We have regulations, the problem is getting regulatory people to communicate and get to know these owners, to educate them, and to get them to cook their garbage. We need them to communicate with them if they have sick pigs so we are able to get a diagnosis.

xiii. There are plenty of regulations; making them work like you want is what is difficult.

xiv. It is most important to communicate with garbage feeder owners. Owners will work well with you if you work well with them.

xv. It takes a certain type of person to be able to communicate with garbage feeder owners.

F) Backyard swine operations (see section on Garbage feeding above)

- These types of operations are very common all across Southern U.S. The owners will have a menagerie of animals in their pens, such as cows, pigs, ducks, horses, etc.
- There are backyard swine operations all along the Rio Grande River, especially south of Laredo, TX going down towards the Rio Grande Valley.
- Borderline economic people will have backyard swine operations. They are a good source of inexpensive protein.
- The number of backyard swine operations is decreasing, but if the economy went kaput, there would be an increase in these types of operations.
- Some states allow feeding of own wastes to pigs without is being cooked. Backyard pig owners will feed their own wastes for awhile, and then will go to other sources, such as neighbors, local restaurants or grocery stores to find waste to feed their pigs.
- Some states commented that it is difficult to enforce regulations on these operations because they are hard to locate
- Some operations never interact with veterinarians
- For the backyard swine population, the only way to perform surveillance is to either test on the farm before sale (ideally) or at the sale barn.
- FADD usually do not get to work with backyard swine

- We need government to communicate better with backyard swine owners. We already communicate well with commercial industry and we can get a quick diagnosis on these types of operations. It is slower to get a diagnosis from the backyard swine population.
- Herd health
  - ***i.*** Pigs at backyard operations are not the healthiest pigs to begin with. It is not uncommon for these pigs to be used as sewage systems.
  - ***ii.*** "It is difficult to find a garbage feeding herd that does not have a disproportionate number of sickly looking pigs in it." However, there are some operations that are tops.
- Increasing number of Caribbean ethnic populations
  - ***i.*** There are an increasing number of Caribbean ethnic populations that will be located around major cities in Southern states. It is common for these populations to have backyard operations due to their heritage.
  - ***ii.*** These types of operations are hard to locate because a) you have to go looking for them, b) these ethnic groups do not want the government in their business, and c) you have to be able to communicate with these individuals.
  - ***iii.*** An awareness campaign about CSF to these types of operations is challenging because a) these operations are hard to reach, b) they are out of touch with most communication avenues because some of this population does not speak English, read magazines, listen to the radio, etc., and c) inspectors that do find them when they come to market to sell their pigs have difficulty communicating with them as well.
  - ***iv.*** Some states have bilingual inspectors. They have tried to speak with owners but to little avail.
  - ***v.*** These operations will never be rid of in the south due to the ethnicity where swine are an important part of their cultural heritage. This is a social as well as a cultural issue; you would have to wait for this generation to die off for standards to be helpful. It is a cultural barrier to educate these ethnic populations.
  - ***vi.*** There is an increasing number of Hispanics owning hogs

G) Biosecurity

i. Having an airtight biosecurity plan that is enforced by management is a must in order to have a profitable swine unit. Although no biosecurity program is 100%, the unit will be more profitable the closer we can get

ii. Because of concern of Porcine Respiratory an Reproductive Syndrome (PRRS) and a nonefficacious vaccine within industry, biosecurity concerns have heightened

iii. Biosecurity has become more of a concern in some operations due to PRRS, FMD in the U.K., and BSE outbreaks

iv. Producers are more concerned with FADs because of the FMD outbreak in the U.K.

v. Biosecurity on farms ranges from none to extreme measures. The further you move to the opposite end of the spectrum from corporate swine operations, the less biosecurity there is.

vi. A person headed out to a swine farm within the U.S. could have live virus within the mud of boot/shoe crevices

- What we need to improve:

  i. Education on biosecurity and consequences of its laxity; producers believe they have acceptable biosecurity practices until big day-to-day mistakes are pointed out.

  Example: Some producers that are not apart of a swine organization believe that having the footbath loaded with mud and organic debris is acceptable and that having only a footbath means that biosecurity is present on their farm

  ii. Biosecurity in the Midwest needs to improve since this has the greatest concentration of swine.

  iii. If someone wants to raise swine in an area populated with feral swine, there are ways to keep to feral swine out, such as depopulation, proper fencing, etc. If people want to truly keep feral swine off their property, it is possible. For example, there was a family from the Caribbean that migrated to the U.S. After the dad died suddenly, the son was left to take care of the family. Not having much wealth, he decided to raise domestic swine for consumption. He knew he wanted to keep the feral swine from intermixing with his domestic swine, so he built a fence three rows wide and three rows deep and was able to keep the feral swine out.

iv. We should have a standard health program, but the economics, money and people are limited.

v. Biosecurity issues are common sense: do not traffic between farms, assume everyone is a risk, etc.

- Commercial/Large Production

  i. Excellent biosecurity because they have more to lose and because workers' jobs depend on strict adherence to biosecurity

  ii. Good biosecurity at corporate swine operations. Most do not allow traffic into of off the farm.

  iii. Most corporate farms follow very good biosecurity measures.

  iv. Commercial operations are largely responsible for outbreaks, especially due to poor biosecurity practices, and they expect government to bail them out

  v. If biosecurity is good enough to keep CSF out of commercial operations, then we may elect not to vaccinate. We would not have to vaccinate if there was good biosecurity and movements of people on and off facilities were controlled.

- Smaller Production Units

  i. Generally more lax

  ii. Good biosecurity is costly, labor intensive, and is of less concern until there is a disease outbreak

  iii. Biosecurity is an add-on cost, so operations will only have the biosecurity that they can afford

  iv. Smaller operations have little to no biosecurity measures. It is especially important to have these measures in the Midwest since this has our greatest concentration of swine.

- Backyard Operations/Garbage Feeders

  i. The Latin American cultures like to roast pigs. You must earn their trust before you can educate them on biosecurity practices.

  ii. Feral swine will commingle with domestic swine between the fencing of backyard operations. These operations have poor biosecurity due to economic reasons; they are just trying to make it day-to-day

  iii. Backyard swine operations need to have good fencing.

iv. It is not uncommon to have intermixing/interbreeding of the swine of backyard operations

v. There are a few backyard operations that sit next to commercial operations in some states.

vi. The farms in PR do not have as good of biosecurity as some regulatory officials would like. There needs to be continued training about biosecurity issues.

- Recommendations

  i. All producers that intend on making profit need to be part of an organization that assists with production questions and that provides information about biosecurity, such as answering questions by phone, offering educational information, and helping producers to write good management plans.

  ii. Better education on appropriate fencing that will reliably keep feral swine out of backyard swine operations.

  iii. It is important to bolster biosecurity practices: more education on how to keep feral and domestic swine separated throughout the spectrum of pig operations (i.e. from backyard pig operations and garbage feeders through major corporations).

H) Slaughterhouses (see section on FSIS)

i. There is a market that sells feral swine to ethnic populations in South Florida.

ii. There are no major swine slaughterhouses in Florida

iii. The major ethnicity of workers at slaughterhouses is Hispanic

iv. If animal movements were about to be prohibited, owners would rush their animals to slaughter immediately

v. Lack of good sanitation and biosecurity mechanisms

vi. In some states, there is about 30 pigs a day that die of unknown causes at large slaughter plants. These pigs should be tested for CSF.

vii. Not much surveillance happens in slaughterhouses – it is very passive. You have to have supervisors at slaughterhouses to push inspection of sick pigs antemortem.

viii. Food Safety Inspection Service (FSIS) will usually put a suspect tag on the carcass and these pigs are allowed to go through slaughter anyways; the pathology is looked at afterwards *ix.* A possible pathway is through pork by-product that is transported and the trucks return to the facility without proper cleansing.

x. Tonsils are always trimmed out of swine and condemned carcasses, so FSIS does not check them

xi. FSIS does not get specialized training for FADs; their instructions are to call APHIS

xii. It is possible for feral swine to make it into slaughterhouses because some feral swine have the same appearance as domestic. This is more likely at mom/pop operations and unlikely at commercial slaughterhouses.

xiii. There are some samples sent it for CSF testing at some slaughterhouses in South Texas, but not all facilities that slaughter swine are doing this.

I) Seasonal/Migrant workers (see section on Mexico in international pathways section)

i. Migrant workers would not pass up a free feral hog.

ii. Until the economy in Mexico increases, there will always be incentive for migrant workers to come to the U.S.

J) Industry

i. Industry must play a role since they have a big stake in protecting the food supply.

ii. Need help teaching producers about CSF and about the possibility of low pathogen CSF going undetected

iii. There is less than 10% retention of USDA backtags for identifying swine back to farms of origin.

iv. It would be helpful to get to the point of helping industry prevent problems instead of waiting for a problem to arise before something is done about it (such as closing operations, etc.).

v. There is a history of a lack of trust between government and industry. There needs to be work to build trust with industry. It is tough to work with producers when there are no clinical signs showing, such as may be the case with low pathogen CSF.

vi. “Industry is only as honest as the economics of the situation will permit them to be.”

vii. It is hard to be concerned with swine brucellosis and PRV until there are tools available to do something about it.

viii. Industry needs to accept responsibility of keeping disease out of all operations

ix. Industry should take on the necessary precautions to keep disease out.

x. "It is amazing what you can accomplish simply by asking people (industry) for help when you explain why you are doing something and how it is beneficial.

xi. We need to make sure industry does not contribute to the problem by releasing animals if the market goes sour or if there is a FAD outbreak

xii. Some of industry has taken their responsibility of FAD prevention very seriously; however, overall industry relies heavily on agricultural schools or the state or federal government to deal with disease issues.

xiii. Industry needs to take on more responsibility with disease and biosecurity issues.

K) Landfills (see section on Meat/Contraband in international pathways section)

i. Landfills located around international entry points or around locations that attract tourists from around the world are risks. Meat scraps smuggled in could get tossed in with the garbage of these places and end up in landfills where feral swine could eat them.

ii. Feral swine can dig up garbage that is not adequately buried deep enough at landfills.

APPENDIX 3.1. SWINE PRODUCERS SURVEY

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As part of the foreign animal disease (Classical Swine Fever) pathway analysis, a survey was developed by the National Agriculture Biosecurity Center Consortium at Kansas State University with cooperation by the National Pork Board to evaluate the role pork producers in the U.S. could possibly play in the introduction and/or prevention of a FAD. In addition, producer concerns pertaining to FAD introduction, travel precautions, and border security issues were also evaluated using the survey.

The 14-question survey (fig. 3.42) was distributed by the National Pork Board to 2479 members in 48 states (fig. 3.43). National Pork Board members include swine unit owners/managers, employees, educational/extension personnel, and government officials. Swine producers were asked to complete the survey and return it to Kansas State University using the business reply envelope included in the survey packet. The survey packet contained a cover letter, copy of the survey, business reply envelope, and an entry form for a prize drawing offered as an incentive for producer participation. The results of each returned survey were entered into a Microsoft Excel database and coded in a 1=yes, 2=no, and 3=don't know format.

Of the 2,479 distributed surveys 970 were returned via business reply to KSU. The overall response rate of the survey was 39% (970/2479). Of the 970 producers responding, 12% (119/970) had traveled internationally to 52 different countries (fig. 3.44) in the past year (December 2002 – December 2003). Of producers who traveled internationally 44% (52/119) visited a farm on their travels and 75% (39/52) of the producers who traveled and visited a farm had contact with livestock. Of the producers who traveled internationally, visited a farm, and had contact with livestock on their farm visit, only 26% (10/39) responded that foot-baths were provided at their point-of-entry to the U.S. Swine producers that traveled internationally were asked if they underwent an inspection of their luggage or person for agricultural products at their point of entry, 49% (58/119) of international travelers replied that their luggage was inspected. However, only 36% (43/119) of travelers were provided with information on the proper precautions to take if they planned to visit a farm upon their return to the U. S.

Of the producers responding, 29% (278) had a herd size of 0-500 pigs, 15% (144) had a herd size of 501-1000, 36%(350) had a herd size of 1001-5000, 13% (122) had a herd size of 5001-10,000, and 7% (68) had a herd size of over 10,000 head (fig 3.45). The majority 53% (513) of the producers who participated in the survey ran farrow to finish operations, 13% (125) had farrow to wean operations, 28% (269) had wean to finish operations, 6% (58) ran breeding operations, and 5% (45) ran other types of operations with 3 no responses to this question (e.g. show, etc.) (fig. 3.46). Of the 970 participants 3% (29) had witnessed wild (feral) swine on their property in the past year. Only 1% (8) of the participating swine producers reported that they were USDA licensed swill feeders.

Of the participating swine producers 82% (797) had 0-5 employees, 8% (77) had 6-10 employees, 4% (41) had 11-20 employees, and 6% (51) had 21 or more employees working within their operation (fig. 3.47). When asked if any of their employees had traveled internationally in the past year (December 2002 – December 2003), 6% (60) said they knew that at least one of their employees had traveled internationally. Twenty-two countries were visited by employees (fig 3.48). Twenty-four (40%) respondents indicated having knowledge of at least one of their employees visiting a farm during their travel. Of the 970 respondents, 7% (63) reported that they had employees that raised swine in their own farming practices.

When asked if they knowingly had bought any agricultural, meat, or biological products from a foreign country, 5% (48/970) of the participants reported that they had bought one or more of these products from a foreign country in the past year. In addition, 23% (11/48) of the respondents who had purchased agricultural, meat, or biological from a foreign country knew that the products had come in direct contact with swine. When asked what threat they felt could be the most damaging to their herd 42% (402/956) with 14 no responses answered Foot and Mouth disease, 22% (224/956) answered Pseudorabies, 10% (98/956) answered Classical Swine Fever, and 26% (255/956) answered other threats of which Porcine Respiratory Reproductive Syndrome composed 70% (178/255). In addition, the bio-security practices of swine production operations were estimated from the survey results. The survey asked swine producers what precautions are used to prevent introduction of disease into their herd by workers or visitors. Of the 970 participants 28% (268/970) used showering in and out as a precaution, 30% (291/970) used footbaths as a precaution, 48% (459/970) mandated the use of clothing provided by the facility, 87% (832/970) restricted visitors, 12% (117/970) used sign-in logs, and 9% (83/970) used other means of precaution to prevent introduction of disease into their herds (fig 3.49). Each participant could use a multi-level approach to disease prevention and indicate all measures taken within their operation.

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Chapter 4

Dissemination of CSF

INTRODUCTION

Early recognition of a foreign animal disease incursion into the U.S. is an important factor in limiting the size of an outbreak. Experience in other countries with a well developed animal health infrastructure has shown that low virulence infections may be difficult to detect and that a considerable time lag may ensue between the presumed date of the initial infection and the diagnosis of CSF infection in the population. In the 1997/98 CSF outbreak in the Netherlands Nielen et al. (1999), using the InterCSF model, concluded that the length of time between introduction of infection and detection of the first case (estimated to be 6 weeks) was a critical determinant of the eventual size of the epidemic. The final tally of infected premises in this outbreak was 428.

In the 2000 outbreak in East Anglia in the United Kingdom the index case is presumed to have been infected in June, yet the first diagnosis was not made until August 8th (UK Parliament, 2001). Even though a period of approximately 6 weeks occurred between first infection and diagnosis, the relatively small number of sixteen herds eventually had CSF confirmed, and the last case was diagnosed in November. The point of this observation is that even though the disease was present in the country for an extended period, existing features of farm biosecurity, the nature of the marketing system and the spatial distribution of farms served to limit its spread. In this section of the report features of the U.S. hog production system which may serve to limit the spread of infection up to the time of initial diagnosis as well as those which may facilitate the spread of infection will be examined. These include structural changes in the swine industry, the distribution of hog farms and the pig population, marketing and transportation arrangements, farm biosecurity (both between premises and between groups of animals on the farm), the threats from other classes of livestock such as feral, pet and hobby pig farms, and the unique challenges posed by fairs and shows. Integral to this analysis is an understanding of the premise and animal identification procedures which would enable rapid identification of contact premises at the time of first diagnosis. This chapter will also briefly address the use of computer models in understanding the dynamics of dissemination of CSF in the pig population.

COMMERCIAL PORK OPERATIONS

Commercial pork operations in the U.S. provide approximately 10% of the world pork supply, with an annual kill of approximately 100 million animals. The number of swine in commercial pork operations far exceeds the numbers in other types of operations. Farrow-to-finish farms, which involved all stages of production from breeding through finishing to market weights of about 255 lbs, used to be the backbone of the swine industry. These have become less common as pork production has become more segmented and different farms specialize in different stages of the life cycle.

Structural changes which have taken place in the U.S. swine industry have led to increased movement of animals between premises during their life cycle. The trend in swine production is towards greater specialization, with each production stage taking place on a different site, whether or not all stages are controlled by the same business operation. This has become a striking feature of intensive swine production in the U.S. Segmentation, together with economic pressures for capacity to be fully utilized, increases the frequency of animal movements between locations (Burrell, 2002).

Commercial Seedstock Operations

Changes in breeding systems that have occurred over the years have changed the way in which genetics are sold, and the way in which breeding stock move between farms. Genetics companies produce breeding stock (boars and gilts) for sale to units that breed and farrow pigs, and either sell feeder pigs or take them on to finishing. Small scale producers of breeding stock have decreased in number except in the show pig sector. Few boars are now sold through boar test stations.

The major change in the last 20 years has been a move from rotational breeding systems to terminal breeding systems. In terminal systems boar lines selected for carcass and production traits are crossed with gilts that are selected mainly for reproductive potential. These matings produce offspring which are all marketed. Most farms purchase grandparent stock from breeding companies. The grandparents make up 10 - 15% of the herd, and produce the F_1 gilts that are mated to a terminal boar. Most farms do not purchase all their terminal gilts because it is not cost effective and carries a larger biosecurity risk. A 1500 sow farrow to finish farm would need to purchase approximately 60 grandparent gilts/year from a breeding company to maintain its supply of F_1 gilts (fig. 4.1).

Both grandparent and terminal boars may be purchased from genetics companies, whether they are used for Artificial Insemination (AI) or for natural mating. Alternatively the farm may purchase terminal and grandparent semen, although this is less cost effective. The increasing use of artificial insemination does potentially reduce the need to move boars from breeding facilities to production farms (fig. 4.2), and in fact, many farms that use AI collect their own semen. Semen is a potential source of CSF transmission (Floegel et al., 2000).

Boar Studs

Boar studs produce semen for dissemination to other units. Stegeman et al., (2002) estimated the rate at which a single dose of semen from an infected boar center would transmit CSF to a susceptible herd in the 1997-98 outbreaks in the Netherlands at 0.0007 per dose.

Farrow to Finish

Family run farrow-to-finish farms that involve all stages of production, from breeding to finish market weights at about 260 lbs, make up a large percentage of smaller hog operations. This type of operation has been the mainstay of the U.S. pork industry, but pork production is rapidly becoming specialized by phases of the life cycle. Contract production of pigs by phases of the life cycle (breed-to-wean, wean-to-finish (10-260 lbs), wean-to-feeder pig (10-60 lbs) and feeder pig-to-finish (60-260 lbs)) is coming to dominate the industry (http://www.traill.uiuc.edu/uploads/porknet/papers/IllinoisAnimal%20Agriculture.PDF).

Feeder Pig Producers

The most common system for providing 40-60 lb feeder pigs for grower-finish units used to be on farms which specialized in farrowing sows and raising pigs to feeder weight in nursery units for onward sale, or for moving to grower-finish units on the same farm. Farrow-nursery farms selling feeder pigs are becoming less common. In some systems weaned pigs are moved directly into wean-finish barns, instead of going through the nursery phase (Wilson, 1999). There is a growing trend for integrators to farrow pigs in North Carolina and then send them to contract growers in the Midwest where feed costs are lower. These would not be classified as feeder pig producers since the pigs are moving within a production system, since they are owned by a single entity operating in multiple states (Appendix 4.1).

Growing and Finishing Units

Growing and finishing units were once distinct phases of the pork production system, and animals were moved from one unit to the other at 120 lbs. Grow-finish pigs are now seldom moved, but are managed through a phased diet system designed to closely meet their requirements. Pigs in the grow-finish cycle may be housed in environmentally controlled closed housing, curtain sided barns, open front units, hoops, or at pasture (Pork Facts, 2002-2003).

Dealers

Feeder pig dealers are licensed by the state and their premises are subject to inspection. These premises serve as concentration points for feeder pigs. Feeder pigs move through dealer premises in both intrastate and interstate transport. Dealers are generally prohibited from acting as peddlers of feeder swine by traveling from premise to premise with swine in their possession for the purposes of trade.

WASTE FEEDING FARMS

A subset of commercial swine operations of particular interest in the context of CSF introduction are those which feed garbage or food waste to pigs. There are two distinct types of garbage feeders; commercial hog operations that are licensed to feed garbage, and have connections to the market system like any other commercial pork producer, and those that feed garbage and plate waste illegally or outside the licensing system – these include small "backyard" producers and pet pig owners, who may not have the same connections to the market system, if they have any at all. Permits are not required for individuals that feed their household scraps to swine, although there are regulations governing the sale or disposal of swine fed in this way. These operations may constitute a higher risk for initial introduction, but a lower risk of spreading a CSF infection into the larger pig population.

The feeding of plate waste or garbage containing meat scraps has been recognized as an important mechanism for the introduction of foreign animal diseases, including CSF. The CSF outbreak in the United Kingdom in 2000 was believed by the Ministry of Agriculture, Fisheries and Food to have been initiated by the feeding of a ham sandwich to pastured pigs by a hiker (http://www.tripesfarm.co.uk/LRNN/comment9.htm). The practice of garbage feeding is limited in the United States and is regulated by individual states. Garbage feeding of swine is only permitted under license from state animal health authorities. Most states do not allow garbage feeding. The 1980 Swine Health Protection Act mandates that food waste must be heat treated by boiling at 212F or 100C (at sea level) for 30 minutes and must be agitated during cooking, except in steam cooking equipment, to ensure that the prescribed temperature is maintained throughout the cooking container. Waste fed swine are not permitted to go through concentration points, such as dealer premises or markets, but most go direct from the waste feeding premise to slaughter.

Surveys of Waste Feeding Operations

A survey of licensed waste feeders was carried out by APHIS in 1993 (http://www.aphis.usda.gov/vs/ceah/cadia/rarc1.htm). Areas with the largest total number of waste-fed swine were Puerto Rico (81,790), Texas (33,100), Florida (14,983), New Jersey (14,133) and Hawaii (10,015). Plate waste, bakery waste and produce made up more than 90% of the total waste fed. The remaining types of waste product included: eggs, unpasteurized dairy products, fish, other products of animal origin, slaughter by-products and carcasses.

USDA:APHIS developed a survey of swine waste feeding premises in 2001. There were 2,718 waste feeding premises reported in the United States. 1,155 waste feeder premises were reported in the 48 contiguous states. States with the highest number of waste feeders reported were Puerto Rico with 1,393, Texas with 596 and Hawaii with 170 (fig. 4.3).

Risk Assessments of Waste Feeding

In December 2000 USDA:APHIS published a “Risk Analysis for Importation of Classical Swine Fever Virus in Swine and Swine Products from the European Union.” The pork model quantitative assessment considered the risk of CSF introduction into the U.S. swine population through the feeding of food waste from restaurants and institutions. APHIS assumed for the purposes of the calculation that all swine slaughtered to produce pork for export to the U.S. from the EU complied with EU regulations for the control and eradication of CSF and that pork intended for the U.S. was produced using standard operating procedures. The results suggested that for CSF by this route the expected incursion frequency was at least one in 22,700 years.

It is ironic that during the preparation of the report the United Kingdom experienced a CSF outbreak in August of the same year with a virus type which originated from Asia rather than the EU, suggesting that the source material “was probably smuggled.” This highlights the threat both from illegal imports of meat into the U.S. and the occurrence of unlicensed feeding of waste food to hogs.

Estimates for the annual risk of CSF entering the U.S. from contraband in untreated household waste fed to swine in the conterminous U.S. has been put at 6.7%, and considerably higher (23.9%) for Puerto Rico (USDA:APHIS:VS, 1995). Given the low risk of a CSF introduction from legal imports of meat cycled through plate waste or garbage feeding to licensed waste feeders, it becomes very important to assess the risk from illegal imports and feeding of food waste, particularly household food waste, to pet, hobby or backyard pigs by people who are not licensed waste feeders and fall largely outside the purview of animal health and regulatory authorities. Unfortunately, the pet, hobby and backyard pig keepers constitute a group about which very little is known. State authorities, in Indiana for instance, know that there are certain areas of the state, particularly in conurbations, in which both U.S. born and immigrant people keep some backyard pigs, but very little is known about the extent or nature of such husbandry.

NUMBER OF FARM OPERATIONS

The number of farm operations selling pigs in the United States has declined substantially from 604,200 in 1969 to 102,106 in 1997. In 1969 operations selling more than 1,000 pigs a year accounted for just 1.1% of farms, whereas larger operations comprised 21.3% of farms selling pigs in 1997 (U.S. Census of Agriculture, 1997). Overall the number of hog operations reported by USDA, Hogs and Pigs Report declined from 873,840 to 81,130 from 1969 to 2001. In the year 2000 producers marketing 50,000 pigs or more per year accounted for just over 51% of pigs produced (Lawrence and Grimes, 2000). However, the same study showed that farms marketing 1,000 head or less accounted for 68.2% of all pig producers.

By 2002, there were 75,350 hog producers located in all 50 States. Forty percent of these producers had fewer than 99 head and 57 percent had fewer than 500 head. In contrast, 0.1 percent (110 operations) of hog producers had 50,000 or more head. These large producers accounted for nearly 50 percent of all hogs marketed in 2002. Thirteen percent of all hog producers are located in Iowa followed by Minnesota with 8 percent and Illinois with 6 percent (Hawks, 2004)

In Senate testimony the undersecretary of agriculture for marketing and regulatory programs (Hawks, 2004) stated that the U.S. had 60.0 million hogs on December 1, 2003. In 2003, 100.4 million head were born, about 7 million head were estimated to die due to disease, predators, and other causes and 100 million head of hogs were slaughtered.

LOCATION OF HOG OPERATIONS

Hogs are produced in every state. Iowa ranks as the nation's leading producer of hogs with 15.8 million head on December 1, 2003. Other states ranking among the top 5 hog producing states include: North Carolina (9.9 million head), Minnesota (6.4 million head), Illinois (4.0 million head), and Indiana (3.1 million head). Nearly two-thirds of all hogs on December 1, 2003 were located in the top 5 producing States.

Figure 4.5 shows the distribution of pigs by state in 2001-2003 in tabular form (NASS Livestock Statistics 2003, http://www.usda.gov/nass/pubs/agr03/03_ch7.pdf). Figures 4.6, 4.7, and

4.8 show maps of the distribution of swine and swine operations by state, and swine numbers by county, for the continental U.S.

PREMISE & ANIMAL IDENTIFICATION

In 1988, USDA published a rule for mandatory identification of swine in interstate commerce (Code of Federal Regulations - 9CFR71.19). Since 1988, mandatory identification of swine in interstate commerce has included:

- Individual ID for all replacement breeding swine
- Individual ID for all breeding swine at commingling and/or slaughter
- Identification of feeder swine
- Market swine identified back to their owner at federally inspected plants

A recent addition to the rule is that feeder swine can move across state lines within a production system as a group based on written health plans and production records (Appendix 4.1).

Official means of identification

- Official eartags
- USDA backtags for swine moving to slaughter
- Official swine tattoos
- Tattoos (ear or flank) recorded in a swine registry association
- Ear notching when recorded in a pure-bred registry
- An eartag or tattoo bearing the premises identification for slaughter or feeder swine

There are a number of methods by which individual commercial hog premises are currently identified, but the introduction of the U.S. Animal Identification Plan will deliver a national database of all premises that sell hogs into commerce. Current expectations are that states will have a premise identification process decided and in place by July 2004, although the current time line of the plan still calls for actual premise identification to be in place by that time. In fact, USDA made a premise number allocator available to the states in June 2004.

Current Premise Identification Systems

Swine moving within the market system are currently identified with a number that theoretically links them to ownership, but in practice may only link them to a corporate address. Because many premises may operate under the same company address this has been a problem. In some states, such as Indiana, steps are being taken to identify integrators by premise address rather than by company name.

There are a number of premise identification number systems. There is a national system with a two digit state identifier e.g. 32+2 alpha characters + 4 numeric digits. These are not often used on market pig tattoos and cull animal backtags because of the large number of characters. The 6 character alpha–numeric National Tattoo System or Backtag System number is commonly used on official backtags or tattoos. This premises identification number consists of the State's two-letter postal abbreviation followed by the premises' assigned number e.g. IN-1234 and is assigned by the state. The premises identification number is in theory assigned to premises that are, in the opinion of state veterinary authorities, epidemiologically distinct, but in practice may be linked to a corporate address. A premises identification number may be used in conjunction with a producer's own livestock production numbering system to provide a unique identification number for an animal. In practice the 6 character National Tattoo System or Backtag number may not necessarily be a unique number for a particular premise, but be a number assigned at the market which is linked to the name and address of the owner in the market record system.

The U.S. Animal Identification Plan – (USAIP)

The purpose of the USAIP is to link the movements of all livestock moving in commerce both interstate and intrastate to the premises through which they pass. The target is to have a system in which animal movements can be traced within 48 hours in the event of an animal health or food safety event. Although not all details are worked out, and concerns over confidentiality of producer data need to be addressed, the full plan can be accessed at the following website: http://usaip.info/USAIP4.1.pdf.

The USAIP working document was agreed on by industry groups in December 2003, with a timetable for premises ID for swine by July 2004 and the ability to ID market swine to their last premise by the same date. The target is to record all lot movements of swine in interstate commerce by July 2005, and in state movements by July 2006.

The current expectations for the implementation of the USAIP in swine are summarized as follows (http://usaip.info/PorkUpdateID3final.ppt):

Phase I -- Date: 2004

- Premises ID on replacement gilt tags
- Premises ID identifying market pigs to the last location, not the owner
- Implementation test projects

Phase II – Date: 2005/2006

- Group/Lot ID standardization
- Record Group/Lot ID movements

Phase III – Date: 2006/2007

- Electronic reporting movements
- Interstate, intrastate

In testimony before the Senate Agriculture Committee on the development of a national identification plan, the undersecretary of agriculture for marketing and regulatory programs (Hawks, 2004), testified that the plan would initially be voluntary and then mandatory. He said that the U.S. hog industry is interested in participating in a national system at the outset. In the winter and spring of 2003-4, the USDA is identifying, validating and verifying the capabilities of premises and animal number allocation systems now in use. Based on the review, USDA will select the most promising infrastructure to fund the national premises allocation number and repository system and an animal identification allocation number and repository system. The next priority will be to get the national premises allocator and repository in place in fiscal 2004 and begin allocating premise identification numbers to cooperating states, tribes and other entities that are ready to register premises.

Premise Identification Component

The National Premises Identification Number will provide a unique number for each premise involved in animal agriculture. This will include not only producer facilities but also collection points, markets, dealer premises, fairgrounds and slaughter plants. This is so that any animal passing through a facility can be linked in the national database to its presence on those premises. The premises identification number will apply to commercial and backyard operations and is expected to be required for pet swine as well. The format for the National Identification Number will be a 7 character alphanumeric number e.g. A123R69, of which the last character is a check digit.

Individual Animal Identification

The national numbering system for individual animals, referred to as the U.S. Animal Identification Numbering (USAIN) System will follow the ISO code structure for radio frequency identification of animals. The USAIN will permit a single animal to be identified with a lifetime number that can be printed on a visual tag, encoded on an RFID transponder, or a combination of both. The format will be the three digit country code for the United States (840) plus 12 numeric digits e.g. 840-123456789012.

Animals that move as a group through a production chain, such as market hogs, will be permitted to be identified by a group ID as long as the group is raised, fed, and harvested as a group. If the animals are at any point commingled with livestock from other premises they will be required to have individual identification. The group/lot identification will consist of the premises identification number and a six digit numerical number in MMDDYY format indicating the date the group was created e.g. A234567100302. This number will be bar coded onto the travel documents for the group as it is marketed and presented to the packing plant on delivery. Upon arrival at the packing plant the premises ID barcode will be scanned, linking the lot tattoo number and owner to the premises ID.

Ear tags with visual premises identification will be applied to replacement breeder swine as they enter the breeding herd. Replacement breeder swine suppliers may apply a USAIN number to identify each animal. A premises ID tag may then be administered to breeding stock in addition to an existing USAIN. Until the national database for recording movement group/lot movement is available the recording of data will be at the local level. The transition to reporting movements to a national repository will occur later.

Some states are already moving ahead with legislation to support the USAIP. On April 13, 2004, Wisconsin Governor James Doyle signed legislation requiring state livestock operators to register their premises with the Wisconsin Department of Agriculture, Trade and Consumer Protection. Premises must be registered by Nov. 1, 2005. Failure to register makes producers ineligible for state livestock indemnity payments for animals killed to control disease. Though North Carolina has had voluntary premise ID for some time, Wisconsin claims to be the first state to require premise ID (Dairy Today eReport, April 16, 2004 (http://www.agnews.agweb.com).

MOVEMENT OF PIGS

Marketing System for Live Pigs

The structure of commercial hog operations is the important determining factor in live pig marketing arrangements in the U.S. With the rise of contract pig production, by 2000 only 29% of pigs were sold on the spot market versus 64% in 1997, the remainder being sold under various forms of contract arrangements. Slaughter pigs may be sold on a live-weight basis in terminal markets (which now account for less than 1% of sales), or in auction markets. However the vast majority of pigs are now sold direct to packers on a live weight or carcass-weight basis.

In State Movement of Swine

Animals over 6 months of age.

Animals over six months of age that move in intrastate commerce must have a health certificate in most states. This means that boars and replacement gilts, which are usually over six months of age when moving from a supplier to a farrowing operation must move under a health certificate. However, for in state movements this is very difficult to enforce since, unlike interstate movement, there is no requirement for any sort of testing of these pigs. On the positive side the change in the source of breeding stock from small breeders to large commercial seedstock companies has generally led to an improvement in compliance. In fact, the remaining small breeders tend to comply with the regulations because they have a reputation to maintain in the market place. Additionally, the changes in the structure of the swine industry have reduced the casual transfer of boars between premises. However, it is clear from the above that there are potential flaws in the security of the movement recording, animal or premise identification, and traceback of breeding stock movements within a state.

Culled breeding animals

Cull sows and boars going directly to slaughter do not require health certificates but must be identified with a back tag or other official identification. Cull breeders belonging to multi-site corporate farms are often picked up on a truck route. Many farms route cull animal pick-up trucks according to the disease risk status of the premises i.e. from low risk to high risk sites. Again, the weakness in the system as far as traceability is concerned is that the given address may lead to a premise with multiple herds. Pigs from multiple sites may be on the same load and some of these may actually come from out of state. Cull breeders may also be picked up from markets or buying stations and these should therefore have a premise ID backtag at the time of pick-up. However, these pigs may go through 2, 3 or 4 markets over a period of 2 weeks. During this time many pigs lose their backtags and therefore any means of tracing their movements or their farm of origin.

It is illegal for breeding animals to leak back from the markets into the production system, and prosecutions have occurred when this has happened.

In markets a space and time separation is required between cull breeders and feeder pigs going through the same market. Cull breeder sales and feeder pig sales are required to be held on different days or in different areas of the market facility. However, there are no regulations concerning the movement of people between the feeder pig and cull breeder areas of the market and this may constitute a biosecurity threat.

Feeder pigs

Feeder pigs moving in state usually go directly from the farrow-nursery or farrow-wean producer direct to the grower. No health certificate or paper trail is required by the state. This is not the case if the state still has herds under quarantine for pseudorabies infection.

Feeder pigs which are moved in small numbers from a number of suppliers to a grower-finisher can constitute a particular biosecurity risk because independent haulers may pick up small numbers of feeder pigs at a number of sites. In this case it is not unusual for the hauler also to own pigs and be hauling for someone else.

Animals moving through markets

Breeding animals must by law go to slaughter if they go through a market. This generally applies to cull sows and cull boars. The market is required to keep a record of the number of animals, their weight and the name and address of the vendor. This record, usually a paper record, is sent periodically to the state animal health authority. Breeding animals must have a back tag number applied at the market to facilitate *Brucella* and pseudorabies traceback. Many states do not have slaughter facilities for cull animals so many of these animals do in fact cross state lines. Generally there is good compliance with requirements for record keeping on pigs moving through markets and with the application of back tags. However 20 – 50% of back tags are lost by the time the pigs are inspected at the slaughter plant.

Market swine

Market swine go either to state inspected or federally inspected slaughter plants. Records of the numbers of animals and the name and address of the vendor are kept on file at the slaughter plant, and are accessible to state animal health authorities. Federally inspected plants are usually large and have computerized databases containing pig numbers, and name and address of the consignor. The weakness in the system is that many pigs going through federally inspected plants belong to large corporate producers. The address of the entity that owns the pig and whose address is recorded in the database may bear no geographical relationship to the premises of origin of the pig, and may even be in a different state.

Interstate Movement of Swine

Market hogs do not need animal identification if going to slaughter out of state. Similarly neither an individual animal identification nor a health certificate is required if animals are moving across state lines in a swine production system operating under a valid animal health plan (Code of Federal Regulations, 2002 http://www.aphis.usda.gov/vs/nahps/animal_id/cfr71/9cfr71-1.txt). However, the animals must be assigned a lot number at their destination and the receiving unit is required to keep a record of the lot numbers, and the state must be notified of the movement.

Large numbers of pigs are moving interstate, especially from North Carolina to the Midwestern states. Swine entering interstate commerce are identified at whichever event comes first: first commingling, first market, transfer of ownership, or arrival at destination.

IDENTIFICATION OF ANIMALS

Identification can be an official eartag, USDA backtag (for slaughter pigs), or official swine tattoos. Market hogs at buying stations are tattooed. Cull breeding animals have a back tag applied.

Tracebacks Through Markets

Indiana has carried out 6-8 tracebacks per quarter through the period from the beginning of 2002 until mid 2003, mostly for pseudorabies. Market records were easy to use, but animals that had lost backtags could not be traced. Difficulties that may occur are that often there is nobody at the market where the records are kept except on e.g. Tuesday, Thursday and Friday of each week. In the past the state has had to trace back from market to market from the final point of sale. Trace back through dealers patronizing the markets may also have to be done, as animals move from dealer to dealer before finally going to slaughter.

FARM BIOSECURITY

Analysis of the 1997/98 CSF epidemic in the Netherlands showed that in different phases of the outbreak modes of transmission between farms assumed different levels of importance. Early in the outbreak, before the initial diagnosis was made, animal movement was the most important means of infecting new premises, accounting for over 60% of the infected premises by the time of first diagnosis. Subsequently, the geographical proximity of other swine units became the major risk factor and accounted for greater than 60% of infections occurring during that phase. During this time veterinarians and officials visiting farms were also implicated in new infections, and birds and mice may also have played a role. In the final phase of the outbreak transport of both live and dead pigs out of restricted areas again became factors in the transmission of the disease (Merks, 2001). Overall routes of infection for the outbreak are summarized in figure 4.9.

Biosecurity Methods

Farm to farm

Methods available:

Distance from other pig units

Isolation/quarantine of new breeding stock

Use of artificial insemination

Visitor restriction

Employee restrictions, including restrictions on swine ownership

Cleaning and disinfection of livestock trucks

Carcass disposal

Control of rats, cats and wildlife

Sanitation or restricted entry by feed trucks

Within farm

Isolation of newly acquired stock

Acclimatization

Separate sites

Age segregation

All-in, all-out production

Cleaning and disinfection of buildings and equipment

Rodent control

Management of pig and people flow

Farm to Farm Links

Some indication of the links between farm premises can be gained from looking at links exposed during other animal disease outbreaks. During the CSF 2000 outbreak in the United Kingdom disease was confirmed on 16 premises. The first confirmation was on August 8th and the last on November 3rd. It was believed that infection of the index case occurred sometime in June 2000. Tracing of links to the 16 confirmed cases resulted in 586 farms being placed under movement restriction (UK Parliament, 2001). In addition, the U.S.' experience with diseases such as PRRS and TGE suggest that the potential for farm to farm spread of disease may be significant. A detailed study of the complex of farm to farm contacts in U.S. swine husbandry systems is certainly warranted.

Distance from Other Pig Premises

Spatial separation of swine premises has been shown to be an important factor in the transmission of CSF, but clear guidelines on the sighting of swine units have not been published. During the established phase of the CSF outbreak in the Netherlands in 1997-8, transmission rates due to the proximity of an infected herd within a 500 meter radius for a period of one week gave a transmission rate which was second only to that due to direct contact with infected animals (Stegeman et. al., 2002).

Although many routes of CSF transmission are presumed, the influence of neighborhood infected premises plays a predominant role once the infection has been established in an area. It appears that both the density of swine premises and the overall density of the swine population are important risk factors. This is important in the U.S. context as consolidation has occurred in the swine industry and the number of independent producers, as well as the number of swine premises, has declined. For the purpose of understanding the current U.S. hog density, and comparing our situation to that of countries with recent CSF outbreaks for which dissemination models have been constructed, Indiana's most swine dense county was evaluated. Carroll County data was collected by the Animal and Plant Health Inspection Service, Indiana Department of Environmental Management, Indiana Board of Animal Health and the county extension educator. Appendix 4.3 includes a description of the data analysis methods. The swine premise density of Carroll County is 0.215 premises per km^2, which is comparable to those areas of the Netherlands described by the European Union as having a low swine premise density. In 2000, the low and high densities areas of the Netherlands were 0.21 premises per km^2 for the southwest and 1.09 premises per km^2 for the south (de Vos et al., 2003). Despite being of relative low swine premise density, a significant percentage of Carroll County premises fall within the neighborhood spread categories, 0-500 m and 500-1000 m. These categories were identified by Stegeman et al. (2002) as being the second and third highest risk factors for CSF development during the 1997/98 Netherlands outbreak. Overall, 27% of premises had a nearest neighbor within 0.5 km and 57% had a nearest neighbor within 1 km. The farthest nearest neighbor distance is 3.7 km, of particular significance when evaluating the culling zones which have been established for past outbreaks of viral diseases. Figures 4.10 and 4.11 illustrate the proximity and density of premises, and figure 4.12 offers a categorization of swine premises by nearest neighbor distances. The Indiana Department of Environmental Management defines Confined Feeding Operations (CFO) as those containing at least 600 swine. Fifty-four percent of the total number of swine premises are CFO's, indicating the trend toward fewer, larger operations. Compared to the overall proximity of swine premises, CFO's tend to be farther from their nearest non-CFO neighbors and farther still from their nearest CFO neighbors. This is beneficial from a disease control standpoint. The overall proximity of premises to each other, however, indicates that even the large operations are connected epidemiologically by series of small operations through which disease transmission may take place. The potential for neighborhood spread to occur in swine dense areas of the U.S., such as Carroll County, is clear. Figure 4.13 provides a summary of the Carroll County data.

Another important change that has taken place which impacts the neighborhood spread of CSF by either wildlife or airborne spread is the change in husbandry systems, particularly for larger operations. Totally enclosed confinement housing has become the industry standard for large units, although other structures such as curtain sided and open fronted barns are also used. There is however growing interest and increasing adoption in the Midwest of hoop structures (Sharp and Hinrichs, 2001), and pasture systems are also promoted as part of a sustainable agriculture movement (http://www.clt.astate.edu/dkennedy/pbsm.htm).

Under the U.S. Animal Identification Plan (USAIP) agreed in December 2003, all premises which sell pigs into commerce will have a unique identifier assigned by the state authority using numbers allocated by the USAIP. The state database has fields allocated for the GIS coordinates of the premise. The state databases will be linked to the national database containing the premise identification numbers for all livestock operations in the country and will provide better data than is currently available on the separation of hog confinement units.

Isolation/Quarantine of New Breeding Stock

Data from the NAHMS Swine 2000 study showed that although the majority of farms isolate incoming breeding gilts and boars a substantial percentage fail to do so. Recommendations for isolation of newly purchased boars are for a minimum period of 4 weeks, but preferably for 8-10 weeks if feasible (Newcomb et. al., 1995). Recommendations for purchased gilts are for an isolation period of 30 days from 120–150 days of age, immediately followed by an acclimatization period in which vaccination and feedback of manure (and occasionally exposure to cull animals) occurs for a further 30 days. This provides an effective isolation period for incoming gilts of approximately 8 weeks (http://www.albertapork.ca/producers/whjournal/spring02/article15.htm). Many herds minimize the number of entries of animals, particularly in the winter months. The threat of CSF justifies the use of a quarantine and acclimatization buildings outside the farm perimeter, with adequate biosecurity control of traffic between the quarantine building and the rest of the operation (http://www.exopol.com/general/circulares/137.html)

Larger farms are more likely to isolate incoming animals for a longer period. On small farms (<250 breeding females) quarantine time averages 35 days, while on large farms (500 or more breeding females) average isolation period is 51 days.

It is interesting to note that in the wake of CSF and FMD outbreaks in the United Kingdom in 2000 and 2001 the government initiated a 20 day rule, under which if any pigs are moved onto a holding, then no pigs can leave the farm within 20 days, apart from those going for slaughter.

Use of Artificial Insemination

One way of reducing the movement of male breeding animals on to production facilities is through the use of artificial insemination (AI) using purchased semen. On the other hand it may be easier and quicker to move a large quantity of infected semen, than it is to move the same number of boars. Twenty-three percent of operations use AI and three-quarters of these purchase semen, although there are striking regional variations with up to 91.2% of AI operations in northern states using purchased semen, while only 31.2% of AI operations in southern states purchase semen. Overall, for sites with more than 500 breeding females, 85.3 percent of sows were mated via AI, whereas approximately 15 percent of sows were bred by AI on farms with less than 250 sows (USDA NAHMS Swine 2000, Part 1: Reference of Swine Health and Management in the United States, 2000). The U.S. Pork Industry Structure Study 2001 showed that on operations marketing more than 50,000 pigs a year over 90% of females were bred by AI.

Visitors

Recommendations for handling visitors to swine units include:

1. Limit access to the farm to one combined entrance/exit
2. Do not allow non-essential visitors access to the farm
3. Provide disposable clothing and foot coverings to farm visitors
4. Where possible implement shower-in, shower-out rules
5. Utilize visitor parking areas

6. No visits from international travelers within 5 days of return to the U.S.

The majority of operations (65.5%) restrict entry to swine facilities to employees only. Almost all large sites (98.3%) require visitors to wear clean boots and coveralls before entry, while only 43.2% of the smaller sites do. 57.7% of large sites require visitors to shower in, while only 4.3% of small operations do. A quarter of operations have a 24 hour “no swine contact” period before permitting entry to the facility.

Employee Restrictions

Most swine operations (89.7%) do not allow employees to have contact with swine not owned or managed by the operation. The percentage is as high as 96.4% for large sites. However, in a survey of biosecurity measures on turkey farms investigators found that lack of training and poor compliance on the part of employees were responsible for biosecurity breakdowns (Ley, 2000). Some farms may provide food for consumption by personnel during working hours because of the biosecurity risk of smuggled meat being brought into the farm in lunch boxes.

Transportation Access

It has been recommended that if vehicles enter the site there should be a disinfectant mat or wheel bath of sufficient length to disinfect the circumference of the tire. However, efficacy of these techniques has not been shown. Disinfectant spray equipment should be available at the farm entrance for disinfection of wheels or vehicle body.

Small sites were less likely to allow trucks transporting livestock within the perimeter of the pig site. Overall 56.8% of sites allowed truck access within the perimeter (small 52.0%, medium 79.6%, large 86.8%) (USDA:APHIS, 2003).

Cleaning and Disinfection of Livestock Trucks

Most sites require cleaning of trucks, especially the inside, before entering the site, but smaller operations were less likely to require the disinfection of trucks. Figure 4.14 shows the percent of operations requiring livestock trucks to be cleaned or disinfected before entering the site. Many operations now do not allow livestock trucks, feed trucks or veterinary vehicles within the site perimeter. The introduction of CSF in 1997 into the

Netherlands has been attributed to a contaminated truck that had been in contact with CSF infected pigs in Germany (Bouma and Stegeman, 2000).

Carcass Disposal

Dead pig pick-up by renderers accounted for the disposal of 40.4 percent of dead pre-weaned pigs and 55.9 percent of dead older pigs. Only 12 percent of pigs were picked up by the renderer off the site of the operation. In the Netherlands 1997-98 CSF outbreak rendering trucks that had picked up a dead pig from an infected premise before picking up dead pigs from an uninfected premise were capable of transmitting infection, although at a low rate of transmission (Stegeman et al., 2002).

Rodent Control and Exclusion of Cats

Wild animals (other than feral swine, which are considered separately) and cats, could conceivably carry CSF infection to neighboring premises. Indeed, cats were used by 60.6% of operations to control rodents. The percentage of sites that constructed swine buildings to exclude rats and mice, or cats is shown in figure 4.15.

Farm Biosecurity Recommendations

A model set of farm biosecurity recommendations was made by Gadd J. 2002, following the FMD outbreak in Britain. Some that are relevant to CSF prevention in the U.S. are included here.

- A "perimeter" mindset is essential. Separate unloading facilities for pig feed and general goods on the farm boundary should be the norm.

- Pig collection and delivery trucks should not be accepted at the farm without a certificate of sanitation issued by the buying organization or vendor.

- All packers, slaughterhouses, feed mills and commercial pig breeding houses should install approved tunnel-type vehicle disinfection bays where the undersides and wheel arches are sanitized. Records of truck disinfection should be mandatory.

- Should deliveries to multiple farms be unavoidable (as for minor suppliers), the farmer should provide a covered, off-road point on the farm boundary where the driver can use a cell phone to alert the recipient to come out and sign the docket.

- No driver should be allowed to help with loading/unloading pigs.

- No drivers should be allowed, by law, to keep pigs themselves.

- All vehicles must be prevented from entering a livestock area — including those used by salesmen or even the veterinarian. If needed, a biosecure area can provided with separate access to a hardstanding with cleaning facilities.

- Farm pig-loading bays are essential with wash-down facilities and drainage off the site. Recent findings have revealed that pig loading and movement is a much more dangerous vector of disease than previously thought. This is because many pig farms have developed piecemeal over the years and have not planned to avoid crossovers in pig movement. Younger pigs and sows often move across outside areas that are rarely, if ever, sanitized.

- Wheel dips for vehicles entering and leaving the farm should be mandatory and adequate, using automatic or manual topside and underside spraying devices..

- Dead animals should be incinerated on the farm. They would only be left for collection at an off-site venue under license, suitably protected from exposure and degradation, with the site disinfected after collection.

- Clear signs should be placed at farm perimeter entrance and exits. Suppliers must be provided with specific, written instructions on the biosecurity measures farmers expect them to follow.

- Farmers must be encouraged to use the disinfection dilution check-strips now available.

- Farms should use their own feed delivery hoses unless the bulk bins are accessible outside the perimeter.

SWINE EXHIBITION

Exhibition of swine presents particular risks of disease transmission. It has been recommended that swine exhibitions should be terminal events (http://www.cdfa.ca.gov/ahfss/ah/pdfs/exbswine.pdf). Events that include breeding stock should be completed and the animals removed from the show premises before market animals arrive.

Identification of Swine at 4-H and FFA Shows

Generally swine must be tagged with an official 4-H tag, tattooed and a hair sample may be taken for DNA testing. Pigs must also be ear-notched using the national universal identification system prior to exhibition. In many states pigs from validated pseudorabies or brucellosis free herds are weighed and verification forms completed at the farm, but all other pigs are weighed and verified at listed verification sites and then returned to the farm prior to exhibition (http://www.extension.iastate.edu/4H/Agriculture/ISFswine.pdf), which would appear to constitute a significant biosecurity risk. In other states such as Nebraska (http://4h.unl.edu/calendarfiles/livestockshow.htm), only ear notches and a description are required to identify market hogs. However the Nebraska State Fair and Ak-Sar-Ben Swine Shows are terminal shows for biosecurity reasons, and county 4-H fairs are strongly recommended to be terminal shows (http://4h.unl.edu/calendarfiles/livestockshow.htm).

As part of this pathways analysis a case study was conducted after the 2002 Indiana State Fair to identify and contact all exhibitors of 4-H swine and to determine where the 2,239 pigs were transported to directly after the fair (Amass et al. 2004 In press). The investigators were able to contact the exhibitors of 70.1% of the pigs through the 4-H sign-in sheets and to determine destinations for 60.9% of the pigs. 53.5% of pigs with known destinations were marketed directly to a packing plant from the fair, 36.4% went home to the 4-H family, 8.3% were sold, 1.4% were returned to their original farm of origin, and 0.4% died at the fair. Of the 113 pigs that were sold, 82 remained in Indiana, four went to Ohio and 27 had an unknown state of destination. The investigators concluded that in the event of a disease outbreak requiring traceback from the fair, the animal identification system, the record keeping system, and the number of phone calls required made such a task extremely difficult, time consuming and incomplete.

Procedures and destinations for animals at open shows are not well documented, and a review of the situation regarding open shows is warranted.

DISSEMINATION MODELS

Importance

Disease modeling is an important addition to the quantitative epidemiological, data management and statistical methods available to describe disease outbreaks, particularly of infectious diseases. Models are very valuable in understanding the dispersion of disease during a disease outbreak. In addition, as the analysis of the 1997/98 Netherlands CSF outbreak showed, the linking of a disease model and an economic model can be of particular value in understanding the impact of decisions made during the course of an outbreak.

Computer models of disease outbreaks are a powerful tool but there are limitations to their application, especially if an attempt is made to use them for tactical decision making in the face of an outbreak.

The use of models is comprehensively reviewed in a report by Nick Taylor (Taylor, 2003) to the UK Department of Environment, Food and Rural Affairs. It describes the use of models in FMD and CSF epidemiology and disease control decision making and constitutes a major source for this section of the report.

Types of Models

Deterministic models and stochastic models

Models which assign average, or most likely, values to all parameters and model the average or most likely outcome of events are termed “deterministic” models and produce a single output for each set of input values. Stochastic models, on the other hand include variability of parameters and the effect of chance in the model. Since the parameter values vary and the effects of chance are randomized, stochastic models are run repeatedly and give a range of outcomes from the same input scenario. Because stochastic models produce a range of possible “futures” they must be used with great care as a decision support tool (Taylor, 2003).

Potential Uses of Models

In the field of animal health, models may be useful in the following ways:

- Retrospective analysis. Where good data are available from past epidemics, models can be constructed as an aid to understanding the dynamics of an epidemic. In this case the model is made to mimic a specific real life epidemic. This was used effectively in the 1997-98 Netherlands CSF outbreak to examine disease spread (Nielen, 1999).

- Contingency planning. Based on the retrospective analysis of previous disease outbreaks models can be used to ask questions about different control strategies for future epidemics.

- Resource planning. This is part of contingency planning but resource planning can be used for short term estimates of resource needs in the face of an outbreak.

- Training. Models can be used in epidemic simulations.

- Surveillance targeting. Risk assessment models can be used to target surveillance. As an example a risk assessment model was used to carry out a risk analysis for importation of classical swine fever virus in swine and swine products from the European Union. (fig. 4.4 USDA:APHIS (2000)).

- “Real time” Decision Support. During the 2001 FMD epidemic in the UK, models were used to support tactical decision making in real time, with controversial results.

Various models have been developed to simulate outbreaks of highly infectious diseases such as CSF and Foot and Mouth Disease. These models have generally been used to compare alternative control measures which may be deployed in the course of an outbreak. Such models may be used to describe the contribution of various risk factors to the between herd and within herd spread of CSF.

Dispersion Models

Restrospective models were used to model the CSF outbreak in the Netherlands in 1997/98.

Stegeman et al. (1999a) used a deterministic, non-spatial model modeling approach to produce estimates of the infection rate parameter *B* (average number of herds infected by one infectious herd during one week) and the herd reproduction ratio R_h (average number of herds infected by one infectious herd during its whole infectious period). Real field data of weekly infection incidence were substituted in the simple SIR equation to derive the value of *B* for each week. Since the model specifically models the transition from the susceptible to the infected state data on real infection dates were needed. The conclusion drawn from the model that is relevant to CSF spread in the U.S. was that culling infected herds, movement controls and contact tracing appeared insufficient to eradicate CSF from regions with high pig-farm density. It was concluded that pre-emptive slaughter of contact herds, increased hygienic methods and reduction of transport movements associated with welfare slaughter, were necessary for the control of the epidemic. This emphasizes the effect of density of farms, rather than density of the swine population, on disease spread and the effectiveness of control methods.

InterCSF was developed from the InterSpread model and adapted for CSF in Dutch conditions by Javingh et al. (1999). InterCSF is a spatial stochastic model that considers three types of contact (animals, vehicles and persons) plus a determinant called "local spread" which considers spread to a specific distance. InterCSF also looked at control measures used in the epidemic:

- Infected premise diagnosis and culling
- Movement controls
- Tracing
- Pre-emptive slaughter (neighborhood culls around IP's)
- Welfare slaughter

InterCSF was calibrated to mimic the real epidemic of 1997. The probabilities of disease transmission by different routes, which are difficult to directly quantify, were adjusted in the model by iteration so that the model matched the actual epidemic. A powerful feature was the linking of the disease model to a financial model (EpiLoss), which allowed quantification in financial terms of the consequences of the outbreak and changes in control strategy. The model showed that interval from the introduction of infection to the detection of infection (in the real epidemic a period of 6 weeks) was a critical determinant of the size of the outbreak. It also showed that pre-emptive slaughter would have reduced the size and duration of the outbreak and halved the cost. The model also suggested that a notional "maximum hygiene" option would have reduced local spread to zero.

In the real outbreak there were huge welfare slaughter costs. The number of animals killed for welfare reasons (9.2 million pigs) far exceeded the 1.8 million animals that were culled from infected herds or in pre-emptive culls. According to the model pre-emptive culling of herds within 1000 meters would have shortened the epidemic and would have saved large costs associated with welfare slaughter. In fact, whether or not pre-emptive slaughter was included in the control had little effect on the total number of farms culled, but only when they were culled, because the same farms would eventually be culled for welfare reasons anyway.

The researchers pointed out that caution needs to be observed in the application of retrospectively applied stochastic models. The model is validated with data from the real 1997 outbreak and caution must be applied in using it to predict the size of another outbreak using a different scenario. In addition, control measures are implicitly included in the model, which makes it difficult to use the model to simulate what would have happened in the absence of control methods.

They emphasize the need to validate the model on the underlying mechanisms of disease spread rather than mainly on the final outcome of the epidemic. To quote the authors directly (Javingh et al, 1999):

However, although a wealth of data seems available, a large epidemic such as occurred in the Netherlands is still only one epidemic from a range of possible epidemics.

The authors point out that the model is extremely sensitive to spread parameters. This is important in the U.S. context where local contact spread based on farm density could be very different. In addition, the researchers found the full complexity of the contact structure between farms was difficult to model. Improvements to the model could be made by making the time delay to detection more realistic (rather than a random effect from a distribution) and by modeling the varying infectivity of a farm which tends to increase as the on-farm infection progresses.

Conclusions from the application of InterCSF in a variety of model scenarios indicate that it would be justified to have different control strategies for areas of differing livestock density (Mourits, 2002).

Stochastic models are better suited to the study of a range of hypothetical situations, in order to provide guidelines for contingency planning, but tactical decisions during epidemics are better based on field data which may rapidly indicate which modeled situation is actually being faced (Taylor, 2003). These are important issues because the evidence from the 2001 FMD outbreak in the UK is that in the absence of good quality field data, model based analysis was used as a substitute for poor information, and a contiguous cull was enforced which does not appear to have been warranted based on a retrospective view of field data (Taylor 2003).

Transportation & Contact Modeling

Despite the limitations of using models for tactical decision making, there is an opportunity to design models which are based on an understanding of the transportation system, and which will track back to find in contact animals as well as propagating forward to focus efforts on disseminated infection. This model would link an epidemiological model to a transportation model. The important need for this to work, and to escape the limitations of other models in resource allocation and tactical decision making is that it has available an accurate animal and premise identification system, and an up to date database of infected premises. A system of animal and premise identification which would provide up to date data (within 48 hours) now seems achievable through USAIP, though, as recent outbreaks of FMD and CSF in Europe have shown, up to date data on disease diagnosis and disposition of infected premises appears to be much more difficult to achieve. The main problem is that in the early stages of an outbreak of any magnitude, the available diagnostic, slaughtering and carcass disposal manpower is likely to be overwhelmed. However, it is essential that at the time of first diagnosis, manpower and data resources are available to trace-back through the transportation system to identify premises already likely to be exposed to infection. USAIP datasets should have the raw data identifying animal movement, contact and premises of origin. What is needed is a data handling system, based on a model of the transportation system, which will provide animal health staff with a list of likely contact premises. This is necessary because, not only are animal and premise ID important targets of interest, but so are the vehicles and vehicle networks themselves.

Indeed, contaminated vehicles that have carried infected hogs become sources of infection, and until they pick up their next load of live animals, are lost to any sort of system (such as USAIP) that tracks connections between premises and animals. Appendix 4.2 contains a theoretical treatment of a massively distributed, decentralized, secure animal tracking system, built by linking epidemiological and transportation models.

Current knowledge of trucking practices for hog transportation is limited. Livestock account for 2.15% of the commodities carried by trucks with five axles or more, and account for 1.58% of the annual miles of travel for these vehicles (Federal Highway Administration, 2001. http://www.fhwa.dot.gov/reports/tswstudy/vius97.pdf). The animals loaded on trucks are identified, but most records pertain to the tractor, not the trailer, and in state truck movements are not necessarily recorded, particularly for smaller farm owned trucks, and occasional haulers. Animals moving interstate are, of course, accompanied by a Certificate of Veterinary Inspection, and eventually, under USAIP, instate movements will also be recorded. These movements, though, are not linked to specific records of vehicle movement. Drivers of interstate and intrastate commercial motor vehicles exceeding 10,000 lbs gross weight are required to keep a Daily Record of Duty Status or "log", or use an hours of operation recording device. The driver is not required by federal regulation to log origin and destination of journeys, but most carriers require "from – to" reporting, in addition to hours logged. However, drivers operating within a 100 air-mile radius of their normal reporting location may be exempt from the logging requirement (Federal Motor Carrier Safety Regulations, Part 395, http://www.fmcsa.dot.gov/rulesregs/fmcsr/regs/395.htm).

Many commercial vehicles are now equipped with GPS tracking or satellite tracking, which are used by trucking companies to manage their fleets. Truck tracking technology incorporated into an animal tracking system has great potential.

OTHER PIG POPULATIONS

Feral Pigs

Wild swine populations within the U.S. consist of feral swine (escaped domestic swine or their descendents), European wild boar, and inter-breeding between wild boar and feral swine. Wild swine can act as a reservoir and vector for many different diseases. Diseases that can be harbored and spread within the wild swine population include pseudorabies, brucellosis, and vesicular stomatitis each of which are already present in swine populations within the U.S. (Muller et al., 2000; Rirtle et al., 1989; & Stallknecht et al., 1993). In addition, wild swine are susceptible to exotic diseases of swine such as CSF and foot and mouth disease (Pech and Hone, 1988; Pech and McIlroy, 1990; Stallknecht et al., 1993). The susceptibility of non-farmed swine to CSF is important because wild swine represent a potential pathway of introduction of CSF. In addition, non-farmed swine could play a role in the dissemination of CSF within the U.S. following an introduction. Thus, it is important to understand the biology and epidemiology of non-domestic swine populations.

History of Wild Swine

Eurasian wild boars have a native range that includes Europe, Asia, Northern Africa, the Middle East, and Indonesia (fig. 4.16) (Huffman, 2003). The domestication and breeding for improved genetic traits in swine began in China circa 3000 B.C. with the domestication of *Sus indica*, a small Asian species and in Northern Europe c. 1500 B. C. with the domestication and breeding of *Sus scrofa,* the Eurasian wild boar (Ryer, 2003). Today's domesticated swine are descended from the European boar with a mixture of Sus indica (Ryer, 2003).

Swine were first introduced into what is now the U.S. by Polynesian immigrants to Hawaii around 750-1000 A.D. (Taylor, 2003). Columbus brought swine to the West Indies in 1493 (Miller, 2002; and Towne & Wentworth, 1950) and Desoto introduced swine from Cuba into Florida during his exploration of the Southeastern U.S. in 1539 (Towne and Wentworth, 1950 and Miller, 2002). Eurasian wild boar were first introduced for sporting purposes to a Sullivan County, New Hampshire game preserve in 1890 (Ryer, 2003), the Great Smokey Mountain National Park area in 1912, and California in 1925 (Barrett and Birmingham, 1994 and Collins, 1991).

Wild swine are currently expanding their range across the Southern and Central United States and are mostly hybrids of domestic origin (Yorkshire, Berkshire, Hampshire, etc) with genetic influence by the Eurasian wild boar (Hellgren, 1997). However, wild swine herds in New Hampshire, North Carolina, California and Texas have a tendency to be influenced more by Eurasian wild boar genetics (http://www.texasboars.com/facts). The true Eurasian wild boar genotype is very rare in the U.S due to crossbreeding with feral swine. However, with the development of a large international market for meat and popularity as a game animal, Eurasians are being released to "enhance" feral swine genetics in controlled preserves and wild swine populations (http://www.texasboars.com/facts.html).

Susceptibility of Wild Swine to CSF

The susceptibility of wild swine to CSF has been established through experimental studies, and documentation of the natural occurrence in the U.S. (prior to eradication) and globally. In addition, there has been documentation of outbreaks involving transmission between domestic and wild swine populations.

Experimental Studies

To investigate the susceptibility of wild swine to CSF, Brugh et al. (1964) experimentally inoculated 10 European wild boar piglets and 10 piglets of feral origin with a 50% infective dose of hog cholera virus at levels of 1,000, 100, 10, 1 TCID50. The 8-week old piglets of European wild boar origin showed symptoms of CSF 2-4 days before feral piglets and died an average of 3.5 days before feral piglets. This could be attributed to the wild piglets being approximately half the size of the domestic piglets of the same age group at the time of inoculation (Brugh et al., 1964). However, these findings indicate that wild boar and swine of feral origin are both susceptible to CSF infection.

Historical Occurrence in Wild Swine Populations in the U.S.

The first documented cases of CSF in the wild boar populations of Europe came from Germany in 1953 (Brugh et al. 1964 and Nettles et al., 1989). There are many documented incidences of CSF epizootics in the feral swine population of the U.S. from the early 20th century until the end of the U.S.D.A. eradication program in 1978 (Degner et al., 1982). The first documented reports of CSF in the wild swine population of the U.S. were made in 1941 including a review of the 1932 epidemic in the Smokey Mountain region of eastern Tennessee and Western North Carolina that decimated the wild swine populations in the area (reviewed in Brugh et al., 1964 and Nettles et al., 1989). Other reports include accounts from Santa Cruz and Santa Rosa Island, California where individual swine in the wild pig population were inoculated multiple times during the 1940's and 50's then released to the naïve population in an effort to control the population growth on the islands (Nettles et al., 1989). This introduction of CSF into the naïve herd resulted in high mortality rates, reduced population densities, and resulted in the quick die out of disease on the island (Artois et al., 2002 and Wheeler as cited in Nettles et al., 1989).

After the USDA eradication program concluded in 1978 and the U.S. was declared free of CSF, a serological survey spanning 1979-87 was conducted by the Southeastern Wildlife Disease Cooperative Study (Nettles et al., 1989). During the course of this study, 5 wild swine (1 in California, 2 in Florida and 1 in Texas, and 1 in Mississippi) had CSF titers of 1:16 using fluorescent antibody serum neutralization. All of the swine with antibody titers were negative using virus isolation following cell culture or direct fluorescent antibody test of tonsil and/or spleen tissue. The authors speculated that the titer levels were due to cross reactivity of antibody tests for CSF and bovine viral diarrhea virus.

In instances where the disease has become persistent in the wild swine population a moderate or low virulent isolate had previously been introduced. In such cases, adult swine develop immunity to the virus allowing herd immunity to increase and virus to perpetuate in young, susceptible wild swine (Artois et al., 2002). This concept of immunity development and age susceptibility difference has been documented in the wild boar population of many European countries (European Commission, 1999) and has resulted in epizootics in domestic swine when they come in contact with infected wild swine.

Occurrence in Wild Swine Populations Globally

The first description of CSF in European swine came from Austria in the late 19th century and Germany in 1894 with infections persisting until the modern day (Straw, et al., 1999). In the past 20 years, growing wild boar populations and the presence of low virulence virus strains have contributed to the persistence of CSF in Europe. The persistence of CSF in wild swine populations has caused recurrent epidemics in the domestic swine populations of Europe (Artois et al., 2002; Kaden et al., 2000; Kramer et al., 1995; & Laddomada, 2000). In 1953, Hutter reported sporadic epizootics of CSF in wild boar of Germany and Spaa reported that CSF was present in wild boar populations of Austria in 1955 (Hutter as cited in Brugh et al., 1964, p. 1124 and Spaa as cited in Brugh et al., 1964, p. 1124).

In 1997, the Lombardy region of Italy experienced an outbreak of CSF in wild and domestic swine. A reservoir of infection persists, as indicated by an antibody seroprevalence rate of 7% in the current wild boar population (Zanardi et al., 2003). In 1998, a CSF outbreak in the wild boar population of Switzerland occurred following exposure to wild boar crossing the boarder from Italy into Switzerland (Schnyder et al., 2002). A CSF outbreak in 2001 in the Northern Vosges region in France was documented and is currently being controlled by natural extinction processes. However, this has caused sporadic outbreaks in wild swine and creates a risk to domestic swine production within the country and their trading partners (Hars et al., 2002). Additional outbreaks in European wild boar occurring in the past 10 years include outbreaks in Croatia, Spain (along with African Swine Fever), Poland, Russia, Czech Republic, Hungary, Bulgaria, and Austria (Office of International Epizooties, 2003).

Outbreaks & Transmission between Wild and Domestic Swine

One of the first reports of CSF transmission between domestic swine and wild boars was in Austria and Germany during the 1950's (Brugh et al., 1964). In 1969-1970, a herd of feral swine in Florida was infected by pig to pig contact with domestic swine during an outbreak (USDA-APHIS, 1981). The feral swine subsequently transmitted virus to other Florida herds in the area via direct contact (USDA:APHIS, 1981). The Florida incident occurred during one of the most aggressive periods in the USDA Hog Cholera Eradication Program and slowed the progress of the program within the state of Florida (USDA:APHIS, 1981). The eradication program was complicated even with the relatively small wild swine populations that existed during the 1960's and 70's (USDA:APHIS, 1981).

Since 1993, there have been 327 CSF outbreaks reported to the OIE in German domestic swine herds, with 59% of the primary outbreaks being attributed to direct or indirect contact with wild swine infected with moderately virulent virus strains (Fritzemeier et al., 2000). In Sardinia, domestic pigs may be kept at free range thus allowing wild boar to come in contact with domestic free range swine (Laddomada, 2000). The presence of uncontrolled CSF in both the domestic and wild swine populations has led Sardinia to declare CSF endemic (Laddomada, 2000).

Once CSF has been introduced into a wild swine population, the disease may be spread by direct contact with animals, body fluids, carcasses, and persistently infected piglets (Kern et al., 1999; Laddomada, 2000; & Schnyder et al., 2002). The virus is then transmitted back to domestic swine by contaminated hunting equipment, feed, and direct contact, which makes wild swine a potential complicating factor in eradication efforts (European Commission, 1999; Kern et al., 1999; Laddomada, 2000; & Schnyder et al., 2002).

The continued CSF seroprevalence in Eurasian wild boar populations and multiple outbreaks within the domestic swine population in Europe led to a resolution by the European community to establish plans for the establishment of new areas of research for controlling CSF in wild swine. In 1999, the European Commission published a study that pinpointed specific areas for further research that included:

1) Improvement of CSF oral vaccination strategies in wild boar

2) Influence of sero-prevalence in different age groups on the progression rates of CSF in young animals

3) Improvement of vaccine technologies

4) Investigation of the effects of different hunting strategies on CSF control and CSF dissemination in endemic areas

   Within this objective there are many questions to be addressed:

   -How does hunting influence movement of wild boar?

   -How does hunting influence population size?

   -How does hunting influence the age structure within the population?

   -How does hunting influence the prevalence of CSF?

5) Epidemiology

   What is the total population of wild boar that is necessary to maintain a CSF epidemic?

   What are the factors affecting the geographical dissemination of the epidemic?

Factors Affecting Dissemination

There are many factors that could affect the percentage of wild swine that display clinical illness. By increasing direct contact with infected individuals, high swine population density and large herd size affect severity of CSF outbreaks in wild swine (Kern et Al., 1999). Epidemics in the European populations have been attributed to feeding improperly sanitized or unsanitized garbage to domestic swine and wild boar (Horst et al., 1998). Classical swine fever epidemics have also been attributed to direct or indirect contact between wild boar and domestic swine or via contact with carcasses, waste, contaminated feed, and other contaminated environmental fomites such as soil based upon previous reports of transmission from wild boar to domestic swine (Blackwell, 2003)

Other factors that affect the severity and dissemination of CSF are the presence of highly virulent viral strains, high mortality rates, decreases in population density, frequency of infectious contacts, animal movement patterns and hunting (European Commission 1999, Laddomada, 2000, and Moennig et al., 1999). In recent years, CSF outbreaks have had a tendency to become endemic within wild boar populations of Europe due to the presence of increasing population size and low virulence viral strains that circulate in the young naive animals (Artois et al., 2002, Dulac, 1999, & Laddomada, 2000).

Biology of Wild Swine

The biology of wild swine has been the subject of many research studies. However, not all aspects of behavior, habitat, lifespan, and other factors are well understood. The basic needs of wild swine are much the same as domestic swine in that they utilize a variety of food sources and need water for cooling due to a lack of sweat glands (Land Protection Organization, 2003). The most popular habitat of wild swine is moist bottom lands, stream/river corridors, and riparian areas that have dense vegetation for optimum cover (Stevens, 1999). However, wild swine can be found in upland areas across much of the Southern U.S. searching for mast crops, such as acorns (Land Protection Organization, 2003). The important elements to support wild swine populations are availability of cover vegetation and water supply (Land Protection Organization, 2003). However, as long as food and water are available wild swine can inhabit a diversity of ecosystems.

Knowledge of wild swine food habits is incomplete. It is known that wild swine are omnivorous and their diets vary from season to season. Spring diets of Eurasian wild boar consist of grasses, forbs, roots, and tubers (Artois et al., 2002). Summer and fall diets consist primarily of soft (berries/fruits) and hard mast (acorns, hickory nuts, etc.), but include a small percentage of meat and insects from various sources (Artois et al., 2002). The animal matter component of the diets is usually very small (<5%), but in some instances may approach 25% of the total diet. The intake of meat from scavenging and cannibalism is seasonally variable with the highest consumption of meat during the winter months (Hellgren, 1997; Kroll, 1986; & Yarrow and Kroll, 1989). Additionally, a higher prevalence of cannibalistic tendencies has been observed in North American wild swine during the winter months, with swine meat composing approximately 30% of the diet for 5% of the population (Hellgren, 1997). The cannibalistic tendencies of wild swine could potentially contribute to the spread of disease within a population because viruses or other diseases can survive for extended periods in proteinaceous environments (reviewed in Edwards et al. 2000). The variation in composition of dietary intake of wild swine and Eurasian wild boar indicate that wild swine can survive by utilizing many food sources. Being a generalist in both habitat and diet preference has enabled wild swine populations to continue to thrive and spread to new areas, thus allowing them to serve as a possible disease reservoir and vector in many different geographic areas.

The ability of wild swine to act as dietary generalists also adds to their ability to reproduce at a proficient rate under a variety of environmental conditions (Hellgren, 1997). Wild sows have a 21 day estrous cycle with an average gestation period of 113 days, which provides the potential for each sow to produce two litters of offspring per year with the typical litter ranging from 4-10 piglets depending on environmental conditions, sow age, and weight (Barrett and Birmingham, 1994; Barrett, 1997; Coggin, 2001; Ford and Ford, 2003; & Land Protection Organization, 2003). The typical wild swine population has the potential to double every four months if optimal environmental conditions are present. However, true Eurasian sows usually do not breed until 18 months of age or older and average only one litter of offspring per year, thus reducing their effective reproductive rate as compared to hybrid wild swine and feral swine (Ford and Ford, 2003).

The reproductive potential within a herd of wild swine contribute to herd size. Research has been conducted on herd size in population dynamic studies. However, little definitive information is available from this research to pinpoint a normal herd size. In some cases, up to 400 pigs in a single herd have been observed in Australia (Land Protection Organization, 2003). In the U.S., wild swine herds typically consist of a sow and 1-3 generations of offspring with a total herd population of 20-40 pigs (Ahlborn, 1999, Barrett, 1978). In addition to herds consisting of sows and offspring, bachelor boars form herds at approximately 18-24 months of age until they become sexually mature at three to four years of age. Following sexual maturity they become solitary and then join herds of sows to breed (Barrett, 1978).

In addition to reproductive capabilities, herd size, habitat, and diet, the average lifespan of wild swine plays a key role in the overall biology of individual populations. On average, wild swine have a lifespan of 4-5 years under hunting pressure. The lifespan can increase to 8-12 years in areas with favorable environmental conditions such as adequate water, food supply, few predators, and no hunting pressure (Coggin, 2001). Due to the secretive nature of wild swine and Eurasian wild boar there is very little information available to establish the differences in the behavior of feral pigs, hybrid wild swine, and Eurasian wild boar. This area provides a base upon which future research endeavors could be established.

There are many different mechanisms, both natural and assisted, that allow feral swine to expand their range in the U.S. and other areas of the world. Under natural conditions without hunting pressure, wild swine have a daily range of approximately 1 kilometer (Caley, 1999) and approximate yearly ranges of 20 km for sows and 50 km for boars. There is little tendency to disperse over areas greater than 5-10,000 hectares in a lifetime (Ahlborn, 1999; Caley, 1999). Adolescent boar bands generally range over 15-20 km^2 but tend to stay within the same territory of their original herds until they reach maturity and then their range expands to 50 Km (European Commission, 1999). Under natural conditions, pigs tend to move to find food and water, and with hunting pressure in avoidance of encounters with humans. However, little research has been conducted to define exact range distributions in hunted wild swine populations. This lack of knowledge is a gap in the information necessary to determine the risk of feral swine acting as a reservoir or vector for a foreign animal disease outbreak in the U.S..

Population Distribution of Wild Swine

A national survey was conducted by the Minnesota Board of Animal Health in 1991 (Mackey, 1991). Chief wildlife officials and livestock disease control officials in all 50 states were sent questionnaires referring to feral swine and the threat they posed to domestic swine production. This survey reported that an estimated 2 million wild swine were present in 23 states. However, the methods used to estimate the populations in each state were not discussed. These states included Texas (1 million wild hogs), Florida (500,000), California (300,000), Hawaii (100,000), S. Carolina (10,000), Tennessee (4,000), N. Carolina (1,000), Kentucky (500), Oregon (400), Virginia (350), Kansas (300) and Colorado (100). States that responded that wild swine were present, but did not provide a population estimate were: Oklahoma, Arkansas, Louisiana, Missouri, Alabama, Georgia, West Virginia, Ohio, Illinois, Vermont, and New Hampshire. The wild swine population within the U.S. as a whole has not been estimated since this survey was conducted. However, the current wild swine population is expected to be significantly higher. For instance, the wild swine population in Texas is currently estimated at approximately 4 million head (Rick Taylor, Texas Wildlife and Parks, Wildlife Biology-Uvalde station, Personal communication, 2003).

The Southeastern Cooperative Wildlife Disease Study conducted a wild swine distribution survey for selected areas in the U.S in 1988. This survey was not based on total numbers of swine per state, but on the population density and spatial demographics of the wild swine population in the U.S. Based on the results of this study, wild swine are located in higher numbers in the southeastern U.S. compared to other regions of the U.S., in particular within Texas, Louisiana and Florida. California, Hawaii, Missouri, Tennessee and South Carolina also have substantial populations. Information from the Southeastern Cooperative Wildlife Disease Study was combined for this report with information collected from journal articles, web pages, and personal communications from the Kansas State University Fish and Wildlife Division, Missouri Department of Conservation, California Department of Fish and Game, Texas Parks and Wildlife, and the Samuel Roberts Noble Foundation to estimate the current population demographics of wild swine within the U.S. (fig. 4.17) (Gipson and Lee, 2003; Tom Hutton, Missouri Department of Conservation, Personal Communication, 2003; California Fish and Game, 2002; Rick Taylor, Texas Wildlife and Parks Wildlife Biology-Uvalde station, Personal communication, 2003; & Stevens, 1999).

The methodology used to complete the population estimations employed in previous wild swine studies was a combination of paper surveys, phone interviews, and personal communications with state and federal officials that included both the wildlife and livestock sectors (fig. 4.18). In California, the population estimate was based on the number of pigs harvested by hunters throughout the state (Doug Updike, California Fish and Game, Personal Communication, 2003). In Texas, population estimates were based on swine population surveys conducted in areas with high feral swine population densities along with the number of wild pigs passing through slaughter facilities (Rick Taylor, Texas Wildlife and Parks Wildlife Biology-Uvalde station, Personal communication, 2003).

The methods used in these surveys were subjective and subject to inconsistencies between individuals surveyed. First, in the interviews and surveys conducted, the individuals responding may not have based their population estimate on actual counts of wild swine populations in the field. Second, the information that was based on actual counts may have overemphasized areas with high wild swine densities (i.e. heavy hunting pressure areas and areas where pigs could be readily observed in the open). Third, due to the secretive nature of the wild pig and the terrain they inhabit, true counts of individual populations are very difficult to obtain (Rick Taylor, Texas Wildlife and Parks Wildlife Biology-Uvalde station, Personal communication, 2003). In many states (e. g. Missouri and Kansas) it is known that wild pig populations exist, but the funding and manpower has not been available to conduct extensive research on the demographics of wild swine populations (Tom Hutton, Missouri Department of Conservation, Personal Communication, 2003). In many instances, including the Mackey study conducted by the Minnesota Board of Animal Health in 1991, surveys have relied on secondary sources that indicated that there were wild pig populations within the state.

Therefore, the available wild pig population estimations within the U.S. are out of date and likely to be an unreliable estimate of current population numbers to accurately determine the current population of wild swine in the U.S., to determine the areas of overlap with domestic swine populations, and to determine the potential for disease transmission from wild to domestic swine, an in-depth nationwide survey based on field counts of wild pig populations is needed.

Of particular interest when determining the risk of wild swine introducing CSF into the domestic swine herd, or being involved in disease dissemination, is the potential for interaction between wild and domestic populations. Figure 4.19 combines information on the population distributions of both domestic and wild swine. Although the highest concentration of domestic swine is in the Midwest and the highest concentration of wild swine is in the south, there are areas where these populations overlap. This includes

California, Texas, Missouri, and North Carolina. Although these populations overlap, this illustration does not address the issue of whether there is sufficient contact between wild and domestic swine for disease transmission to occur. In the survey of domestic swine producers conducted for this project (Appendix 3.1), we asked producers whether they had seen wild swine on the premise within the last year. Twenty-nine out of 969 (3%) had observed wild swine near their operations in the past year. However, more research is needed to determine whether sufficient contact between these populations occurs and the geographic areas of highest risk.

OTHER RESERVOIRS OF CSF

Two additional reservoirs exist that could potentially provide a pathway for CSF to enter the U.S., disseminate the virus within the U.S., and hinder control efforts if an outbreak occurred in wild or domestic swine: javelina and pet pigs.

Javelinas

Javelinas currently have sizeable populations in Texas, New Mexico, and Arizona (fig. 4.20) (http://www.scwds.org) with more migrating northward from Central and South America (Ryer, 2003). As the northern range of javelina expands in the southwestern U.S., there are many factors that prevent them from migrating throughout areas with cold winter climates (Ray, 2003). The javelina's migration northward is hindered by the lack of suitable habitat and a lack of under fur such that they do not survive in cold winter climates (Ellisor, 1974 and Ray, 2003). Current estimates of populations are 250,000 in Texas, 60,000 in Arizona, and 5-8,000 in southwest New Mexico (Arizona Game and Fish, 2003).

The javelina is mildly susceptible to infection with CSF under experimental conditions, but they do not exhibit the acute disease symptoms and high mortality of swine (Dardiri et al., 1969). Dardiri et al. (1969) reported that five of six javelina inoculated with Ames virulent strain CSFV had temperatures ranging from 101ºF to 104ºF by 3-4 days post inoculation. During the febrile period rapid respiration, slow movement, and lacrimation were observed with temperatures declining after 8-10 dpi. Body condition, strength, and aggressiveness soon returned to normal. However, this study did not report if, or at what level, infected individuals shed the virus so their potential role in transmission is unknown.

The Office of International Epizootics reported a case of CSF in a white-lipped peccary (*Tayassu pecari),* a species closely related to the collared peccary, under field conditions in Peru (OIE working group on wildlife Diseases, 2001). However, knowledge of the ability of CSF to transmit via inter or intra species means is lacking. In order to establish the full potential of peccary species to act as a pathway for CSF to enter and disseminate within the U.S., transmission rates of CSF from peccary to peccary and from peccary to swine need to be established.

Pet Pigs

Another potential reservoir of CSFV in the U.S. is pet pigs, such as the Vietnamese pot belly pig (PBP). Modern PBP's are the result of cross-breeding several types of indigenous swine in southeast Asia. They are characterized by pointed ears, sway backs, straight tails, small size and an easy going disposition (Magidson, 1993). The typical PBP has a lifespan of 20-25 years, almost three times that of our domestic or wild swine (Scott, 2003). The first pot bellied pigs were imported to the U.S. in 1985 from Canada. They were imported for breeding stock at the San Diego, California zoo (Magidson, 1993). As the miniature pig became more popular at the zoo, the desire to own the pigs as pets increased, leading to the PBP becoming a fashionable pet in the early 1990's. However, as more people bred the pigs the prices fell along with popularity, leading to abandonment and over population in adoption facilities (Wanke, 2003). Pet pigs were also reported to have entered the auction market system as the popularity of pot-bellied pigs as pets waned in the mid 1990's.

Vietnamese pot-bellied pigs may serve as potential pathway for a foreign animal disease to enter the U.S. and could potentially be involved in the epidemiology of endemic diseases. The lack of resources to enforce regulation (such as having a health certificate within 30 days of interstate transport, being brucellosis free, and being free of foreign animal disease) allows people to transport their pet pigs in vehicles without veterinary inspection. To establish the risk of PBPs serving as an important pathway for the introduction of CSF, an estimation of the population within the U.S. would need to be established. Therefore, more research must be conducted to fully determine the risk of pet pigs acting as a pathway for CSF to enter or disseminate throughout the country.

Following the CSF outbreak in the United Kingdom in year 2000 the Department of the Environment, Food and Rural Affairs proposed that every single premise with pigs should be registered. One of the reasons for this was that in the East Anglia region lack of knowledge about pet pigs hampered the imposition of controls. Under EU regulations in force at that time sites with less than three pigs were not required to register (NFU, 2002). Registration of small pig herds in the United States does not presently occur if pigs do not enter the market system, particularly since pseudorabies testing is now not widely required, and in any case compliance with regulations for animal identification and health certificates for animal movement for pet pigs was always questionable.

Backyard Pigs

It is not known how many small hog producers there are in the U.S. that fall outside of the reporting of commercial hog operations. In a survey of licensed waste feeders in 1993, 32 (1.5%) responded that they were neither farrow-to-finish, grower-finisher, feeder pig nor breeding stock producers. More than half of these 32 operations described their swine as for home use or hobby production (USDA, 1993). Small scale producers who raise pigs for home use or hobby production are considered to be more likely to feed household plate waste without a permit. They may represent a higher risk of disease introduction since smuggled animal products contaminated with an animal disease and brought into the country by international travelers would most likely be discarded in household waste (USDA, 1993).

USDA:APHIS has recognized the potential threat from waste feeding and backyard swine and feral hunt clubs by issuing a Veterinary Services Notice to provide guidelines for developing a CSF surveillance program in the most at-risk areas (USDA:APHIS, 1999). These were identified as California, Florida, Georgia, New Jersey, New York, North Carolina, Puerto Rico, Texas, and areas around military bases in all States. The Area Veterinarians in Charge (AVIC's) were instructed to collect data on the number of premises, the number of swine on each premises and the location plotted using GPS coordinates in a GIS database. This surveillance program is currently being developed with a focus on high risk populations in high risk states (Classical Swine Fever (CSF) Surveillance Fiscal Year (FY) 2004 and Beyond – USDA internal document, 2004; and Dr. Don Rush, personal communication).

CRITICAL RESEARCH NEEDS

1. Need more information on spatial separation of premises (potential for "neighborhood spread").

2. Need better understanding of contacts between farms.

3. Need information on movement through markets and dealers of cull breeders.

4. Need information on backyard pigs, location, relationship to commercial hog units, management practices, fate of pigs.

5. Need research on aerosol spread of CSF.

6. Need research on role of rodents and wildlife other than feral pigs in disease transmission.

7. Need more research on the contacts between wild swine and domestic pig populations.

8. Need to have a better understanding of biosecurity practices in the trucking system serving farms.

9. Need research on improved animal identification, especially improvement in retention of back tags or an alternative. Also need to have a better understanding of the way backtags and tattoos are used in practice. Is the 6 character alpha numeric national identification number assigned uniquely to an epidemiologically distinct premise?

10. Need to find a way to improve time from introduction to first diagnosis.

11. Need to better understand practices of farm employees on commercial swine units (lunches, contact with other swine).

12. What happens to pet pigs – to what extent do they enter the market system.

13. Need to better understand swine movements through dealers.

14. Need description of animal movement within the Open Show circuit.

15. Need general exploration of biosecurity risks of county and state fairs – mapping of animal movements?

16. Need improved tracking procedures for pigs exhibited at fairs and shows.

APPENDIX 4.1

Definitions: Animal and Premise ID numbers, Swine Production System

Abstracted from the Code of Federal Regulations Title 9, Vol. 1, Chapter 1, Part 71.1
http://www.aphis.usda.gov/vs/nahps/animal_id/cfr71/9cfr71-1.txt

Official Eartag

An identification eartag approved by APHIS as being tamper-resistant and providing unique identification for each animal. An official eartag may conform to the alpha-numeric National Uniform

Eartagging System, or it may bear a valid premises identification number that is used in conjunction with the producer's livestock production numbering system to provide a unique identification number.

Official Swine Tattoo

A tattoo, conforming to the six-character alpha-numeric National Tattoo System, that provides a unique identification for each herd or lot of swine.

Premises Identification Number

A unique number assigned by the State animal health official to a livestock production unit that is, in the judgment of the State animal health official or area veterinarian in charge, epidemiologically distinct from other livestock production units. A premises identification number shall consist of the State's two-letter postal abbreviation followed by the premises' assigned number. A premises identification number may be used in conjunction with a producer's own livestock production numbering system to provide a unique identification number for an animal.

Swine Production Health Plan

A written agreement developed for a swine production system designed to maintain the health of the swine and detect signs of communicable disease. The plan must identify all premises that are part of the swine production system and that receive or send swine in interstate commerce and must provide for regular inspections of all identified premises and swine on the premises, at intervals no greater than 30 days, by the swine production system accredited veterinarian(s). The plan must also describe the recordkeeping system of the swine production system. The plan will not be valid unless it is signed by an official of each swine production system identified in the plan, the swine production system accredited veterinarian(s), an APHIS representative, and the State animal health official from each State in which the swine production system has premises. In the plan, the swine production system must acknowledge that it has been informed of and has notified the managers of all its premises listed in the plan that any failure of the participants in the swine production system to abide by the provisions of the plan and the applicable provisions of this part and part 85 of this chapter constitutes a basis for the cancellation of the swine production health plan, as well as other administrative or criminal sanctions, as appropriate.

Swine Production System

A swine production enterprise that consists of multiple sites of production; i.e., sow herds, nursery herds, and growing or finishing herds, but not including slaughter plants or livestock markets, that are connected by ownership or contractual relationships, between which swine move while remaining under the control of a single owner or a group of contractually connected owners.

Interstate Swine Movement Report

A paper or electronic document signed by a producer moving swine giving notice that a group of animals is being moved across State lines in a swine production system. This document must contain the name of the swine production system; the name, location, and premises identification number of the premises from which the swine are to be moved; the name, location, and premises identification number of the premises to which the swine are to be moved; the date of movement; and the number, age, and type of swine to be moved. This document must also contain a description of any individual or group identification associated with the swine, the name of the swine production system accredited veterinarian(s), the health status of the herd from which the swine are to be moved, including any disease of regulatory concern to APHIS or to the States involved, and an accurate statement that swine on the premises from which the swine are to be moved have been inspected by the swine production system accredited veterinarian(s) within 30 days prior to the interstate movement and consistent with the dates specified by the premises' swine production health plan and found free from signs of communicable disease.

APPENDIX 4.2

Theoretical Basis For A Distributed, Decentralized, Animal Tracking System

This appendix describes a a massively distributed, secure, decentralized animal tracking system. The system includes an expert decision making module, tailored for different users, and incorporates backward tracking and forward projection of in contact animals and premises, based on epidemiological and transportation models.

Web-based Software for Veterinarians, Sale Barns, Producers, and Transport Companies

A major component of the proposed CSF tracking system allows veterinarians, sale barns, producers, and transport companies to obtain and enter information on suspect swine syndromes. This component will follow the design principles of Sandia National Laboratories and Kansas State University's Rapid Syndrome Validation Program for Animals (for an overview of that system, see http://philostrate.unm.edu/cgi-bin/rsvpa/rsvp_a.php http://clh.vet.k-state.edu/index.jsp):

- Web-based design supports ease of maintenance;
- Openly accessible and password-accessible sections protect data quality;
- Semi-anonymous data entry allows disease tracking while protecting private or proprietary information;
- Useful and timely information to users provides an incentive to use the system; and
- Web-page design allows users to enter and receive information with minimal effort.

Each of the user groups has different needs, and for this reason the web-based portion of the CSF tracking system will be subdivided.

Producers: Assume that a swine producer has a symptomatic pig. The producer opens his web browser, goes to a web site with secure http, and logs in. Login is essential because it must be possible to authenticate the data to a genuine member of the swine industry. Depending on acceptance by producers, the system may already contain information on what pigs are present at the operation. The producer enters the symptoms and other information, e.g., how long symptoms have been present, how many pigs are symptomatic, whether the pigs are new to the operation, etc.

Swine facilities, particularly larger operations, will commonly have one or more pigs displaying clinical signs of disease and generally manage disease at a pen, rather than individual pig, level. Therefore, the development stage of this system would need to consider the appropriate level of concern (pig versus pen) and the number of sick animals which constitutes a reportable event. This will vary by disease, and therefore by disease symptom. For illustrative purposes, we will refer to a symptomatic pig, understanding that this may represent a "group" event.

At this point the expert system analyzes three kinds of information: data in the database on disease symptomatology, data entered by the user, and recent data collected from other users. The expert system provides immediate feedback to the producer that includes a list of differential diagnoses. If any of the possible diseases are serious, the expert system could take the following steps:

- Ask the producer additional questions designed to distinguish among the possible diseases;
- Recommend the producer consult with a veterinarian and schedule an appointment with a veterinarian who has a calendar on the system, confirming that the time is acceptable to the producer; and
- Recommend what the producer should do in the meantime, e.g., quarantine, and how critical is it to perform these activities.

If the pig has symptoms of a potentially serious disease, such as CSF, the expert system will stress the importance of contacting a veterinarian.

The producer has several incentives for using the system—immediate feedback on the likelihood that his stock has a potentially serious disease, recommendations for on-farm disease management, and convenient appointment scheduling. Producers who use the system become sentinels for the expert disease-tracking system, providing data that can in turn be used to provide useful guidance to private and state veterinarians.

Veterinarians*:* The veterinarian may be called in to examine a symptomatic pig by the tracking system or by the producer. If the tracking system has set up the appointment, it will also offer a description of the symptoms and a list of differential diagnoses consistent with the symptoms entered by the producer and recent data collected from other producers and veterinarians. The specific veterinarian contacted can be determined either by the producer or by the expert system using protocols set up in advance by individual veterinarians. When the veterinarian examines the symptomatic pig, he must make a tentative diagnosis (or collect samples for laboratory examination), estimate when the pig was exposed and how long the pig has been contagious, and suggest the source of the disease (e.g., wild pigs, on-farm infection, introduced with new pigs).

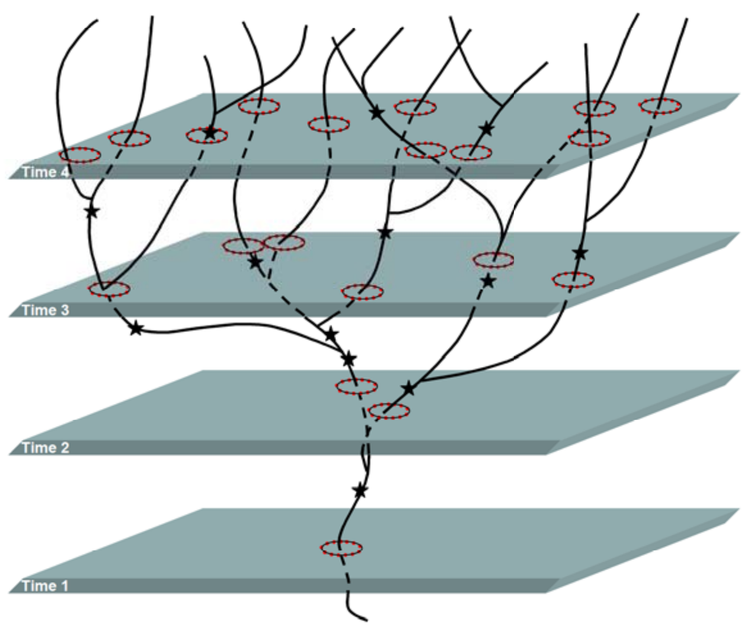

Figure 1 Schematic of hog transportation as a function of time. Red circles are animals contacted at one instance in time.

At that point the veterinarian will enter new information about the pig that supplements information previously entered by the producer. The veterinarian will have password login privileges not available to the producer. The veterinarian will be able to list the tests and examinations performed, the results, and the diagnosis. The veterinarian will be able to do a preliminary epidemiological study with the producer and the tracking system. If the pig has a potentially serious disease like CSF and was not born on this farm, the system will track the pig, let the veterinarian assess the information, and then if he agrees, notify sale barns, transport companies, the state veterinarian, etc. If he does not agree to these notifications, he should be able to justify his objections based on possible time, place, and vectors of disease transmission; enter his own assessment; and get a new analysis from the system.

The expert system should prioritize for the veterinarian the most to least likely diagnosis and the most to least likely region of an outbreak. For serious contagious diseases, this information can be delivered to other veterinarians in the region automatically.

Veterinarians benefit from using the system by knowing what diseases they are most likely to see, the likely area of impact, and what categories of pigs are most likely to be infected. Tests and treatment can be much more efficient. The state veterinarian can monitor disease progression and potentially detect and stop an epidemic in the very early stages. The tracking system can provide information on where the symptomatic pigs have been and what other pigs may have been in contact with them. This allows targeted testing, beginning with the pigs most likely to have been exposed, rather than random testing. Depending on the nature of the disease, it allows treatment or slaughter of pigs in selected areas, with testing in a ring around that. In areas where the expert system offers good confidence that no pigs can be infected because of the tracking history, normal production, sale, and transport can be allowed.

***Sale barn**:* Swine movement would be tracked in part by recording data on lots that pass through sale barns. The sale barn clerk would enter the following data for each lot of swine received:

- Lot number;
- Total number of animals in lot;
- Where it came from (best estimate);
- When it arrived;
- What areas of the sale barn it occupied (e.g., pens, auction blocks);

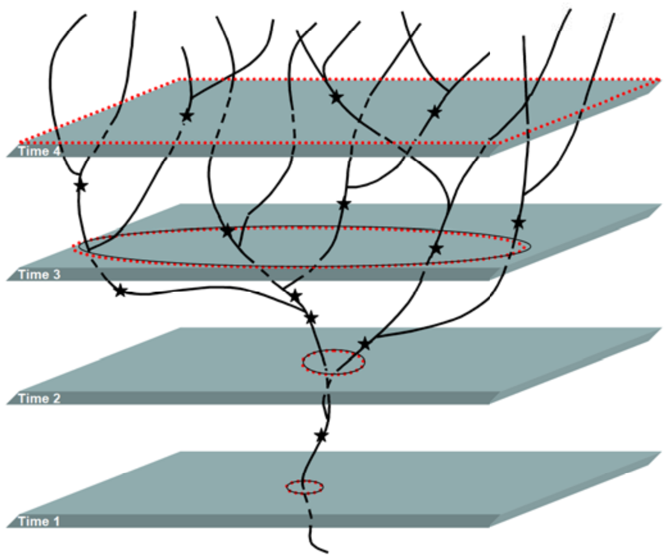

Figure 2 Determination of location and associations at previous times in a hog's life.

Traditional quarantine would require mass treatments. The red circles represent effected animals.

- When it left; and
- Where it went (best estimate).

For lots that are subdivided at sale, the information must be entered for each portion of the lot.

If swine are likely to be sick because of their prior association with sick pigs, the expert system notifies the sale barn immediately. If pigs with a serious contagious disease are tracked to the barn, the expert system offers recommendations about what to do and how critical it is to do this, e.g., shut down for some specified period of time, disinfect pens or auction blocks, call a veterinarian, notify the state veterinarian, etc.

The primary incentive for sale barns to use the system is to enhance continuity of operations. Data from the sale barns will make it possible to track each lot of swine forward and backward through time, as discussed below. This tracking, which is the core function of the expert system, enables the detection of a disease outbreak in the very early stages, while it is still possible to control the disease with minimal quarantine areas, slaughter of diseased and exposed stock, and disruption of commerce.

***Transport companies**:* Currently transport regulations do not allow separate lots of swine to be carried on the same vehicle. We suspect that it probably happens and does not get reported. Using the expert tracking system, it would be possible to safely transport separate lots together by requiring the trucker to record what animals are on the truck when. Any animals exposed to others that subsequently became sick could be tracked rapidly to their current location for observation or testing. The routing clerk would enter the following information into the system for each lot of animals:

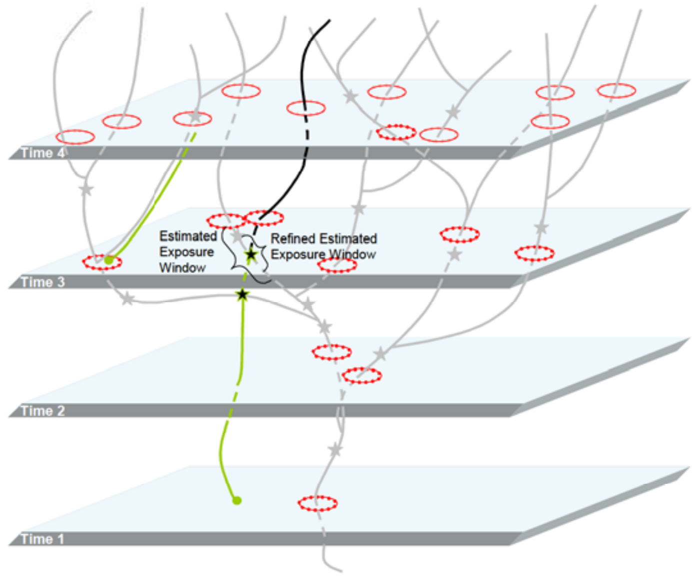

Figure 3 Quarantine area is smaller based on trace back understanding

- When and where it was loaded;
- Route and truck stops;
- When and where it was off-loaded; and
- When the truck was disinfected.

For drivers and trucks on a regular schedule, the expert system will present the regular route for confirmation or emendation.

Transport companies gain in efficiency by transporting fewer partial loads.

PC-Based Software for Decisionmakers and Veterinarians

The web-based tracking system described above will provide information on where livestock are and have been; what pigs have which symptoms or diseases; and where symptomatic or diseased pigs have been located through time. Using this information, the software predicts what asymptomatic animals have been exposed to a pathogen and makes recommendations that are likely to stop the spread of the pathogen. It does this using two models, an epidemiological modal and a transportation model. When an animal is diagnosed with a disease, the veterinarian estimates what stage of the disease the animal is in, and (either directly or through inference using a model of the disease's progression) when the animal contracted the disease. The system uses this estimate as the starting point for a model-based search.

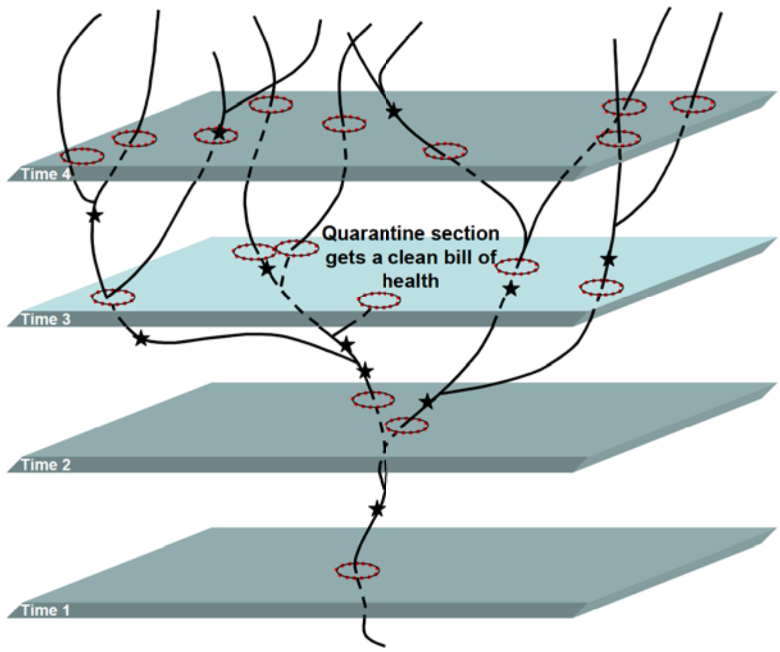

Figure 4 Identification of exposure windows based on new algorithms.

Using the veterinarian's estimates of when the primary animal contracted the disease and inferences on when it may have been contagious, the expert system uses the epidemiological model and the transportation records to track all secondary animals that were exposed to the primary animal during the infectious period. The expert system predicts when the secondary animals would have become contagious and started to exhibiting symptoms, etc. Sick animals can also be traced back to the animals that may have infected them to identify potential sources of a disease. Subsequently an estimate can be made of what other animals may have been infected by all the animals along this pathway, and this estimate can be propagated forward again to the current time. In this way feasible sources and the possible current status of a disease can be rapidly assessed.

The estimate predicts what animals should be symptomatic or asymptomatic at what times, and it assesses what pathways are isolated by choke-point vectors. This allows decisionmakers to contact producers and veterinarians so that they can rapidly confirm or disconfirm paths the disease may have taken. Producers, veterinarians, and laboratories can be prepared to diagnose animals by looking for symptoms or by doing laboratory tests.

If particular diseases always require lab tests or even autopsies for diagnosis, decisionmakers can justify stricter quarantines and suitable delays on transportation of animals into or out of the potentially affected regions. A cost model in the software could estimate the number of veterinarians needed to perform the distributed diagnosis in a timely fashion, the financial impact of a disease if left unchecked vs. the cost of delays in production and transportation, etc., and roll this information up to the decision-maker's view as well, along with estimates of how delays or national aid might affect the final numbers.

All the temporal inferences of where and how a disease is propagated must be modeled with error margins and likelihoods. When a constraint (such as time of transportation, exposure to other animals or potential vectors, or laboratory results) appears that improves confidence and reduces the error of an exposure-time estimate, inferences should be propagated forward and backward from the constraint to control spiraling uncertainty . Search rules can be responsive to features of the disease, and the system should be able to model a variety of diseases, nominally without modifying the search algorithm. For example, for more or less virulent diseases the estimated likelihood that branches of the search tree will actually be affected goes up or down; this may affect what conservative and marginal quarantine zones proposed or lead to more aggressive diagnosis efforts on more remote branches in an attempt to catch up with the disease. For diseases where surviving animals become permanent carriers, exposures propagate forward to the present for all animals; for diseases that are contagious for the duration of the illness, the modeled incubation time is zero, etc.

***Decision-makers**:* Decision-makers can get a conservative estimate of where disease may currently be, so they can decide what to quarantine, establish primary and secondary quarantine zones. For example, transport in or out of a state may stop, but within that, nothing may go in or out of County Z, to accommodate uncertainty to protect the rest of the state.

Preliminary Description of the Expert Tracking System

The modeling software that predicts what pigs are currently infected with a disease must to be probabilistic. In the ideal disease model, a description of the current state of a pig and a history of transportation of the population of pigs allows the software to estimate the likelihood that all potentially exposed pigs actually have been exposed to the disease and the likelihood that they have contracted the disease. Having a generative model should also allow us to ask questions like "if disease x, with these features, had been introduced here, where would it be now?", not just the (more typical, in practice, given the need to isolate diseases) question of "if xyz disease is at certain points now, where did it come from and where else could it be?" This information could potentially be used by policy makers to predict the effects of changes in transportation and market rules, if we could generate hypothetical transportation data following different rules. However, there are challenges related to the use of models for predictive purposes in an outbreak (reviewed by Taylor, 2003).

Assume that a model of a disease is available, in at least the following terms:

- From the time of infection, the probability density function (pdf) of a sick pig being contagious over time (the instantaneous probability of an exposed pig catching the disease from this host, taking into account an exposed pig's exposure time and when in that period it may have caught the disease).
- From the time of infection, the pdf of a sick pig being symptomatic (per symptom, including death as a symptom) over time.
- The conditional probability of the pig being contagious given symptoms, or given the pig is asymptomatic (presumably higher and lower than the default curve, respectively).

The software will estimate the time the disease was contracted (or a range of time). All pigs that have come in contact with the symptomatic pig since that time can then be

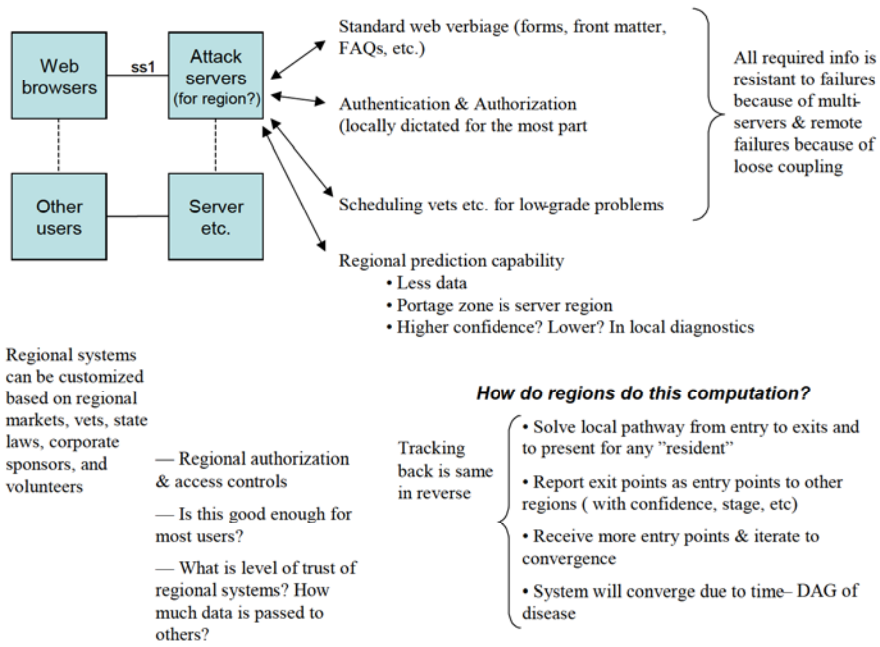

Figure 5 Animal tracking system.

Users interact with the system through web browsers. The bulk of the system is regional servers that have client service functions (web matter, authentication and authorization, and personal schedules) and disease modeling functions (for local prediction and tracking, which can be coordinated between many regions to perform wide-area prediction and tracking). Regional systems are sufficient, but wide-area systems with authority to request more information are useful to establish broader situation awareness. Regional systems may be several computers, and may back up their local data to many neighboring regional systems. Recovery would mean installing a replacement, giving it the original system's cryptographic identity, and letting it automatically recover its information.

assigned a pdf describing their odds of passing on the disease at any particular time, taking into account the period of contact and the uncertainty in the estimate. Then every pig that has come in contact with those next-generation pigs can be assigned a pdf in a similar manner, and so on until all points of contact have been established to the current time and all pigs can be assigned a probability of being sick, infectious, etc.

Based on an estimate of when the original pig got sick, the pigs associated with it at that time can be tracked both forwards and backwards as follows. Some of the pigs that the original pig was in contact with at that time were carrying the disease and have a pdf that describes the likelihood that they became sick at various times. If we cannot determine which pig was the source, we have to treat all lines as suspect. On the other hand, other pigs that were in contact with the original pig when it got sick were in contact with the source at the same time, and they must be traced forwards again to identify other lines forward that may have been infected from the same source. Tracing pigs backwards generates a tree just like tracing pigs forwards.

Trees must be pruned at every opportunity to prevent the data set from exploding. Any time a pig or a lot of pigs is given a clean bill of health, that information should be entered into the databases. Such a sample point, when it occurs on a branch tracing forward or backward will at the very least cut the tree at that point, preventing the branch from growing (unless the testing procedure is unreliable, but even then it should attenuate the pdfs of the pigs sampled). Zeroed-out pdfs or attenuated pdfs allow the pigs in contact with the sampled pigs *prior* to the test to have their pdfs recalculated or eliminated – if the pigs are not sick, in many cases they could never have been sick or it would be detectable, and so could not have given it to pigs prior to the test. Given that a group of pigs is not sick, the pdf of the hypothetical source of the disease along the clean branch can be recomputed as a conditional probability given that the supposed source did not actually pass the disease on. For particularly virulent diseases, this should allow the likelihood of related branches to be attenuated a great deal based on clean samples, because one sick pig in fact should lead to second- and third-generation cases with very high probability. The lack of those cases would indicate that the pig was not sick (and in particular, given the tracking backwards and forwards, this is exactly what should allow the elimination of potential sources of the disease – certain sources of virulent diseases will have highly probable future impact zones, that can be distinguished from one another).

Another means of pruning the tree is through analysis of exposure opportunities. If we see pigs that could have (based on more and more spread-out pdfs) been infected at any of a wide range of times, but have only come in contact with potential sources at certain times, their pdfs can be recomputed based on the actual opportunities of infection and those changes rolled forwards.

There are a few ways that the probabilities involved in the epidemiological model could be managed. The likelihood that a pig in various stages of health might come down with a disease when exposed for a certain length of time to a positive pig could be represented as a closed-form probability density function, probability tables, or clouds of points making up an implicit distribution. In addition to combining and adjusting distributions over time, it would be productive to not only provide a model to the system, but to use the model and the evidence to come up with better assessments of the parameters of the observed system. This is essentially a machine-learning problem: the system refines its understanding of the significance of contributing factors to disease spread (is physical proximity necessary? Is a clean stall mostly safe? What's the mean and variance?). In particular it uses the evidence of diagnoses and outbreaks to inform the epidemiologists of the specifics of the diseases it observes. Whether epidemiologists would use this system to improve their estimates is an issue. Possibly the system should be capable of observing when a disease's rates of transmission (based on feedback from advised sample pigs) is more than one standard deviation away from the mean and of hypothesizing a new virulent strain of the disease, predicting where that would mean it had gotten to, and working with the

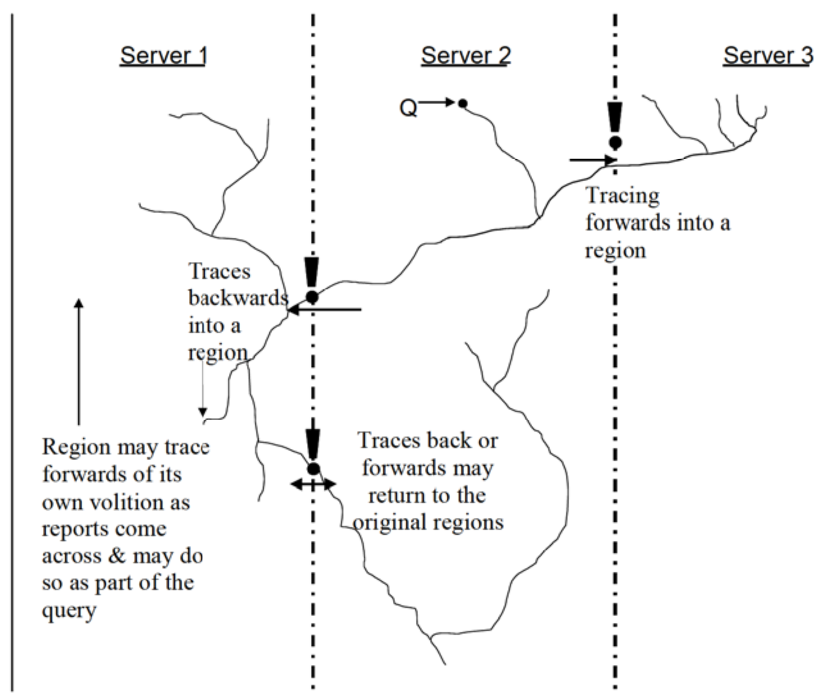

Figure 6 Scenario of query and its effect on the tracking of animals.

When a query (Q) is submitted to Server 2 asking about the most likely source and current state of a disease, the disease is traced back and forth through associations until the regional boundaries (in an information sense) are reached. Information about boundary elements is passed to the servers for those regions in the form of a query and can be a source, status, or dual query. It is possible that the regional point of contact is a place where pigs from one region are exposed to pigs from another region and are then transported elsewhere within either region. Secondary and tertiary regional servers tracing backwards or forwards may reach their own information limits at some point and pass their own queries to others or even to the original system.

scientists to narrow down the source of the more virulent strain separately from other more average, controllable strains.

The system design could be a simple web client at the user end. A regional server provides https service and does authentication and permissions checking. This server is responsible for providing web forms, front matter, FAQs, medical data sheets, links to medical journals, etc., and for referring more important matters to the actual disease tracking computers. These computers are assigned locales within the region if need be, or a single computer might manage an entire region, depending on the quantity of data. The tracking computers are informed of and record all entry, exit, and movement within their area in a timely fashion. They track diagnoses and the current state of diseases as far as is known. Regional systems are sufficient, but wide-area systems with authority to request more information than is typically shared are useful to establish broader situation awareness. Regional systems may be composed of several computers and may back up their local data across many neighboring regional systems. Recovery would require only installing a replacement, giving it the original system's cryptographic identity, and letting it automatically recover its information.

When a request to track down the source or the current spread of a disease is made, the initial data point for such a query may be at an entry or exit point or a point within a region . Regional knowledge is used to trace the disease into the past, to the present, into the future (making predictions given known schedules, with lower confidence), back to any possible points of entry, or forward to exit points. When the boundaries of the region are reached, the boundary point information and possibly a query is sent to the bordering regions, stimulating those regions to perform similar computations. Queries may potentially contain information about the original poser of a question so that the answers may be directed to the right people.

At the next level up (the state level, perhaps, or regions with many locale trackers) the information of interest may be more along the lines of current status. Each county potentially may have a server, or in counties with sparse pig populations perhaps several counties would be run by the same server. Regions and locales afflicted with a disease in the population could be requested to provide current status information, and the severity or presence or even details could be reported and displayed as a summary with little difficulty. As regions report in or update their status, the rolled-up information could be updated. For example, at the state level a disease-control official interested in what the current status of all counties could be presented with a colored county map. Counties with no traceable pig population are white, healthy counties are green, and sick counties fade to red as the problem becomes more severe in terms of the percentage of pigs sick optionally weighted by the size of the population.

Several display options could be available for conceptualizing the same information. County colors could become less saturated over time if they had not reported new information, to simultaneously give some idea of the timeliness of the available data. Changes over time could also be reported either as a different view or on the same view to give an idea of where outbreaks were being brought under control. A graph of exchanges between counties (paralleling inter-server communication) could also be presented, to give a picture of the spread of the disease. This could be presented as a single directed graph, or as a time-series of images of traffic. All county information could be consolidated for the state-level computers. A similar consolidation could be done at the federal level, if regional servers knew that certain regional borders were also state borders. The transmission of diseases across those boundaries could be consolidated at the state level as well, and the state-level computers would have comparable information to feed up to the federal level. At the federal level, states of particular interest could be probed by asking the state servers for more detailed information, and states could do the same for particular regions

Data entry and data quality issues

This system, as described, is dependent on complete and timely input of disease symptom information by swine producers. In order to ensure compliance and data quality, the system would need to be value-added to the producer. This has been a constraint with many previous livestock disease-recording systems. Typically, disease information within multi-farm management systems is considered confidential. This is an area which needs to be addressed to ensure buy-in by the integrated swine producers.

Due to the non-specific nature of the symptoms of CSF, another concern would be the considerable potential for false-positive alarms. The system must balance the need for timely identification of an actual CSF case with the potential for disease symptoms to be mimicked by endemic diseases. Regular false-positive alarms would be a serious disincentive to producer compliance.

Software Development Issues

As envisioned, the expert system described above would be a powerful tool for the U.S. pork industry and the veterinary community. However, it will contain substantial amounts of proprietary data. System security is absolutely critical to success. Furthermore, the ability of the system to recover in the event of accidental failures or malicious attacks must be built in.

It is important to consider the feasibility of implementing the system as a massively distributed, decentralized, and, most important, secure information system. While such a system could be built, existing systems of this sort are rife with security vulnerabilities, must be periodically taken offline, or require large maintenance efforts. Many examples of such systems are owned, maintained, and arbitrated by individual corporations. The system we are proposing must be secure, would be owned and managed by many organizations, should rarely require individual systems to be taken offline, and should never require the entire distributed system to be taken offline. In addition, maintenance of the system should be trivial; the bulk of the installation should be automated, and upgrades to the system should not require local administrative efforts, except possibly to sanction installations.

Security: Given the scale and visibility of the system being proposed, network attacks are inevitable. The regional systems should be set up as small clusters of redundant dedicated servers running only the application of interest. The cluster should sit on a private local area network behind a state-of-the-art firewall. The system can use this same medium to pass inter-system queries and data for other system functions. Insider threats cannot be ignored. Malicious or misbehaving insiders may be system administrators, users, or compromised or malfunctioning computers, and may cause failures opportunistically in a crisis. Disabled or disconnected regional systems must have their data recovered and managed by other systems, and users of the original system must be able to automatically fall back to the replacement. Systems that stop reporting or misreport source and status information must be identified and superseded, and users that begin introducing false information into the system must be reported and their information excised or independently verified.

Making the entire system exhibit these security features requires a mix of redundancy and pre-emptive analysis. Success requires an in-depth analysis of the possible threats and acceptable and unacceptable failure modes, and a design that provides for the various contingencies. Given the need for security, extensive logging, oversight, and policy support must be included in the design. Access to this information by the appropriate individuals needs to be independent but only slightly separated from the process of acting on this information.

Utility: Installing and maintaining the expert system described here could be expensive. To prevent this effort from being wasted, the system must be designed and developed with the active participation of potential users and administrators from all parts of the pork industry, the veterinary community, and regulators.

Maintainability and Reliability: An entire server, OS and all, should be installable onto a new computer from a CD or available as an uninitialized-server hard drive image to simplify installation and recovery. New servers should be easily added to a regional system by an administrator. Adding the installation to the network, registering it with a Certifying Authority, and using a web interface to inform the regional system of the addition should be simple. Multiparty threshold cryptography provides some security advantages against compromised or malfunctioning servers. When a server is added to a regional system it should automatically be initialized with the region database and configuration. Loss of servers in a regional system should be reported to the administrators. Replacements should be given a new cryptographic identity, added to the regional system, and sanctioned by an administrator to take over the responsibilities of the previous machine. The system should be able to recover the data from the distributed representation in case of failure.

Creation of a new regional system should amount to the installation of a set of servers, plus steps to form a regional system out of the set of servers, configure the system, and register it with other regions. Upgrades should be published on the web electronically by the distributors with the appropriate cryptographic signatures after extensive testing, or distributed on CDs for administrators to install manually.

The resulting system will have many attributes ascribed to “agent” software systems (autonomy, persistence, reasoning, collaboration, etc.). During requirements analysis and design, it should be considered whether an agent metaphor is appropriate and whether existing agent frameworks can provide the necessary infrastructure.

Recommendations

Based on the description of the disease spread above, the models used and an analysis of the outbreak in the UK, a number of recommendations for further work can be made.

First and foremost is the need for a national system. Since the pork industry is by and large an interstate process, there is a need to communicate between the states' veterinarians, the farms and the slaughterhouses. A national network of communication channels between these would enable immediate exposure information to be shared with all those affected.

Second is a need for individual animal identification. The next improvement over a national database of communication nodes is a method to now identify the life and travel history of every pig in the country. Just as the airline industry has chosen to ID people's risks as they board airplanes, so to can the national system ID the dangers to animals based on their itinerary or place of origin.

The third recommendation is a completed epidemiological model that includes all of aspects of this process that would enable scenarios to be played out with a significant degree of accuracy. This would enable tests of the national database and ID program as well as planning for disease outbreak occurrence.

Finally, any software tools built to carry out these programs must be designed and built with an emphasis on security and reliability.

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Appendix 4.3

Carroll County Swine Premise Spatial Analysis

The density of swine premises in Carroll County, Indiana's most hog dense county, was evaluated using data collected by Indiana Department of Environmental Management (IDEM), Indiana Board of Animal Health (BOAH) and the county extension educator. Confined Feeding Operations (CFO) are identified by IDEM as those containing at least 600 swine (IDEM, 2004). Global Positioning Systems data was collected for CFO's by IDEM and for all known swine premises by the BOAH and the extension educator. The number of swine present in Carroll County was provided by Animal and Plant Health Inspection Service. Arcview 8.3 was used to evaluate the data. CFO data was filtered so that only hog operations containing more than 0 hogs at the time of record were included. Overlap between the two data sets was eliminated by looking at aerial photography of Carroll County and merging multiple points representing a single premise. Once the total number of premises was determined, the nearest neighbor to each swine premise was identified and the distance to that nearest neighbor calculated. Nearest neighbor distances were also calculated for CFO to CFO points as well as CFO to non-CFO points. The percentage of these nearest neighbor distances within 0.5 km and 1 km were determined for comparison.

Carroll County Indiana

Total Premises	209
CFO	112
Non-CFO	97
Density of swine premises per sq km	0.215
Total Swine	255,176
Percentage of total swine premises	
with a nearest neighbor within 0.5 km	27%
with a nearest neighbor within 1 km	57%
Percentage of CFO premises	
with a non-CFO nearest neighbor within 0.5 km	20%
with a non-CFO nearest neighbor within 1 km	41%
Percentage of CFO premises	
with a CFO nearest neighbor within 0.5 km	9%
With a CFO nearest neighbor within 1 km	26%

The density of swine premises in Carroll County is 0.215 per km^2. In the Netherlands during 2000, the European Union defined the southwest area as low density, having .21 premises per km^2, and the south area as high density, having 1.09 premises per km^2 (de Vos et al, 2003). Comparing these densities is useful for evaluating the models constructed after the 1997-8 outbreak of CSF in the Netherlands. Neighborhood spread to farms within 0.5 km was determined by Stegeman et al (2002) to be the risk factor for CSF development second only to direct contact with infected, live pigs. As 27% of the farms in Carroll County were found to have a nearest neighbor within 0.5 km, the potential for this mode of spread to occur within Carroll County becomes evident. Confined feeding operations tend to be farther from each other and farther from the smaller operations than indicated by the overall density. The CFO premises, however, are connected epidemiologically by series of smaller operations, which provides the potential for disease dissemination through neighborhood spread.

The limits of this analysis involve the limits of that data available. There are 7 premises which lie within .5 km of the county border and do not have a nearest neighbor within .5 km. Premises outside of the county border were not included in this analysis, hence it is not possible to determine if these border premises may have a nearest neighbor within .5 km outlying the county border. This may serve to artificially decrease the number of nearest neighbors within .5 km. Another restraint is the method of data collection by the sources. Carroll County collected its swine premise data by driving the roads and recording a GPS value at the mailbox of every known swine premise. The method for CFO data collection from IDEM is not known. When all points were overlaid upon the aerial photograph, it was apparent that neither data set gave the GPS location of the actual animal holding area (barn). The spatial analysis that was conducted to obtain nearest neighbor distances was based upon the given data sets, so the actual values from animal location to animal location may be slightly different. Further, the collection date for the BOAH data occurred in 2003, while the IDEM data collection spans the dates of CFO permit approvals.

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Chapter 5

Diagnostics, Detection and Surveillance of Classical Swine Fever

INTRODUCTION

Current methods of laboratory and on-farm diagnosis of Classical Swine Fever (Hog Cholera; CSF), a discussion of issues related to CSF detection as it might enter the U.S., as well as ongoing and post-introduction surveillance are described by applying three major approaches. First, in all cases a critical document and literature review appropriate to each of three tasks was applied to identify past, current and planned practices both nationally and internationally. Second, semi-quantitative analyses of documents and/or survey responses indicating numerically based risk and/or capacity were used to supplement and support our arguments. Third, and most prominently, our approach centered largely on an extensive series of face-to-face, telephone, or mail-out interviews, questionnaires and surveys administered to key persons involved in state, federal and private-sector agencies germane to questions of CSF diagnosis/detection, interdiction, and surveillance. The results of these responses are summarized/paraphrased and/or presented *verbatim* as either stand-alone arguments or are used to support or refute contemporary or planned strategies regarding CSF. Separate headings with separate bullets are comments from different individuals about the same topic. Most key materials are presented within the text while additional documentation is necessarily supplemented in the appendices as matrices and/or tables. In addition, the instruments used (e.g., questionnaires, spreadsheets, surveys) are included as appendices. We analyzed 91 responses, from state (18) and national (7) regulatory officials, veterinary diagnostic laboratory directors (24), international animal health experts (10) farmers and ranchers (6), and veterinary practitioners (6) in previously CSF endemic areas, from industry (5), and other experts such as USDA inspectors, game wardens and wildlife biologists (11) (see appendix 5-1).

CURRENT RECOMMENDATIONS FOR DIAGNOSIS AND IDENTIFICATION OF CLASSICAL SWINE FEVER VIRUS

Classical Swine Fever is a highly virulent infectious disease that has the potential to cause a major economic problem for the United States with respect to international trade of swine and swine products. With recent outbreaks in the European Union of domestic and wild herds, the accuracy, reliability, reproducibility, and time management of diagnostic testing methods during an outbreak situation have come under question. Current laboratory methods for classical swine fever are tests that detect the CSF virus, its viral antigens, and antibodies.

Currently, there are three prescribed tests for CSF, which are required by the Office of International Epizootics (OIE) for international trade. These serological tests (Neutralizing Peroxidase – Linked Assay (NPLA), Fluorescent Antibody Virus Neutralization (FAVN), and Enzyme Linked Immunosorbant Assay (ELISA) using monoclonal antibodies (MAbs)) are used as marker tests by the OIE if a country wants to be internationally seen as CSFV free when vaccination is not used. For international trade purposes, samples being tested by FAVN and NPLA should be have an initial serum dilution of 1/5 (1/10 final dilution). Sometimes sera from pigs infected with Bovine Viral Diarrhea Virus (BVDV) can react in the FAVN or NPLA at low dilution as if they were infected with CSFV. The usually high antibody levels reached after exposure to CSF infection, including strains of low virulence, allow the use of comparatively high initial dilutions in NPLA tests for CSF antibody, thus avoiding most, but not all, cross-reactions. These techniques allow the required specificity and sensitivity detection for international trades.

Serological tests are used for monitoring purposes, detecting CSF strains of low virulence, and detecting antibodies in herds 30 days post infection. Antibodies will not be detected because they do not originate until the thrid week of illness. Classical Swine Fever comes from the genus pestivirus within the family Flavivirdae. Pestiviruses are antigenically and structurally close to one another, so serological diagnosis of CSF using Enzyme Linked Immunoabsorbent Assays (ELISA) and immunoperoxidase procedures are used to reduce the risk of cross-reactivity between CSF and other ruminant pestiviruses (BVD in cattle and BD in sheep). MAb against CSFV recognize all field strains and the anti-vaccine MAb recognizes all vaccine strains. Production of new ELISA's (competitive, blocking or indirect) contain monoclonal antibodies within them which will differentiate between CSF viral antigens and non-CSF viral antigens. If a lab uses an ELISA that cannot distinguish between the pestiviruses, further test should be run. One type of ELISA (Complex-trapping-blocking) will screen a large quantity of sera for antibodies against CSFV. It contains two MAbs that recognize the envelope protein E2 (gp55) of the CSFV. This ELISA is a one-step method and is suitable for use in automated ELISA systems e.g. robots. The sera are tested undiluted. The test is fast and easy to perform, and detects antibodies against low virulence strains of CSFV at an early stage after infection. Positive results should be confirmed using NPLA.

Antigen Capture ELISA's detect early stage infection in herds. It is used as a good screening method against many samples that are thought to have been recently infected. The advantages to this test are that it is easy to perform, doesn't require tissue culture facilities, and results are provided within 36 hours. This test is less sensitive than virus isolation, giving a higher risk of false negatives to be reported.

Molecular diagnostics have led to alternative methods for the antigen capture ELISA and Virus Isolation using a reverse-transcription nested polymerase chain reaction (RT-nPCR). Studies have found RT-PCR for CSFV to be more sensitive than current diagnostic methods used. These also have the advantage to reduce the risk of contamination by using tubes that are not opened between reaction steps. Currently, there is no standardized method used internationally (see appendix 5-2) (http://www.oie.int/eng/normes/mmanual/A_summry.htm).

DIAGNOSIS AND DETECTION OF CLASSICAL SWINE FEVER VIRUS IN THE UNITED STATES

We used a combination of literature review (based on national and international sources) and direct contact via structured interview laboratory questionnaires (both face-to-face, phone, and mail-out; see appendix 5.3) and surveys to determine past, present, and future methods and current as well as potential laboratory capacity to deal with CSF surveillance, detection, and outbreak support. Separate headings with separate bullets are comments from different individuals about the same topic.

Laboratory Reagents and Kits

- ELISA AB: IDEXX commercial kit
- FAT: make anti-CSF hyperimmune CSF or get antibody from Europe (ABC monoclonal AB test – Lelystad)
- Real-Time RT PCR: positive control using armored RNA or Bis-ethylamine amine inactivated CSF virsus; machine is USA made by a private company. The U.S. has no reference bank or national standards for serum. They do run proficiency testing in Germany.

CSFV Diagnostic Laboratory Testing

- All CSFV diagnostic testing is performed at the USDA Foreign Animal Disease Diagnostic Laboratory (FADDL), at the Plum Island Animal Disease Center (PIADC).
- Laboratory capacity / turnaround time with the United States (fig. 5.1).
- Number of individuals we currently have that can accurately diagnose CSF (fig. 5.2).

The National Animal Health Laboratory Network (NAHLN)

The role of NAHLN

- All pilot labs within NAHLN will have real-time PCR capability for surveillance of certain foreign animal diseases.

- For the quantity of samples that could occur in a massive outbreak, laboratories within the U.S. don't have the capacity for the potential enormous volume overload as occurred with the tens of thousands of samples per day that the Netherlands was doing during their outbreak.

The purpose of NAHLN

- There are a total of 12 labs within NAHLN: Colorado, Georgia, Wisconsin, California, Texas, Washington, Arizona, New York, Iowa, Louisiana, Florida, and North Carolina. Each lab received funding to build Bio-level 3 laboratories within their facilities. These labs were set up for surveillance purposes and to allow a higher throughput within the laboratories. Any CSF virus tests that may possibly be requested will still be diagnosed at FADDL-PIADC. The reason for this is to decrease the risk of sending live reagents that could potentially become a source for a possible outbreak.

- Each lab within NAHLN must obtain the proper proficiency testing/training in order to be able to have the capacity and reagents to detect these diseases.

- Currently, not all pilot labs include containment facilities, but as part of the stipulation of becoming a pilot lab within NAHLN, there will be Bio-level 3 labs to prevent dissemination of the virus or the possibility of the lab becoming a contamination point. Packages will be identified and specially labeled/boxed before entering into the laboratory facility. However, for samples that come in for regular testing that may be CSF infected (and not realized at the time), the possibility of dissemination is still present and technicians/lab personnel that handled or were in contact with that sample can then become a vector for spread of the disease.

- The USDA has to maintain some funding for hub labs so they do not mothball; they should stay open for surveillance.

- Once each state laboratory establishes a bio-level three (BL3) laboratory, they will be allowed to run real time RT PCR testing for specific FADs. For example, the Texas Veterinary Diagnostic Lab has been assigned to do surveillance on samples for CSF, Avian Influenza, Exotic Newcastle Disease, and FMD.

- The goal is not to redirect samples from FADDL, but to allow the state labs to run tests on samples they feel might have clinical suspicion for CSF.

- The overall goal for NAHLN is to increase surveillance for FADs in laboratories where clinical diagnostic testing is routinely occurring. Secondly, NAHLN is there to establish a network of reasonable labs that can respond if there is an outbreak. This will increase surge capacity for testing and cleanup.

- The laboratory network won't prevent diseases – it will help to prevent the spread with earlier detection, providing less of an impact.

- Having this network is critical – we needed something like this a long time ago. It is important so we can share information of what is going on in different states and labs.

Equipment standardization

- It has been left up to each state laboratory as to what type of equipment they want to run the real-time PCR.

Detection and diagnosis of Classical Swine Fever Virus: NAHLN Survey

The assessment of laboratory surge capacity and preparedness within the United States for the rapid detection and diagnosis of CSFV is a crucial feature that should be evaluated and not overlooked in the detection and prevention of all emerging and foreign animal diseases. In response, twelve identical laboratory evaluations were sent to all laboratory directors who are associated with the NAHLN. However, only eight laboratories responded to this survey. A sample survey with questions as well as a table of current laboratory test capacity and turnaround time of NAHLN has been provided as appendices 5.4 and 5.5, respectively.

Responses to NAHLN survey

1. **What is your laboratory's ability to run real-time PCR? How many individuals are trained in your laboratory to run real-time PCR? What is your expected date to have a bio-level 3 laboratory facilities built? What do you feel is the best diagnostic tool that could be used to diagnose CSFV?**

   ***See responses in figure 5.3.**

Note: The responses to this survey were received in the summer of 2003. Since then, all laboratories within NAHLN, including the National Animal Health Laboratory at Ames, Iowa, have proficiency trained 2 personnel at PIADC using the single-tube "dried down" form Real-time PCR assay by Tetracore ® on the Cepheid Smart Cycler ®. The assays to be deployed to the NAHLN network will be a Binary Ethylamine inactivated (BEI) for CSFV. This is being done to allow for a greater surge capacity, increased surveillance, and regional diagnosis within the US to allow for a more rapid detection and diagnosis response plan for emerging diseases. Results from PIADC proficiency testing are still pending.

2. **Do you feel that a portable real-time PCR is a feasible machine that could be used for on-farm diagnosis? Why or why not?**

   - No, due to the cost of equipment, reagent availability, quality assurance programs lacking at a practicing veterinarian, and due to international trade implications. This test should only be conducted at accredited laboratories and should also certified by the USDA.

   - While the technique is feasible, related issues of quality assurance, scientific background and especially control of contamination & cross contamination are difficult issues in practice. Also, probable low throughput would make per sample cost expensive.

   - No, due to these problems: cost of the machine ($55,000.00), centrifugation of samples, requirement of a computer system, and the manual extraction of nucleic acid. It would be very unlikely for a practicing veterinarian to buy this machine now because the costs outweigh the benefits.

   - No, there is too much is at stake in a Foreign Animal Disease, as well as establishing control at the local level.

- No, the machinery can be expensive and technologically challenging.
- No, because veterinary programs do not provide adequate training in molecular biology. PCR requires skills that veterinarians are not usually trained in unless they pursue an advanced degree.
- There is no good way to track data and no compliance with standards. The individual really must be AAVLD accredited.

3. **Do you feel that the current real-time PCR technology is the best diagnostic tool available for the diagnosis of CSFV?**

- Yes, for acute cases.
- Currently, machines configured for high volume 96 well format combine high throughput with increased sensitivity & specificity, quick turnaround and good control of cross contamination.
- Yes you get faster results, the turnaround time is quicker but you have a problem with false positives.
- Real-time PCR technology is a very efficient diagnostic tool in terms of sensitivity, specificity and turnaround time. There are multiple types of "machines" or instruments designed to perform real-time PCR.
- It is rapid, precise and amenable to high volume testing. All PCR tests detect the agent and not the antibody response. Animal will be viremic long before there is an antibody response. This is a crucial difference if the goal is to accurately predict infection.
- Yes, because it is accurate & fast.

4. **Is there a need for a surveillance program for feral swine population? If so, why?**

- A federal feral swine surveillance program for CSF and for pseudorabies has been conducted in the US for several years using feral swine slaughter samples.

- Obvious reservoir or nidus of infection where such animals co-mingle with commercial swine. Iowa has very low feral swine population and high level

  of confinement/biosecurity.

- In our state the feral swine population is large and in all area of the state. Monitoring this population is critical not only for CSF.

- Need perhaps, possibility no; newsletters now remind practitioners to be vigilant for FADs.

5. Do you have any other suggestions that might be helpful in laboratory detection and diagnosis for CSFV?

- Feral swine may act as a reservoir for CSFV similar to the wild boar reservoir problem in Germany. However, it would be costly to trap these pigs.

- A NAHLN lab in the Midwest has a program of producing foreign animal disease training packages for students and practitioners. It includes a "train the trainer" component and establishing a volunteer corps of DVMs who can respond to use their training in an emergency.

- Some labs have begun the process of educating producer groups, but have not targeted the large non-rural urban populations that have no connections to animal agriculture.

- Pig operations are becoming rare in some southern states. Newsletters now remind practitioners to be vigilant for FADs.

- A grant of one NAHLN lab paid for the attendance of 10 veterinarians to attend a FAD course. This will be offered again in 2 years. This course is highly recommended for increasing awareness.

- More education is needed of emerging and Foreign Animal Diseases. This could best be provided through state Veterinary Medical Associations.

6. **What are your laboratories emergency/contingency plans for foreign animal disease?**

- Our lab has a comprehensive plan for any presence of a highly contagious disease. It is generic and not specific for CSFV or any other particular disease. The State and Federal Veterinarians are to be informed of any reportable disease findings.

- 1) We have increased FAD training level in our DVM staff. 2) Proficiency in real time PCR, ready for official PCR test.

  3) Bio Safety Level-3 laboratory in progress.

  4) Immediate notification of state and federal veterinary officers

- Currently if a FAD is suspected, the State Veterinarian and USDA would be informed with appropriate steps to stop the spread locally (in the lab) by proper C&D as specimens are sent to FADDL. The notification would drive a process to handle the crisis.

- Nothing systematic.

- Isolate and disinfect as appropriate Contact State veterinarian's office Contact Federal Veterinarian's office.

- In our own region, we will be the principal NAHLN laboratory handling swine FADs. A NAHLN lab in a nearby state will assist with overflow conditions. In the event of a CSF outbreak we would assign 4 microbiologists to the Bio Safety Level-3 lab and expect a capacity of 1300 samples.

- All testing is done in the Bio-Level 3 lab.

Discussion of NAHLN Survey

Unanimously, all laboratory directors believe currently deploying a real-time RT PCR assay for CSFV will be ineffective and unproductive to practitioners in order to rapidly diagnose and detect CSFV on-farm. Common problems were highly emphasized from individual responses regarding the feasibility issues of a real-time RT PCRs for on-farm detection and diagnosis due to quality assurance programs, increased probability of contamination/cross contamination issues in the field, and the extremely high costs of the machine. However, all laboratory directors did feel the best diagnostic tool available to diagnose CSFV currently is the real-time PCR technology. The reason most individuals responded in this form was due to the rapidity of the test, increased sensitivity/specificity of the assay and the ability to have a high throughput system for increased turnaround time with a decreased amount of contamination.

There were mixed responses over the need for a national surveillance program for the feral swine population in the United States. The government has provided a national feral swine surveillance program from feral swine slaughter samples, however the need for targeted surveillance programs of feral swine is dependent upon each of the state's feral swine demographics. Therefore, each state should assess its own risk on the probability in which CSFV could enter their states feral swine population and take the appropriate surveillance measures to reduce the risk of CSFV entry and spread.

In conclusion, the current laboratory detection methods for CSFV are quite laborious and cumbersome. In response, the ability to deploy rapid, sensitive/specific diagnostic assays into the field is needed in order to allow regional diagnosis, surveillance, or surge capacity in the event of an outbreak. Scaling up these assays to a high throughput format for increased CSFV detection and diagnosis will enable a reliable network of laboratories within the United States as long as they are properly equipped, funded, allowed adequate storage capacity, and include effectively trained personnel. Increased surveillance measures should be assessed by states once these assays are deployed.

Laboratory triage procedures

- Priority numbers (1-4) are assigned to suspect samples either from attending veterinarians or samples submitted to state veterinary diagnostic laboratories. The classification of the 4 priority numbers is as follows:

1- The sample is hand delivered to PIADC where it is immediately tested due to its nature of being a highly possible diseased sample.

2- The sample is overnight delivered (courier) to FADDL where the lab will get the sample by 11:00 A.M. the day after the sample was sent for testing. The sample is then logged into the computer registering system and it is then taken to the laboratory to be cultured/incubated overnight. The ELISA assay for CSF virus will be run the next morning. The virus isolation test is performed and read over 24, 48, and 72 hours before results are reported. The immunoperoxidase test is performed and diagnosed within 4 hours. Most samples sent to FADDL are given this priority number.

3,4-These samples will be looked at as FADDL is able to get to them

Results are then faxed to the Area Veterinarian in Charge (AVIC), who decides how and when to share results with the rest of the state. If a sample is positive for a FAD, then the AVIC, Emergency Programs Coordinator and the deputy advisor of the USDA will be contacted and made aware of a positive sample.

- **Two likely scenarios: (this is what would take place right now)**

    1. The history received by the state diagnostic laboratory says "CSF suspect"- The lab will not touch the sample and it will be sent straight to FADDL.

    2. A sample comes in for testing that is not a suspect for CSF, (i.e. Salmonella, Erysipelas) and the pathologist recognizes lesions for CSF. In this event, the sample first would be tested for the disease requested on the submission form. Then, when CSF is suspected, the lab would call the Plum Island Animal Disease Center, contact the state veterinarian and send the sample straight to PIADC via Federal Express.

Certain state laboratory emergency plans

- Memoranda of Understanding (MOU) have been crafted between some states to be certain state animal disease diagnostic can facilitate normal laboratory capacity testing in another state laboratory in the event that an emerging/FAD is introduced within their state. The MOU is twofold: (1) Certain state diagnostic laboratories have agreed to assist other state laboratories regarding routine diagnostic testing if a disease emergency should occur in one of these states. Routine samples normally tested by a certain laboratory would be forwarded from the lab in the state experiencing the disease emergency to one of these states' labs for testing to allow the diseased state to focus on the emergency. If a state is experiencing a disease emergency and requires additional capacity, states agree to allow samples to be sent to their BSL3 labs for testing.

New Diagnostic Developments

- A single-tube "dried-down" real-time reverse-transcriptase polymerase chain reaction (rRT-PCR) assay (Tetracore, Inc., Gaithersburg, MD) for the detection of CSFV is currently being validated on the SmartCycler™ II (Cepheid, Sunnyvale, CA). Transfer and optimization of this assay to a 96 well platform, high-throughput format for use in surveillance and/or an outbreak situation is being evaluated at Plum Island Animal Disease Center (PIADC) for high-throughput detection and diagnosis. The SmartCycler™ II has the capacity to run 96 samples at once when six processing blocks are serially connected. However, scaling up of a "dried-down" single-tube rRT-PCR assay for CSFV to multiple 96 well platforms using a wet chemistry would increase laboratory surge capacity and allow a larger sample load to be processed at a more rapid rate. Approximately 2,000 samples could be processed within a 24 hour period when these assays will be transferred over. The CSFV rRT-PCR assay is rapid (< two hours), sensitive/specific (has a detection limit over four logs), has the ability to be stored at ambient temperatures and is scheduled to be deployed to laboratories within the National Animal Health Laboratory Network by December of 2004. It is intended that when these platforms have been validated to begin proficiency training individuals for CSFV on 96 well platforms which will eventually be deployed to NAHLN.

- Plum Island Animal Disease Center (PIADC) is also in the process of obtaining Virus Isolation, ELISA, FAT/IPT and real-time RT PCR results for low pathogen isolates of CSFV because there is no data on the performance ability to detect CSFV isolates of low virulence. Clinical samples such as nasal swabs, blood, sera, etc will be taken from animals inoculated at PIADC and field samples in order to obtain the best type of field sample with the highest sensitivity/specificity results. Feral hogs will not be used in this study.

New Directions

Mobile laboratories

- It would be nice to have mobile laboratories, but there needs to be some type of national bar-coding system where samples are coded before they are tested. During the FMD outbreak, the U.K. had three labs accepting samples with around the clock shifts; the U.S. laboratories would most likely do the same thing in the event of an emergency depending on the number of samples to be submitted.

- Ideally, diagnostics validation should be done within the quarantine zones. A mobile lab equipped for all FADs would require too many different tests and machines. In addition, there is the problem of sample disposal, viral containment, etc., of samples within the quarantine zone.

- Money should not be spent to make a mobile lab because you would not be able to get the quality of service as you would if the sample were sent to a diagnostic lab.

- Currently, the United Kingdom is not equipped with mobile laboratories. There are pros and cons to having a mobile laboratory. The advantages are providing a somewhat more rapid diagnosis, particularly if diagnostic teams work in shifts, and keeping the disease samples within the quarantine zone. The major limitation is, they could help to spread infection and could possibly be blamed for such, even if they were not. Such as, delivery vehicles driving from a suspect farm to the mobile lab, then onto the next farm to pick up more samples.

- This would be helpful; however, a rapid diagnostic test is also essential to make decisions on swine herds rapidly and with dependable specificity.

Meat juice testing

- There is at least one group in Europe testing for CSF virus in meat juices using PCR techniques. The United Kingdom is trying to develop new detection methods for CSF virus, such as meat juice ELISA, in order to lessen the impact and tediousness of taking samples at slaughterhouse facilities. Currently there is no research or technology available for "on-border" surveillance for CSF virus in the U.S. To make use of the new real time RT PCR, the existing equipment needs would outweigh the costs and would not be adaptable for border surveillance detection, considering the many ports of entry that are regulated. Until validation and further testing occurs, we are not currently confident or able to use RT-PCR for CSF diagnosis.

Penside testing

- The potential effects of CSF virus as a high consequence pathogen for bioterrorism justify surveillance methods. Rapid, and easy to perform diagnostic tests need to be developed, emphasized and put into the hands of veterinary practitioners, and/or regional laboratories. Real-time PCR methods are being developed by the USDA at the Plum Island Animal Disease Center. The United Kingdom is working on the same type of test, but with variations (i.e. different promoters and probes). This type of testing is being conducted globally, to see if the real time PCR method would be feasible for detection on an international scale. The use of this type of test is not thought to have as much value within the United Kingdom. This type of testing will most likely have more value in third world countries. There are relative advantages and disadvantages to penside testing in that being low technology, penside tests are relatively insensitive; while the counterpart high technology penside tests will be valuable in the beginning (i.e. mobile PCR) , but lose value quickly due to risk of contamination from the ability for lots of positive PCR product accumulation to occur. For Europe and the United Kingdom instead of using high tech penside tests (PCR) a more attractive solution would be mobile laboratories. For the U.S., real-time PCR would not be an effective tool for on-farm diagnosis or border surveillance, because the current real-time PCR methods and machines within laboratory settings require sample centrifugation, cost of the machine ($55,000.00), a required computer system to be used; and the time constraints posed by manual extraction of nucleic acid from various tissue samples. Another problem that is occurring for rapid detection of penside testing is the marketability issues that arise in testing of large animals as compared to small animal. It is very unlikely that practicing veterinarians would spend the time and money for the machine, since these costs outweigh the benefits of the machine from the practitioners' point of view. It is likely that the practitioners that would be profiled to use the machine (large animal/ mixed practice vets that deal with pigs in any way) would not be willing to learn/use the highly advanced/sophisticated technology that a machine like this demands. For now, research to develop a dip stick test would be the most beneficial for on the border/pen side surveillance for CSF within the U.S. until the above disadvantages for real-time PCR assay testing are taken care of. There are other tests that could be utilized that are more cost effective (i.e. fluorescent polarization assay or phase shift technology that can be read in minutes).

CURRENT AND PLANNED CLASSICAL SWINE FEVER SURVEILLANCE PROGRAMS IN THE UNITED STATES

Overview of Surveillance Concepts

The literature on CSF well supports the opinion that early detection and efficient control are critical to reducing losses from an accidental or intentional introduction of CSF. However, early detection involves multiple elements, including awareness of an "abnormal" level of "normal" clinical syndromes such as abortions, respiratory disease, and "just off feed." A typical situation in the U.S. might involve a breeding unit, producing piglets that would normally be moved to nursery units at another location. CSF would probably be seen first in one of the nursery units. Also, depending on management, concurrent diseases such as Porcine Respiratory and Reproductive Syndrome (PRRS), porcine multisystemic wasting syndrome, and porcine dermatitis/nephropathy syndrome, could present similar symptoms, including high mortalities in young pigs. Meanwhile, in the absence of a definitive diagnosis, normal production activities, such as mingling of market pigs from various sources and transportation of pigs across state lines to sales and finishing operations, carry on as usual. Even as the presence of the CSF infection is being established, the vulnerability continues to expand exponentially and dimensionally. Thus, in the current production and trade environment, it is unlikely that a simple outbreak of CSF, even in one animal, would end up affecting only a single farm or state. The Bovine Spongeform Encephalopathy (BSE) case in Washington in late December, 2003 is a good example of how the inter-dependencies of a single case of an exotic disease can extend beyond local geographical, political, social, financial, and even, species' boundaries.

Given these diagnostic and disease control dilemmas, the current APHIS strategy promotes a vigorous animal health surveillance system. A rationale for, and a concept of a comprehensive surveillance system were established by the Animal Health Safeguarding Review in late 2001 (The Animal Health Safeguarding Review, 2001). The framework for the APHIS implementation of the system was presented in late 2003 (Regan, 2003). The new structure calls for a coordinated surveillance effort based on suspicious clinical signs. Coordination will be through an APHIS National Surveillance Unit, drawing upon information developed from a variety of cooperators and collaborators, including universities.

The current APHIS CSF surveillance plan was completed in late 2003 by Dr. Don Rush and others (see appendix 5-6), and is currently being reviewed (Blanchard et al., 2003). The plan well describes and justifies a concept of targeted surveillance of swine populations at highest risk for CSF. Swine in Puerto Rico (considered very high risk) and in the high risk states of Florida, Georgia, Texas, New Mexico, Arizona, and California, in Kansas, Oklahoma, Iowa, Illinois, Minnesota, Indiana, Nebraska, North Carolina, New Jersey, New York, Washington and Hawaii, would be sampled if two criteria were met. First, if the premise has certain characteristics (garbage feeding, foreign workers, etc) and second, if the swine are exhibiting 2 or more clinical signs (persistent fever, conjunctivitis, etc) consistent with CSF. Samples (nasal swab, tonsil scraping, whole blood) would be tested for both antigen and antibody. A positive result would trigger an appropriate response by APHIS in coordination with state and local authorities.

A concept of “scanning surveillance” was also recommended. Blood samples collected from market swine at all slaughter plants (including small custom plants) in the high risk states and Puerto Rico would be tested for antibody activity to selected CSF antigens. Such serological testing would have several objectives: First, to inculcate a “testing philosophy” within the industry; second, to establish the sensitivity and specificity of various tests under U.S. conditions; and third, to detect unapparent infections with so-called low pathogenic strains of CSF.

The laboratory results from the targeted and scanning surveillance activities outlined above are good examples of the impact of the speed of delivery of information to prevent the dissemination of CSF. If a sample is positive for CSF viral antigens and/or antibody activity, then the sooner the animal can be identified, all relevant information about the affected farm made accessible, and the better the chances of success in containing, controlling, and eliminating the subsequent outbreak. The more quality information we have immediate access to regarding the event, the better results we can expect for control at the primary and secondary locations of exposed and affected pigs.

As noted in Chapter 3, a pathway analysis must include knowledge of CSF wherever it exists in the world, as well as how animal health experts in other countries employ various strategies for the control of CSF. We must now learn to use information and speed as tools to prevent the introduction and establishment of diseases such as CSF in the U.S. The first step in this process is obviously prevention, and we are learning to use electronic information to evaluate disease movements and control strategies in near real time, if necessary. In a broad sense, the most timely and easily available resources include ProMED, the Humanitarian Resource Institute, reports from the OIE and Food and Agriculture Organization (FAO), and various reports on websites such as APHIS, Department for Environment Food and Rural Affairs (DEFRA), EMPRESS (FAO), the state animal health agencies, and allied groups such as the U.S. Animal Health Association, the National Institute for Animal Agriculture, the Animal Agriculture Alliance, the Animal Health Institute, and the National Pork Board.

Although beyond the purview of this project, we well understand the need for relational databases that monitor various electronic resources and databases for CSF outbreak information, the effectiveness of control strategies, and, most importantly, the environmental, political, and trade events that may have preceded the outbreak. Inputs for CSF and other diseases would include symptomatic data, pre-condition and transmission factors, data on geographic/ecological hot-spots for the diseases, and those conditions conducive to their existence, propagation and control. Such resources would also include databases for GIS/spatial analysis, wind spread, water spread, and transportation patterns. Outputs would include models for disease spread under prevailing conditions, as well as the impact of various control options and strategies. Aside from the eventual ability to predict disease outbreaks, the research and educational applications of such electronic tools are considerable. Epidemiologists could utilize their own algorithms in conjunction with the tools and the data for risk analysis. Engineers could model transportation plans and contingencies based upon predictive or interpretive disease spread patterns. Most importantly, educators could develop asynchronous mini-courses on specific diseases that would demonstrate the relative importance of clinical signs, diagnostic tests, preventative measures, containment options, and communication.

We used a combination of literature review (based on national and international sources of information) and direct contact via structured qualitative interview surveillance questionnaires (both face-to-face, phone, and mail-out; see appendix 5.7) to present perceptions regarding current methods to deal with CSF surveillance, detection, and outbreak support.

Current U.S. CSF Sampling Methods

- Current U.S. sampling strategies:

  Domestic:
  - First- clinical look-alikes
  - Second- undiagnosed VDL cases
  - Third- poor-doers
  - Fourth- serology on market swine according to epidemiological sampling strategy

  Feral:

  Sample whatever is available; some organizations are involved in providing samples, but a sampling objective for feral swine is unable to be regulated.

- Number of domestic and feral swine tested annually:

  Anywhere from 40,000 to 80,000 samples for CSF in 2002, and of those about 5,000 were submissions sent in from feral swine.

- The laboratory screening process has moved away from only testing areas where swill feeding occurred in the past, to a more proactive approach in testing animals which are showing clinical symptoms and in testing animals located in areas that are deemed as high risk populations for CSF (i.e. feral pigs, backyard pig operations).

- Although clinical reporting should not be the only means of sampling for CSF, it is incorporated into CSF surveillance so people have some idea of what to look when running a sampling program instead of blindly sampling healthy animals. A certain percentage of healthy market swine do get sampled as well.

- To limit over-capacity, statistical sampling methodologies should be used that are based on the number of animals in a herd and the number of herds.

- Some measure of clinical diagnosis should be used during outbreaks. Once an outbreak is established, there would be herd diagnosis instead of individual animal diagnosis. Later in the outbreak, laboratory support is useful to establish a negative diagnosis in suspect herds. Laboratory support would be used if owners claimed they did not have disease in their herds. During outbreaks, laboratory support is primarily used for the index case and then at the end.

- It is a dilemma when there are low clinical symptoms, especially when trying to get onto owners' premises.

- It would be easy to perform surveillance at corporate swine operations because of vertical integration. Surveillance should also be done in packinghouses.

- For the backyard swine population, the only way to perform surveillance is to either test on the farm before sale (ideally) or at the sale barn.

- It would be ideal to test swine at sale barns. It would be difficult as the samples needed are hard to get because swine are hard to handle. However, this should still be done.

- Incorporating surveillance at sale barns would be beneficial, but difficult to carry out due to shortage of people and inability to sample as some owners see it as "unfriendly" business.

- We need to develop a better cosmetic sampling strategy at sale barns in order to get compliance with owners/buyers to perform surveillance.

- As NAHLN becomes fully functional, more testing of ill animals by state diagnostic laboratories will increase the amount of samples and surveillance within the U.S. In turn, state laboratories will still be required to first send in a sample that has high potential for CSF to FADDL- PIADC. An increase in the number of labs that can test and detect CSF increases the amount of search capacity due to increased trained individuals having the ability to perform CSF detection.

Surveillance and sampling of feral swine

- Surveillance is needed within high-risk areas; however there is a problem with government funding. The real-time PCR machines given to these labs need to remain in some type of use. However, the state labs do not have the funds to run surveillance and the owner will not pay for a test he/she did not request. Having a form of surveillance program at the lab seems more beneficial than at the slaughterhouse because samples sent to the lab are from diseased suspects.

- Having a surveillance program in which samples are tested for CSF using the real-time PCR machine will be beneficial; in that it keeps individuals trained to use the machinery and up-to-date and familiar with the protocols for running the tests; so as to be better prepared for an emergency situation.

- Feral swine should be sampled periodically for CSF and other porcine infectious diseases. State diagnostic laboratories should be accredited to do this. This could be done in all feral hogs commercially slaughtered. That would help train several laboratories for potential (terrorist or spontaneous) reintroduction of CSF.

- Even though it would be difficult to reintroduce the virus, some form of surveillance should be instituted. More laboratories should be established to do routine surveillance for CSF and other eradicated diseases. This would prepare us for rapid diagnosis/rapid response should there be an outbreak and would retrain accredited veterinarians in signs and lesions of CSF. Two populations that would be reasonable to look at would be slaughtered feral swine and hogs that died prior to slaughter in packing plants. These two populations are convenient to federal officials. The U.S. might even find that an avirulent strain (low pathogen) still exists within our borders.

- It would be helpful to sample feral swine at feeder stations.

- Sampling feral swine in areas where there could be an increased incidence of spread of disease may be beneficial.

- Suggested ways to sample feral swine:

1. Make agreements with hunting clubs; provide monetary incentives for providing samples
2. Trap
3. Offer rewards for notifying the USDA of sick animals from which they are otherwise unable to collect samples
4. Sample pigs captured that are being moved interstate illegally
5. Sample transitional swine due to their interaction with feral swine, especially in SE states
6. Plug into ongoing projects involving feral swine
7. Random surveillance of feral swine is not of much use by itself because it is too costly. It is better to carry out random surveillance by finding out what projects are currently going on regarding feral swine, and then choosing projects to carry out surveillance based on location, high risk areas, etc.

- We need a better understanding of what feral swine hunting projects are going on so as to perform surveillance

Best sampling strategy

- It is dependent upon each lab's capacity to run diagnostic tests. Since the signs for CSF do not always distinguish it from other diseases, it may not be reasonable to use a sampling strategy that relies heavily on clinical symptoms, which can overburden labs.
- Survey on samples with signs consistent with FADs.
- Introduce a surveillance program for CSF like the scrapie program: samples are collected in the field and are all sent to National Veterinary Services Laboratory (NVSL). NVSL will then send samples to state labs capable of FAD testing with an identification number only; labs will run tests and report back.

Focus of surveillance efforts and funding

- Surveillance should be used in states which have high risk populations for CSF (i.e. feral pigs, backyard pigs, etc.), but it should be the states responsibility to fund such programs.

Relative merits of active versus passive monitoring

Active:

- Gets an answer and a quick turn-around time on active disease.
- Expensive, but cheap if the disease is correctly identified in a timely manner.

Passive:

- Useful in order to pick up subclinical cases and recovered animals.
- Cheap, but expensive if the disease gets out of hand.

Current State of Foreign Animal Disease Education within the U.S.

A key component of Foreign Animal Disease (FAD) prevention and control is having competent individuals that can confidently and actively suspect, identify and report FADs. As such, education is an important part of a surveillance strategy for the prevention and control of Classical Swine Fever. The following are comments from the qualitative survey regarding the current state of education throughout various entities within the U.S. involved in FAD prevention and control.

Education within the U.S.

- "Every FAD that has ever been suspected of entering the USA was done so by a combination of the following three: owner, practicing vet, and the state veterinary laboratory. So, education and arming both the laboratory and veterinarian are a necessity for preventing [detecting] FADs from entering the USA."

Education and training of diagnosticians/practitioners

- Even introduction of a low virulent isolate could be devastating. CSF is often not considered a differential diagnosis in current US laboratories.

Education and training of veterinary students/practitioners

- There needs to be added encouragement and information set aside for veterinary students to allow more students to take part in getting FAD education at the Plum Island Animal Disease Center. There should be a national campaign between all veterinary schools to realize the importance of training new and upcoming veterinary students about the roles they should and will play when dealing with a potential FAD. More training should be emphasized on which diseases can look like one of the many endemic diseases seen within the U.S., in order to remind students what diseases should be kept in the back of their minds.
- Students within veterinary schools should be educated about FADs to allow students to readily see the necessity for continuing education for FAD. Most practicing veterinarians within the U.S. were never taught much on the need for FAD training, so may not be seen as such a high priority of emphasis to these practitioners on how foreign animal diseases can impact the nation's economy. Small animal veterinarians should be more educated about FADs, especially with the increasing rise of pocket pets.

- A required FAD education should be enforced for veterinarians to be re-licensed or reaccredited, especially for large/mixed/exotic practitioners.
- Greater FAD education should be emphasized upon entry into the curriculum for veterinary students because we are not living in the same world as we were ten years ago.
- Greater efforts should be undertaken to emphasize the role and training of FADs within the veterinary curricula.

- Practitioner accreditation would be a possible option for many of the large animal veterinarians to allow a greater network of individuals trained in the defense of FADs. There may be more resistance in making small animal practitioners take accreditation classes. Better knowledge of the role a small animal practitioner will play and the impact each of these diseases may have upon their clinic that is backed up by joined forces from national, state, industrial, and academic arena, may provide incentive for the small animal practitioner to go on ahead and get the accreditation they need.

Education within Food Safety Inspection Service (FSIS)

- The normal textbook symptoms seen in an animal with high pathogenic CSF will most likely be detected by an FSIS inspector, although because of the varying nature of signs and pathology for low pathogenic CSF there is a much higher probability for low pathogenic CSF to be accidentally overlooked or unrecognized by FSIS inspectors. Because of this, the ability for a silent, asymptomatic, low virulent strain pig to end up going through the slaughter-house process is greatly increased. Since there is growing concern by officials within the USDA about the correct type and amount of training that an FSIS inspector should undertake, FSIS veterinarians must to be kept up to date and allowed more extensive training on FADs and as part of their job description they should be held more accountable pertaining to these issues.

Education within industry

- There are many people who deal with swine within the industry, spanning from the large piggeries in the Midwest all the way to the backyard farmers located in the southeastern U.S. Because of this huge diversity, there is a varying range of the amount of emphasis on FAD education that is allotted. Individuals who have the most to lose economically will know about diseases such as CSF, African Swine Fever (ASF), FMD, etc., and what these diseases can do. However, FAD education still needs to be stressed throughout the industry (i.e. backyard pig operations). Individuals who are just trying to make it to the next day (backyard farmers) still need to be educated about CSF and its consequences to U.S. agriculture. Education should be directed toward individuals who raise hogs in areas where the government does not have that much control over, such as backyard pig operations. There should be a national effort to make industry and government work more closely together in order to help the prevention of an FAD from entering the U.S.

- Industry must play a role because their role is very large with the protection of the national food supply. Much help is needed in giving producers knowledge about CSF and the chance for undetected low pathogenic CSF to be within their facilities.
- The amount of education within commercial and corporate industry is acceptable. The individuals who need more training are those that work at most waste feeder facilities and non-permitted waste feeders.

- There is little concern of the consequences of CSF by smaller producers because CSF is not endemic within the U.S. There is much of an out-of-sight, out-of-mind mentality between these individuals. Within the corporate sector, there is concern about CSF, but this concern is usually overshadowed by endemic diseases such as PRRS, Salmonella, and PRV.
- Within the U.S. CSF is a forgotten disease that has been reintroduced within the veterinary community to a certain extent due to apprehension within the U.S. from bioterrorism. The problem is that CSF, as of now, is not as major of concern within industry because they are more worried about PRRS. It would be beneficial to educate industry about CSF concerns, biosecurity plans, and health maintenance within one pamphlet to be distributed within the U.S.
- Parts of industry have taken their responsibility related to FAD prevention very seriously; still, on the whole industry relies heavily on agricultural schools or the state or federal government to deal with disease issues for them. Industry should take more responsibility with disease and biosecurity issues.
- With the amount of immigrant labor increasing within the swine industry, extra biosecurity measures, precautions, and education should be emphasized within the industry to prevent the accidental introduction of CSF virus into the U.S. For example, it as been documented that Hispanic immigrants will eat native meat in the employee lunch-room at pig production facilities. While this it is not a common situation or representative of all production facilities, it is a distinct source of vulnerability that should be remembered by all individuals within industry.

Education at the ports of entry

- A strong national and state effort should be emphasized in order to make more awareness of CSF virus at borders/ports, particularly in areas where it will most likely enter.
- Brochures at these ports should be available about the laws and fines of bringing in illegal goods. For this to be effective, the awareness campaign needs to not only have information, but the consequences of bringing in illegal goods that may contain CSF virus should be clearly stated and enforced.

Surveillance Alternatives

Sentinel herds

- Sentinel herds are not currently being used in U.S. CSF surveillance; logistics could be problematic.
- Sentinel herds are only helpful in high risk areas, so it would not make sense to introduce a feral swine herd just for this purpose in an area that did not have feral swine to begin with.
- Accredited veterinary practitioners that deal with corporate/private swine, and who are alerted if FAD is suspected, work well as sentinel activity; however, this brings up the issue of how well are practitioners educated on FADs and how comfortable are they to report their suspicion.
- In a way, garbage feeding operations are forms of ‘sentinel’ herds.
- Sentinels could be helpful at corporate entities if samples taken for PRRS, Swine Brucellosis (SB), etc. are also taken for CSF surveillance.
- Every herd is a kind of a sentinel herd.
- It would be helpful to identify swine producers that would be willing to participate in a sentinel program.
- Instead of being afraid of feral swine, we need to use the feral swine population to our advantage. Feral swine could serve as border sentinel herds.

COMMENTS ON DIAGNOSTIC, DETECTION AND SURVEILLANCE ISSUES THAT NEED TO BE ADDRESSED

- There is a common lack of staff and support within field positions of the USDA (i.e. animal health technicians). This is in part due to the time constraints posed on many of the employees within the USDA. Due to the cultural influences of where CSF will most likely enter, especially within Mexican, Caribbean, and Spanish populations, it will take a lot of trained, skilled and bilingual individuals to deal with the many backyard pig operations. The USDA does not have enough people in these types of positions to allow for sufficient detection and surveillance of CSF. In order to better understand the relationship of how cultural differences within various backyard pig operations occur, as well as to instill a sense of trust between the backyard pig owner and the attending government veterinarian, much education should be stressed to the owner and extended training for FADs should be emphasized to all government employees within the USDA.

- The area where the USDA is most short staffed for detection and prevention of foreign animal diseases is FADDL- PIADC.
- Training, people, equipment, protocols, and reagents are needed. Right now, most state diagnostic laboratories could only survive a week in the event of an emergency, primarily due to a lack of trained personnel.
- The USDA needs to get proper samples to these laboratories in proper condition on a regular basis (to keep the equipment and staff fresh). Also, all state laboratory capacities should be known, when it is best to deliver samples and if the lab has the capacity to store FAD samples which many state labs do not.
- With regards to NAHLN:
    1. The network needs to expand by gradually bringing in more state laboratories as part of the network.
    2. Funding should be maintained to already developed labs within NAHLN.
    3. Before adding new labs to the network, funds should be given to previously funded labs in order to maximize their capacity and throughput.
- Issue of surveillance legality: The lab will have no liability because FAD is a national issue and they are ethically bound to stop a disease. However, the issues state laboratory directors are concerned with:
    1. Running tests without the owners' knowledge (even though they could probably do this legally).

2. If a state sends a sample to another state, and the sample is FAD infected, then the index case gets into other states' environments.

3. It is recommended to USDA and state animal health associations to pass a law that if anyone has a sample that is a FAD suspect, they have to clearly mark it and send it to USDA - PIADC first.

- Better vaccines and better diagnostic tests. There needs to be improvements made in serologic testing to prevent false positives. Funding for FAD tests within state labs is needed. A nationally standardized bar coding and robot system is needed.
- A few state diagnostic laboratories are in the process of constructing a database modeled on the medical community. For example, a veterinarian fills out a form online to be submitted for a routine testing request. The online form would require certain fields (history) to be filled for the request to be submitted. Once the form is submitted, the information about history, tests run, etc. would be seen and analyzed by the lab epidemiologist for tracking purposes so that a "red flag" would go up if there is an increasing prevalence of certain "indicator" signs for a possible disease (i.e., syndromic surveillance). There are problems with this process:

1. Practitioners need to be willing to take the time and have the technology available to submit request forms online without the process being aggravating.

2. Due to certain state laws, results from these databases cannot be dispersed to other individuals because legally the specimens and results are owned by the client that submitted it.

3. Confirmatory tests could be submitted to FADDL, but sometimes there is not enough sample left, If this occurs the USDA will most likely want to go back to the source to obtain more samples from the animals. However, if the farmer never requested the test to be performed in the first place, state laboratories could face legal action by the client that legally owns the suspected sample.

4. When a veterinarian submits a sample to the state diagnostic laboratory it is based completely on voluntary discretion and not

forced, presenting a dilemma between the lab operating as a business and the government operating as a regulatory agency for disease prevention.

- An issue not yet addressed is if an outbreak occurred in some state, would the adjacent state allow samples to come in because the lab could become contaminated and have the potential for introducing CSF into swine in the second state.

- There is a lot of untapped money within the government and industry that could be used to do surveillance for CSF. For every pig slaughtered the industry gets pork check-off money. Why not use the money from the pork check-off to maintain population health? There are also billions of dollars in customs receipts that go untapped or that are used for the purchase of commodities to prop up prices. Things work better when there are incentives for producers.

EXAMPLES OF INTERNATIONAL STRATEGIES FOR CLASSICAL SWINE FEVER PREVENTION AND CONTROL

Mexico Interviews

- The Mexican government tests all animals within the Yucatan Peninsula using ELISA to check for antibodies. Through testing, the Mexican government has found these areas to be CSF free.
- Classical Swine Fever virus does contain truly low virulent strains, and the U.S. should not assume that Mexico has just one strain within its borders.

- Strain virulence within Mexico varies from low to moderate.
- Mexico does not consider itself to have a feral swine population. They have backyard pigs, not feral pigs.

- Central Mexico has a lot of backyard swine operations. 35% of the pig production in Mexico is by backyard swine operations. In Central America, some countries have 80% backyard pig production. In Nicaragua, it is 95-100%.

- Backyard swine operations are a risk in Mexico in regards to CSF. The government is not trying to stop these kinds of operations because it is impossible to do. These types of operations are part of Mexican culture; this is true in developing countries throughout the world. In Mexico, there are 2-3 backyard pigs per household.

- Currently, the Mexican government is not educating backyard pig owners or the public about CSF. Instead, they are vaccinating, which is bringing in money for the government. The policy in Mexico is to vaccinate, not slaughter, CSF-infected swine. The vaccinated pigs do get into the human food chain.

- A larger program to help eradicate CSF from Mexico, Central America, and the Caribbean would help keep CSF out of the U.S. The expensive way to keep CSF out of the U.S. is to tighten surveillance on the border and at ports. The more virus that there is, the easier it is for it to spread to currently disease-free areas.

- The problem with CSF being endemic in Mexico is that people get used to the disease and stop caring about its significance.

- Pork producers in Mexico are suffering from CSF being endemic in the country, but they would not support an eradication program internationally. The farmers do not accept that the virus is there. Farmers are more worried about the economical aspects of their herd rather than eradicating the disease. Price of pork in Mexico has gone down, and small producers are hurting because production is concentrated in larger farms. It is difficult for these small producers to sustain themselves. Small farmers are not worried about whether or not Mexico has CSF; they are worried about if they will able to survive with large pig producers.

- CSF is mainly in Central Mexico and pig production in this area has increased 20-30%.

- Northern Mexico was easier to convince to eradicate CSF because there are more industrialized pig producers in this area. There were also new pig producers that wanted to have clean herds. There are not as many pig producers in the North as there are in Central Mexico.

- It has been commented that people do smuggle pigs from Central America to Mexico.

European Union (EU) Member Countries

- Confirmation of CSF based on clinical signs and post-mortem lesions; laboratory detection of virus, antigen or genome in tissue, organ blood or excreta samples; and demonstrating specific antibody response in blood samples. (Anonymous, 2002)

Main criteria to be considered for suspecting CSF:

1. Clinical and pathological findings, especially:

    a. Fever with increased morbidity and mortality; hemorrhagic syndrome; neurological symptoms of unknown origin where treatment with antibiotics were unsuccessful

    b. Abortions or increased fertility problems during the last three months

    c. Piglets with congenital tremors

    d. Chronically diseased animals

    e. Growth retarded (runted) young animals

    f. Petechial and ecchymotic hemorrhages, especially in lymph nodes, kidneys, spleen, bladder and larynx

    g. Infarctions or hematomas, especially of the spleen

    h. Button ulcers in the large intestine of chronic cases, especially near the ileo-cecal junction

Guidelines for clinical examination and sampling procedures on pigs in suspected holdings:

1. When CSF is suspected at a pig holding, the official veterinarian is to check the production and health records (if available) and to inspect each subunit of the holding to select the pigs that will be clinically examined. Concern will be given to pigs:

    a. Sick or anorexic

    b. Recently recovered from disease

    c. Recently introduced from confirmed outbreaks or other suspected sources

    d. Kept in subunits recently visited by external visitors which had recent close contacts with CSF suspected/infected pigs or which other particularly risky contacts with a potential source of CSFV have been identified

    e. Pigs already sampled and serologically tested for CSF, in case the results of these tests do not allow to rule out CSF, and in-contact pigs

2. If inspection of the suspected holding does not indicate pigs as referred to above, then pigs should be selected out randomly for clinical examination from the subunits for which CSF introduction has been identified or suspected.

3. Samples to be clinically examined:

    a. Live pigs:

        i. Minimum number of pigs to be examined allows for detection of CSF if it occurs at a prevalence of 10% with 95% confidence.

        ii. If breeding sows: 5% prevalence with 95% confidence minimum.

        iii. Semen collection centers: all boars must be examined.

    b. Dead/morbid pigs:

i. Postmortem examination on at least 5 of these pigs, especially those that before death had shown or are showing very evident signs of disease, have high fever, or have recently died.

ii. If these lesions are not indicative of CSF but further investigation seems necessary, then clinical examination is to be carried out as laid out for "live pigs" above and blood samples are to be taken as laid out in "blood samples to be taken" in the "dead/moribund pigs" subunit. Postmortem exams may be carried out on 3-4 in-contact pigs.

iii. Irrespective of presence/absence of lesions suggesting CSF, samples of organs or tissues from pigs subjected to postmortem exam must be collected (preferably from recently dead pigs) and submitted for virological tests. Tonsils, spleen, and kidney are most suitable. It is also recommended to collect two samples of other lymphatic tissues, such as retropharyngeal, parotid, mandibular or mesenteric lymph nodes and a sample of ileum. In case of autolysed carcasses, an entire long bone or the sternum is the specimen of choice. (see "collection of samples for virological tests")

c. For pigs who are suspected of CSF due to previous serological tests results, blood samples should be taken along with samples from in-contact pigs, as well as from the following:

i. If seropositive pigs are pregnant sows: some of them (preferably not less than three shall be euthanized and subject to postmortem examination. A blood sample is to be taken prior to killing for further serological tests. The fetuses shall be subject to examination for CSFV, virus antigen, or virus genome to detect intrauterine infection.

ii. If seropositive pigs are sows with suckling piglets blood samples must be taken from all piglets and shall be subjected to examination for CSFV, virus antigen, or virus genome. Blood samples must also be taken from sows for further serological tests.

4. If a subsequent examination is carried out on suspected holdings and clinical signs/lesions suggestive of CSF are not detected, but further lab tests seem necessary to rule out CSF, then the sampling procedures stated under "blood samples to be taken for laboratory tests" shall be used.

5. Blood samples to be taken for laboratory tests:

   a. Blood samples are to be taken if further clinical signs/lesions that suggest CSF are detected, but these findings are not sufficient to suggest a CSF outbreak and lab tests are needed.

      i. Blood samples must be taken from suspected pigs and from other pigs in each subunit in which the suspected pigs are kept.

      ii. Serology – The minimum samples taken must allow for the detection of 5% seroprevalence with 95% confidence. If breeding sows, then 5% prevalence with 95% confidence (in certain cases, such as CSF is suspected in a holding with a limited number of young pigs and therefore the proportion of breeding sows may be very small, then a higher number of sows must be sampled). If at a semen collection center, then blood samples are to be taken from all boars.

      iii. Virology – The number of samples to be taken will depend on the tests which are to be preformed, the sensitivity of the lab tests to be used, and the epidemiological situation.

Sampling procedures in a holding when pigs are killed following conformation of disease:

1. Blood samples are to be taken at random from pigs when they are killed for serological tests so that the manner of introduction of the virus into an infected holding and the length of time elapsed since its introduction may be established.

2. Minimum number of pigs to be sampled must allow for the detection of 10% seroprevalence with 95% confidence in pigs in each subunit of the holding. Samples may also be taken for virological tests with the instructions of the competent authority, with procedures the same as stated under "virology" above.

3. In the case of secondary outbreaks, the competent authority may decide to establish ad hoc sampling procedures, taking into account the epidemiological information already available on the source and means of virus introduction into the holding and the potential spread of disease from the holding.

Sampling procedures when pigs are killed as a preventive measure on a suspected holding:

1. Blood samples for serology as well as blood/tonsil samples for virology must be taken (in order that CSF may be confirmed or ruled out and additional epidemiological information is gained) on:

    a. Pigs showing signs or postmortem lesions suggesting CSF and their in-contact pigs

    b. Other pigs which might have had risky contacts with infected or suspected pigs

2. Sampling procedures:

    a. Pigs proceeding from each of the subunits of the holding must be sampled at random, allowing for 10% seroprevalence with 95% confidence

    b. For breeding sows: 5% seroprevalence with 95% confidence

    c. Semen collection centers: blood samples are to be taken from all boars

    d. Virology- samples will be taken as mentioned above for "virology."

Checking and sampling procedures before authorization is given to move pigs from holdings located in protection or surveillance zones and in case these pigs are slaughtered or killed:

1. Clinical examination must be carried out by an official veterinarian within the 24-hour period before the pigs are moved.

2. Pigs moved to another holding: subparagraph 1 above plus a clinical exam must be carried out in each of the subunit holdings in which the pigs are kept.

    a. If pigs are older than 3-4 months: exam must also include taking the temperature of a proportion of the pigs

    b. Minimum sample size checked must allow detection of 10% prevalence with 95% confidence of fever if it occurs

    c. Breeding sows: 5% prevalence of fever with 95% confidence

    d. Boars: all boars to be removed must be examined

3. Pigs to be moved to a slaughterhouse, processing plant, or to another place to then be killed or slaughtered: subparagraph 1 plus a clinical exam of pigs in each subunit where the pigs to be moved are kept.

    a. If pigs are older than 3-4 months: exam must also include taking the temperature of a proportion of the pigs

    b. Minimum sample size so as to detect 20% prevalence with 95% confidence of fever if it occurs

    c. Breeding sows/boars: minimum sample size so as to detect fever at 5% prevalence with 95% confidence

4. When pigs referred to in number 3 are slaughtered or killed, blood samples for serology or blood/tonsil samples for virology must be taken from pigs proceeding from each of the subunits where pigs have been moved.

    a. Minimum amount of samples to be collected must allow for 10% seroprevalence or viral prevalence with 95% confidence in each subunit

    b. Breeding sows and boars: 5% seroprevalence or viral prevalence with 95% confidence in the subunit where the pigs are kept

    c. Type of samples to be taken and tests to be run will be decided by the competent authority

d. If clinical signs/postmortem lesions suggest CSF when pigs are slaughtered or killed, then sampling will take place as it is mentioned under "Sampling procedures when pigs are killed as a preventive measure on a suspected holding."

Checking and sampling procedures in a holding in relation to repopulation:

1. Reintroduction of sentinel herds: blood samples for serology must be taken at random from a number of pigs so as to detect 10% seroprevalence with 95% confidence

2. Total repopulation: blood samples for serology must be taken at random from a number of pigs so as to detect 20% seroprevalence with 95% confidence

3. Breeding sows/boar reintroduction: samples taken so as to detect 10% seroprevalence with 95% confidence

4. If any of the pigs become diseased or die due to unknown reasons after reintroduction, testing for CSF is to be done immediately.

Sampling procedures in holdings in the protection zone before lifting restrictions:

1. For all holdings: clinical exams must be carried out as described under "Guidelines for clinical examination and sampling procedures on pigs in suspected holdings."

2. Blood samples for serology must be taken to allow detection of 10% seroprevalence with 95% confidence in each subunit

    a. For breeding sows: 5% seroprevalence with 95% confidence

    b. At semen collection centers blood samples will be taken from all boars

Sampling procedures in holdings in the surveillance zone before lifting restrictions:

1. For all holdings: clinical exams must be carried out as described under "Guidelines for clinical examination and sampling procedures on pigs in suspected holdings," section 2.

2. Blood samples for serology must be taken from:

    a. All holdings where no pigs between 2-8 months are kept

    b. Whenever the competent authority deems that CSF might have spread unnoticed amongst breeding sows

    c. In any other holding when the competent authority deems necessary

    d. In all semen collection centers

3. The number of samples to be taken will be carried out as described under "Sampling procedures in holdings in the protection zone before lifting restrictions."

Serological monitoring and sampling procedures in areas where CSF is suspected to occur or has been confirmed in feral pigs:

1. In areas where CSF has been confirmed or is suspected to occur, the size and geographic area of the target feral pig population to be serologically targeted should be previously defined so as to establish the number of samples to be taken. Sample size is established as a function of the estimated number of living animals and not as a function of the number of animals shot.

2. If data on population density and size are not available, the geographical area to be sampled must be identified taking into account the continuous presence of feral pigs and the presence of natural or artificial barriers efficient to prevent large and continuous movements of the animals. If such circumstances do not occur or in cases of large areas, it is recommended to identify sampling areas of not more than 200 km^2, where a population of about 400-1000 feral pigs may usually live.

3. The minimum number of pigs to be sampled within the defined sampling area must allow detection of 5% seroprevalence with 95% confidence. For this purpose, at

least 59 animals must be sampled in each area that has been identified. It is also recommended that:

a. In areas where hunting pressure is higher and regularly performed, or selective hunting is carried out as a disease control measure, approximately 50% of the sampled animals belong to the 3 month to 1 year age class, 35% to the 1-2 year age class, and 15% to the greater than 2 years age class.

b. In areas where hunting pressure is very low or absent, at least 32 animals are sampled for each of the three age classes stated above.

c. Sampling is to be performed in a short time, preferably no longer than one month.

d. The age of the sampled animals is identified according to the teeth eruption.

4. Collection of samples for virological tests from feral pigs shot or found dead will be carried out as described under "Guidelines for clinical examination and sampling procedures on pigs in suspected holdings," section 3.b.iii. If virological monitoring on shot pigs is deemed necessary, it must be primarily carried out on pigs 3 months to 1 year old.

United Kingdom (U.K. Interviews

- Current CSF surveillance in the U.K. is restricted to monitoring boars exiting Artificial Insemination (AI) units and monitoring test results of animals being exported if the importing country requests. An extensive surveillance program is projected to be introduced soon that will target nucleus and outdoor swine herds as well as abbatoir surveys. Abbatoir surveys provide good sources of CSF survey material since they are not disruptive to farmers and they enable large scale testing to be carried out. However, they can be disruptive to abbatoir facilities, so the U.K. is trying to develop other testing methods to lessen this impact, such as detecting CSF in meat juices. Various GIS systems and databases are also being integrated so as to provide comprehensive resources for surveillance.

- World Information System for Disease Outbreak Monitoring and Mapping (WISDOM) was created and implemented by the International Animal Health Division (IAHD) of

DEFRA in 2002 and is an animal disease geographical information system (*The Veterinary Record, 2003).* IAHD can use WISDOM to enter disease information from a multitude of sources, produce maps and tabular/graphic reports. WISDOM can also record any actions that the IAHD or the European Commission take related to outbreaks and allows tracking and mapping of worldwide trade restrictions for regions that are disease affected. This database will be integrated into the surveillance system that is currently being developed by DEFRA's Veterinary Surveillance Division. The IAHD uses standard sources, such as the Animal Disease Notification System managed by the EU or the websites of individual countries, to crosscheck all disease information it receives.

- Outdoor swine herds in the U.K. are considered to be the highest risk for CSF introduction because they are relatively insecure as compared to indoor herds. Swill feeding is not allowed anywhere in Britain. Imported semen also poses a risk, but the degree of this risk depends on the source.

- At this time, sentinel herds are not being considered for incorporation into CSF surveillance in the U.K., but higher risk groups are intended to be targeted as part of an active surveillance plan.

- In the past, part of E.U. legislation forbade CSF testing without a movement restriction order being served. Because of large numbers of Porcine Dematotis and Nephropathy Syndrome (PDNS) and Post-weaning Multi-systemic Wasting Syndrome (PMWS) within the swine industry in the U.K., and because these diseases can mimic CSF, testing for CSF would halt the swine industry. It caused swine practitioners to be hesitant about submitting samples and imposing rigorous conditions on farmers. Recent changes to legislation now permit active surveillance, and plans for this are as stated above. Active surveillance will allow the U.K. to rule out CSF rather than waiting for strong suspicion of the disease before samples are submitted.

- Many export tests are subsidized by government in return for the data provided. There is not a formal relationship between government and industry for CSF currently, but there is this relationship with other diseases. Industry is involved in CSF disease prevention by supporting and adhering to legislation, such as animal movement regulations, import restrictions, vaccine acquisition, and vehicle disinfection.

- The value of penside tests is appreciated, but it is likely these tests will be of more value in Third World countries than in Europe. There are few places in Europe that are more than six to eight hours away from a National diagnostic lab, so requirement for rapid diagnosis is essentially met. Low-tech penside tests are insensitive, so they will quickly confirm a positive diagnosis but not a negative. High-tech solutions, such as using mobile PCR machines, are valuable in the beginning, but then quickly lose their value due to the risk of test results being compromised by contamination when large amounts of PCR positive product accumulates. Mobile labs seem to be a more attractive solution. Mobile labs are not currently being used in the U.K., but they are being considered. The dangers of using such labs would be that they could potentially help spread disease and be blamed for such, even if they had no role. Delivery vehicles driving from one farm to get samples, delivering to the mobile lab, and then heading to the next farm to get more samples could also cause apprehension amongst farmers about aiding spread of disease to their "disease-free" farm.

France

- France follows a strategy of natural of wild boars within a designated surveillance zone. Their strategy assumes that the natural disease may control susceptible animal populations, but promote immunity in adults. As a consequence, most wild boars are positive on serology.

Comments on Control Strategies

Vaccinating against CSF

- Currently, most animals worldwide, which are located in CSF endemic localities, are vaccinated with modified live virus vaccines. Globally, vaccinated animals can also mechanically transmit wild type virus and are thus an enormous problem. This is due to the ability of the virus to endure within its natural environment and be shed horizontally and vertically for further dissemination. Also, there are no diagnostic assays available that can determine the field virus strain vs. another strain in a short time. Because of these factors, the Modified Live Virus (MLV) vaccine will most likely not be used in the event that CSF occurs in the U.S.

- In other countries, such as Mexico, a vaccination policy is strictly enforced in areas that are endemic. Vaccination campaigns with the MLV are occurring within Mexico, which have reduced the amount of virus, but has not made it disappear from the whole country. There is a great problem with the whole area of Central America (not just Mexico), in that there is low herd immunity (about 30- 40%) making it easy for the transmission and spread of CSF. This is mainly driven by cultural, political, and social influences. Individuals are living on a day-to-day basis. This can be seen easily by individuals in rural areas. For example, backyard pigs are not vaccinated in Mexico allowing a constant circulation of the virus within the central to southern part of Mexico.

- CSF marker vaccines rely on the animal's response to the Erns viral protein antibody that would only be induced following infection of a field virus, as well as, showing the percentage of carrier animals within a population. Current E2 sub-unit marker vaccines protect against challenge, but are not as effective at inducing a protective antibody in animals infected with CSF virus. Even though these vaccines protect against challenge, they do not protect rapidly enough if an epidemic is moving into a swine herd; the classical MLV vaccine is better in that regard. The problems with these vaccines are based on the fact they take greater than two weeks to provide immunity, leaving a 14 day window for extra infection within a herd; an animal will need more than one vaccination to induce a protective antibody response; and in fact these vaccines still allow vertical and horizontal transmission of the agent. Also, the ELISA assays that are used to detect the Erns specific antibody activity are not particularly specific or sensitive. Use of the Intervet vaccine in Mexico during an outbreak decreased clinical signs, but virus shedding was still being detected in samples obtained to test for field viral antibodies. The reasoning behind having a marker vaccine is well established and sound, but due to the unresolved problems with the MLV vaccinations for CSF and their accompanying assays, most individuals within the U.S. feel it would be wise not to use these vaccines in the event of an outbreak. An alternative to making a proper vaccine would possibly be looking into making a disabled infectious single cycle (DISC) type of vaccine. Recommendations for the diagnostic sensitivity to the current E2 marker vaccine discriminatory tests could possibly be improved if the test was applied to detect infected herds rather than infected pigs. Marker vaccines have limited use as a tool for rapidly controlling an outbreak of the disease in countries free of CSF: 1. They do not protect the pigs against the disease before day 14 post-vaccination, and animals challenged at day 7 post inoculation (PI) are not protected, and 2. The discriminatory (Erns) ELISA test is not very sensitive, increasing the possibility that some animals respond as a false negative.

- The two current vaccines available protect upon challenge, but will not protect quickly enough if a wave of epidemics is occurring throughout swine herds; accompanying diagnostic tests for these marker vaccines are not specific or sensitive enough.

- E2 CSFV is being incorporated into a BVDV backbone using cDNA technology.

Ring vaccination

- Is a good idea in dealing with prevention; however it depends on the stage of the outbreak.

- Should be set in place to control the spread, but this is heavily dependent upon the situation.

- Until there is testing and vaccine availability to differentiate field versus vaccine virus, this would not help any more than routine safeguards like biosecurity and effective cleaning and disinfection.

- The U.S. does not need to use ring vaccination due to its potential for starting new outbreaks. Also, there is an increased probability of the production of shedders that have no clinical signs. It would be helpful if the USDA would put together a protocol program for this topic.

Marker vaccination

- A marker vaccination needs to be developed for CSF that will not cause shedding.

- The marker vaccines that are available right now and have the beginnings of an approach for viral vector vaccines are not satisfactory.

CLASSICAL SWINE FEVER: PREVENTION VERSUS RESPONSE

Comments on Prevention versus Response within the U.S.

- "Prevention is occurring now. We will never reach 100% on the prevention front due to the inability to detect the terrorist waiting to move in and plant a pathogen (as just one of hundreds of possible examples). Response to infection must always be there to accompany prevention when it fails. If prevention is not the best we can make it, then our response capability resource wears thin rapidly. If our response action is not the best we can make it, more and more response actions will be necessary until the resources to respond are expended."
- "Prevention is technology dependent. Until we find better ways to detect pathogens earlier and detect non-clinical animals, prevention will lag behind what capability we really need. Response is able to cure that lagging prevention technology as a back-up catch net."

The following are suggested preventive measures compiled from the various questionnaires:

- Better surveillance measures for all swine with international connections to people, fomites, garbage etc.
- Better control over garbage feeding, especially development of a pelletized heat-treated garbage product
- Constant communication with the diagnostic laboratories
- Continued work on a rapid, pen-side CSF test
- Teaching and communication for practitioners and youth groups (4-H, FFA)
- Work more with the swine industry (National Pork Board, National Pork Producer's Council)
- Provide diagnostic service to producers who notify FADDs of sick animals that they might sample as long as there is no interference with private practitioners
- A better understanding of the mechanisms, pathology, and epidemiology of low pathogenic CSF virus
- A better understanding of how cultural, political, and social backgrounds influence incidence of CSF in the U.S.

- Better understanding of the influence of cultural demographics on where this disease will most likely enter
- Providing better incentives to individuals to work within the government to help re-staff the USDA
- An assay that will be economical for the practitioner and farmer
- Continued funding for targeted surveillance with state diagnostic laboratories
- Continuing education for veterinarians in areas of targeted surveillance
- Increase the number of laboratories within NAHLN.
- Continued funding in teaching students about the consequences of FAD's in veterinary degree programs, undergraduate programs, as well as in, high school and junior high
- Producers must be knowledgeable
- Producers must watch their operations closely and ask themselves how they can bring biosecurity up another notch toward an airtight system
- Producers must be aware of swine production in their area and what works to keep disease out
- Producers must have a dependable diagnostic pathway for sick animals through local veterinarians, a VDL, and swine organizations like the National Pork Board (NPB)
- Industry needs to take more responsibility in its teaching and outreach for the prevention of CSF
- Government and industry need to work together in education, teaching, sharing the surveillance workload, transparency and communications and sharing a common goal of protecting our food supply

- Product exclusion from suspected countries; recognize possibility that some countries could allow movement of infected products from infected countries through their "disease free" country to the U.S.

- Educate travelers

- Better biosecurity by producers in areas where feral swine can interface easily with domestic swine

CSF Prevention: Should the U.S. collaborate to eradicate CSF in other countries?

- The best way to conduct CSF surveillance in the U.S. is by assisting endemic countries. This will decrease the risk of CSF introduction into the U.S.

- There should be collaboration between the U.S. and other countries to eradicate CSF.

- It always helps to have international collaboration to prevent disease and its spread.

- A larger program to help eradicate CSF from Mexico, Central America, and the Caribbean would help keep CSF out of the U.S. The expensive way to keep CSF out of the U.S. is to tighten surveillance on the border and at ports. The more virus that there is, the easier it is for it to spread to currently disease-free areas.

- There is not much CSF research, if any, going on now in the U.S. Therefore, U.S. collaboration to eradicate CSF in other countries would be beneficial because we would be more prepared if and when we have an outbreak.

- Disease awareness, such as for CSF, can be increased if the U.S. engages with countries that actually have the disease.

- Collaboration is helpful to learn effective control methods and give personnel a firsthand look at the disease and the eradication. Many veterinarians in the U.S. have never seen a case of CSF. Personnel and funding would be the biggest hurdle to cross.

- Good infrastructure would be needed in the country the U.S. would help. If an infrastructure is set up or is already present, it may not be maintained. Politics and leadership can change frequently in other countries. Funds will need to keep coming in order to keep programs like this running; otherwise, they were wasteful to begin with.

- The people of the collaborating countries have to want to do better. Favorable politics and a desire within the people are needed no matter how much the U.S. wants the collaboration. For example, with the tick eradication project in Puerto Rico (PR), millions were spent when smashing the ticks with bricks would have been more beneficial. Incentives bolster these types of programs, but they are not the answer to getting rid of diseases. A rapport with the cultural populations of the collaborating country needs to be established, especially if there are ethnic groups from that country living in or that migrate to or visit the U.S.

- Eradicating CSF from Mexico is more of an economical and social issue. It is not a matter of not having manpower, new diagnostic techniques or new machines. Since 35% of the pig production in Mexico is from backyard swine operations, there could be a cultural backlash. Most people in Mexico use these pigs for their livelihood, and if CSF eradication started by killing off all of the backyard pigs, there would be widespread panic.

- It is not feasible for the U.S. government because of logistics and cost. Since people in Mexico and the Caribbean have learned to live with the disease, there is no benefit compared to the eradication costs; people are still able to make some sort of income even though the disease is present.

- The U.S. would end up paying for most of it. This was done well with other diseases, such as screwworm, but it may not be cost-effective for CSF unless things get worse.

CONCEPTS AND SIGNIFICANCE OF LOW PATHOGENIC STRAINS OF CLASSICAL SWINE FEVER VIRUS

What is Low Pathogenic CSFV?

- During the CSF outbreak in the United Kingdom in 2000 the CSF virus isolated was found to be of 'medium' pathogenicity. The clinical symptoms in adults were not always evident and mortality was about 10 to 20% in young pigs and less in adults. Questions have concerned clinical symptoms and gross pathology. With the advancement of real time PCR, will current tests detect apparently low pathogenic CSF virus? Low pathogenic CSF may have a variety of disease signs, ranging from pyrexia to the recognized descriptions of "classic" or highly pathogenic CSF. However, most textbooks fail to note that, in some circumstances (multiple host factors), no clinical signs may be seen. Clinical signs that have been reported thus far range from muscular tremors, unthrifty piglets that do not nurse well, mild to moderate ataxia, thin crusty skin, decreased body weight, conjunctivitis which is found in newborns, to no clinical signs in adults. Opinions also differ on the time when animals begin to show clinical signs, ranging from 10-20 days post-infection (one authority) to never for low pathogenic strains (another authority). There is also the opinion that such low pathogenic strains have all the potential for full virulence, but tend not to exhibit the usual signs of early infection in a susceptible pig. Thus, there is great potential for infection without being able to recognize the infected animal.

- There is debate among pathologists about the "severity" of lesions seen, and whether those differences can be considered evidence for low pathogenicity. Some pathologists consider that low pathogenicity means no clinical signs and no gross lesions. Others argue that even though CSF virus has a tropism for lymphoid tissues, characteristic lesions are sometimes difficult to demonstrate because:

    1. lesions can easily be masked by a great number of other diseases that are seen in everyday slaughterhouse facilities;

2. lesions seen in the slaughterhouses may be an artifact of the slaughter process;
3. lymph node hemorrhages are commonly seen in slaughter facilities;
4. low pathogenic CSF will not be detected in the slaughterhouse;
5. FSIS inspectors should be better prepared and more aware of the many possibilities that may lead to a CSF-type syndrome, and condemned carcasses should be tested

- Diagnosticians have found that sows and gilts affected with the low pathogenic strain of CSF virus will be detected by either ELISA or PCR tests on tonsil biopsies or scrapings. However, tonsilar biopsy and scraping is not routinely covered when CSF is discussed in veterinary infectious disease courses in the U.S. Also, seroconversion usually follows infection in adults in the absence of clinical signs.

- The CSF virus strain within the Dominican Republic is of low "virulence," which may be the same as the low pathogenicity strains discussed above. Regardless of terminology, apparently low pathogenic strains are of concern for nearby countries or territories considered free of CSF. Current surveillance in Puerto Rico takes into account CSF strains of low virulence. Also, there are apparently true low virulent strains occurring within the Dominican Republic that are probably not a function of the CSF virus circulating among relative immune animals within an endemic area. Whether such strains, also seen in Mexico, would mutate into a highly virulent strain if introduced into a naïve population is an important, unanswered question.

Diagnostic and Detection Dilemmas of Low Pathogen CSF

- "The old approach of reliance on clinical signs as primary indicators of suspect disease should really no longer apply," because any systemic disease, septicemia, heat stroke, vitamin E/Se deficiency or imbalance, sodium intoxication/water deprivation, and upper respiratory diseases will mimic any form of low to high pathogenic CSF. A thorough history from practitioners to diagnosticians and an epidemiological workup is needed to aid in a more rapid detection of low pathogenic CSF. Perhaps a better ability to understand the mechanisms of this disease, specifically low pathogenic CSF, for a more rapid detection response could be attained through surveillance of CSF endemic countries or surveillance panel testing for diseases which will mask CSF.

- Due to the fact that CSF clinical signs and pathology look readily like many other endemic swine diseases within the U.S. (i.e. PDNS, PMWS, PRRS, erysipelas, etc.), during an outbreak situation FSIS will not be ready for the detection of CSF, due to a lack of repetition in training for FADs.

Early detection of low pathogenic CSF

- The gold standard according to the OIE for detection of CSF virus is virus isolation. But, because real time PCR is faster and more sensitive than virus isolation, the research community is trying to get more rapid and sensitive tests (such as real time reverse transcriptase PCR) accepted for CSF-free countries such as the U.S. In theory, real time RT- PCR may substitute for virus isolation and will also determine varying strain differences. However, a disadvantage is the test cannot determine whether the virus is live or dead. This assay has detected virus as early as four days before clinical symptoms appeared, and can detect viral RNA in samples that have been negative by virus isolation. The effectiveness of real-time RT PCR for low pathogenic CSF virus has yet to be determined, because clinical symptoms "may never be seen."

- The sensitivity for real-time RT PCR is much greater than the gold standard virus isolation, in its ability to detect a viremia within 2-3 days of infection, as well as, for its ability to detect infected tonsils more rapidly. During eradication, routine field testing was done on the tonsils of living pigs. CSF virus is known to have a tropism for lymphoid tissue, however, pigs being inspected within FSIS slaughterhouse facilities are not having their tonsils inspected or tested by FSIS personnel.

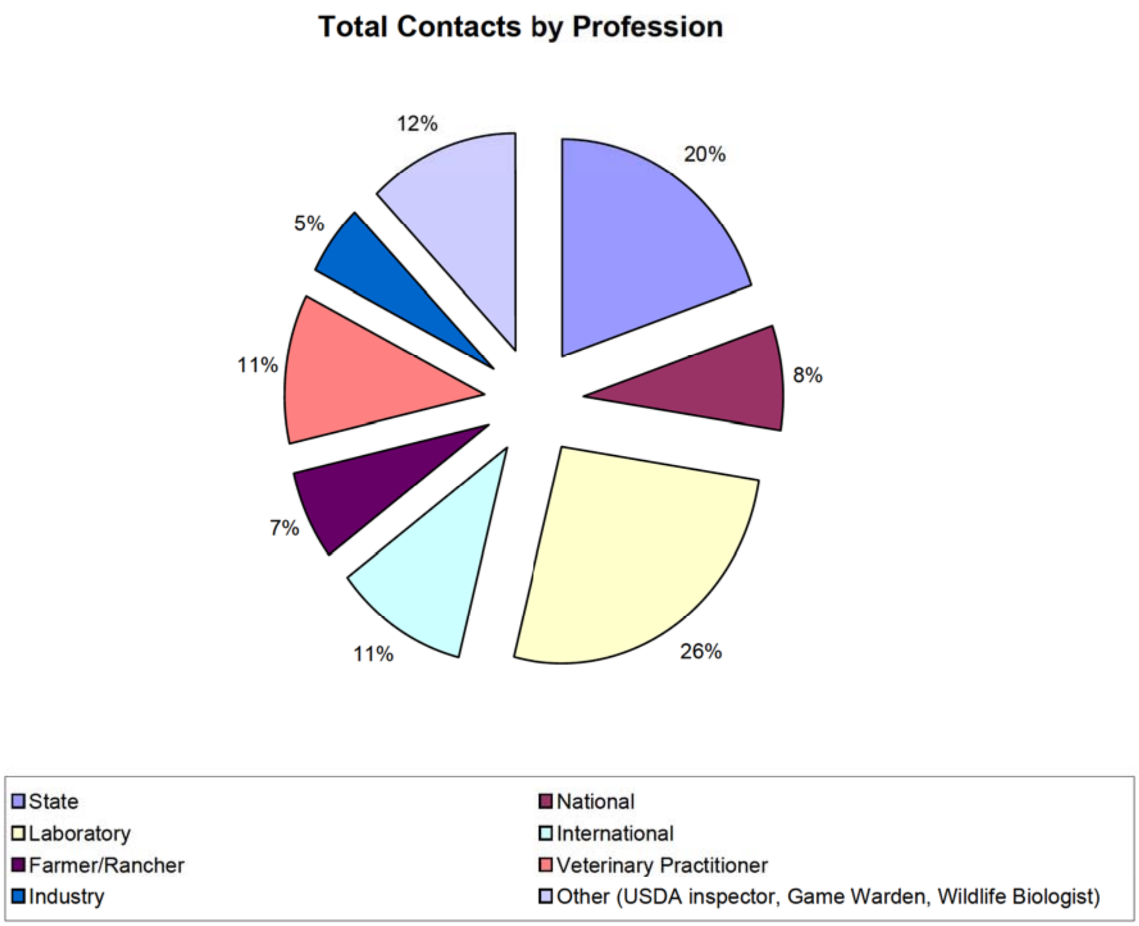
- "Both clinical reporting and serologic reporting are extremely deficient methods for the identification of low pathogenic CSF virus as an early response mode". The reason for this is twofold. (1) Clinical cases are expected to be seen only in piglets, which are usually killed by commercial enterprises and losses of about 8-10% are considered "normal." (2) In rural populations, clinical CSF is mimicked by other diseases with similar symptoms. Passive methods of surveillance can allow low virulent strains of CSF virus to go unreported and not detected. A common question that arises globally is how many different ELISA and PCR procedures are being used. This is a problem because many of these diagnostic assays are designed to pick up Pestivirus group specific signals, while others will only pick up only CSF virus signals. Prevention is dependent upon technology. Until there are better ways to detect pathogens earlier and detect non-clinical animals, prevention will lag behind what capability is really needed. Real time PCR would not be a practical approach for on-farm diagnosis by practitioners.

- Even introduction of a low virulent isolate could be devastating. CSF is not often considered a differential diagnosis in current U.S. laboratories.

Detection of low pathogenic CSF at slaughter facilities

- FSIS believes that there are numerous opportunities for non-clinical, non-symptomatic pigs infected with CSF virus to go undetected within slaughter plant facilities during antemortem inspection. The testing of condemned carcasses currently performed would not detect low virulence or low pathogenic CSF. Differences occur in the way Inspectors-in-Charge handle carcasses for one thing. Additionally, the current tissue sampling for general histopathology to determine a disease condition is far short of what needs to be done for a CSF surveillance plan. Major contributors to the dilemma are the time required to examine a carcass, and a deficiency in the refresher training courses available to inspectors due to personnel shortages within FSIS.

Appendix 5.1: Description of survey respondents



Total Responded Contacts	
Personal	47
Telephone	10
Email	23
Responded Lab Surveys	7
Presented at Texas A&M	4
Total Responded Contacts:	**91**

Total Contacts Separated by Profession	
State	18
National	7
Laboratory	24
International	10
Farmer/Rancher	6
Veterinary Practitioner	10
Industry	5
Other (USDA inspectors, Game Warden, Wildlife Biologist)	11
Total	**91**

Appendix 5.2: Methods used for detection of CSFV in Europe

Country/Territory	Date	Susceptible	Cases	Deaths	Destroyed	Slaughtered	Laboratory	Virus Isolation	Immunofluorescence Test		Rt-PCR	ELISA	5'NTR Nucleotide Sequencing
									Direct	Indirect			
Spain	Jan-98	17,558	381	98	17,460	0	N/A						
Germany	Jan-98	62,850	3,402	1,545	61,305	0	Veterinary Research Services, Rostock and Oldenburg	X					
Germany	Feb-98	11	11	….	11	0	Veterinary Research Services, Rostock		X				
Moldavia	Apr-98	4,827	….	….	….	703	All-Russia Research Institute for Animal Health Vladimir, Russia		X*	X*	X		
SPAIN	Apr-98	4,113	1,694	414	3,699	0	N/A						
Moldavia	May-98	14	5 piglets	0	0	7 piglets	Republic Veterinary Diagnostic Centre		X*	X*			
Switzerland	May-98	6 wild boar	6	4	….	…..	Institutes of Virology and Immunoprophylaxis, Mittelhausen			X	X	X	X
Spain	Jul-98	4,117	413	138	3,979	0	N/A						
Italy	Aug-98	1,375	….	53	1,322	0	N/A						
Moldavia	Aug-98	31	….	5	37	7	Veterinary Diagnostic Centre		X*	X*			
Germany	Oct-98	208	48	3	205	0	State Department for Animal Health research, Munster	X					
Germany	Oct-98	2,683	5	1	2,682	0	State Department for Animal Health research, Lower Saxony Land	x					

Germany	May-99	47	1	0	47	0	Staatliches Veterinaurunterschungsamt, Krefeld	X				
Germany	Jun-99	633	20	5	628	0	Staatliches Veterinaurunterschungsamt, Krefeld	x				
Croatia	Jul-99	9	5	1	4	0	N/A				X	
Germany	Aug-99	1,669	41	37	1,632	0	Staatliches Veterinaurunterschungsamt, Krefeld	X				
Germany	Aug-99	569	30	0	569	0	State Department of Veterinary Research, Koblenz	X				
Bulgaria	Mar-00	104	….	15	33	56	Central research Institute, Sofia		X* X*			
United Kingdom	Aug-00	9,435	….	…..	…..	…..	Veterinary Laboratories agency, Weybridge	X	X	X	X	X
Germany	Jul-00	1,045	….	….	1,045	0	State Department of Veterinary Research, Koblenz	X			X	
United Kingdom	Aug-00	1,037	….	….	….	….	N/A					
United Kingdom	Sep-00	13,455	….	….	….	….	N/A	X				X
United Kingdom	Sep-00	5,509	6	1	…..	….	Veterinary Laboratories agency, Weybridge	X	X	X		
United Kingdom	Sep-00	6,940	250	13	….	….	Veterinary Laboratories agency, Weybridge	X	X			
Austria	Oct-00	50 Wild Boar	1	1	0	0	Federal Veterinary Research Institue, Modling		x w/ NPLA			
Romania	Apr-01	552	14	7	7	0	Institute for Diagnosis and animal helath (national reference Laboratory for Classical Swine Fever)		x			

Spain	Jun-01	2,053	195	65	1,988	0	National refernce Laboratory for CSF, Madrid			X	X	
Spain	Jun-01	5,143	630	509	4,634	0	N/A					
Spain	Jun-01	5,213	1,019	52	5,131	0	N/A					
Germany	Jun-01	822	1	1	821	0	EU Reference Loaboratory for CSF, Hannover		X			
Spain	Jun-01	966	87	5	961	0	N/A					
Slovakia	Jun-01	612	30	14	598	0	State Veterinary Institute, Zvolen		X			
Spain	Jul-01	3,907	467	33	3,873	0	N/A					
Germany	Jul-01	2,100	1	1	2,099	0	N/A					
Ukraine	Jul-01	Wild boar	….	…..	…..	….	Tcherkassy State Zonal Specialized Laboratory of Veterinary Medicine	X	X			
Spain	Jul-01	5,592	874	438	5,154	0	N/A					
Spain	Jul-01	739	82	16	723	0	N/A					
Spain	Aug-01	4,409	122	30	4,379	0	N/A					
Spain	Sep-01	401	….	15	386	0	N/A					
Spain	Sep-01	626	0	0	626	0	National refernce Laboratory for CSF, Madrid			X		
Germany	Oct-01	2	1	0	2	0	Department for Research in Veterinary Medicine and Food Safety		X			
Germany	Oct-01	2,105	>651	51	2,054	0	Rhineland-Palatinate Veterinary research Service, Koblenz		X			
Germany	Oct-01	651	….	….	651	0	Rhineland-Palatinate Veterinary research Service, Koblenz		X			
Luxembourg	Oct-01	Wild boar	….	5	…..	…..	Veterinary and Agrochemical Research Center, Brussels Belgium	X				

Spain	Dec-01	9,707	270	33	9,674	0	CISA-INIA			X	X	
Germany	Jan-02	198	2	2	196	0	Rhineland-Palatinate Veterinary research Service, Koblenz		X		X	
Germany	Feb-02	1,383	….	12	1,371	0	Rhineland-Palatinate Veterinary research Service, Koblenz		X		X	
Germany	Feb-02	526	31	7	519	0	Rhineland-Palatinate Veterinary research Service, Koblenz	X	X		X	
Luxembourg	Feb-02	148	2	1	147	0	Veterinary and Agrochemical Research Center, Brussels Belgium	x	X		x	
Luxembourg	Feb-02	2,910	….	….	2,910	0	Veterinary and Agrochemical Research Center, Brussels Belgium	x	X		x	
Germany	Mar-02	1,187	….	17	1,170	0	Rhineland-Palatinate Veterinary research Service, Koblenz	X	X		X	
Bulgaria	Mar-02	38	3	3	35	0	Central research Institute, Sofia		X		X	
Luxembourg	Mar-02	1,371	….	….	1,371	0	Veterinary and Agrochemical Research Center, Brussels Belgium	x	X* x*		x	
Germany	Apr-02	13	4	0	13	0	Rhineland-Palatinate Veterinary research Service, Koblenz	X	X		X	
Romania	Apr-02	282	61	30	132	120	Institute of Diagnosis and Animal Health, Bucharest		X			
Bulgaria	Apr-02	5	3	0	3	0	National Diagnostic and Research Veterinary Institute, Sofia		X		X	
Bulgaria	Apr-02	250	23	8	242	0	National Diagnostic and Research Veterinary Institute, Sofia		X		X	

Bulgaria	Apr-02	62	28	5	52	5	National Diagnostic and Research Veterinary Institute, Sofia		X		X	
France	Apr-02	395 piglets	5	5	390	0	French Agency for Food Safety, Ploufragen	X		X	X	
Germany	Apr-02	273	150	20	253	0	Rhineland-Palatinate Veterinary research Service, Koblenz	X			X	
Bulgaria	May-02	16	8	2	14	…..	National Diagnostic and Research Veterinary Institute, Sofia		X		X	

Appendix 5.3: Example questions related to CSF laboratories used in qualitative survey

1. Are current laboratories able to conduct CSFV testing?
2. What is the current number of samples that could be tested in your lab per day for CSFV using FAT, VI, ELISA, etc.?
3. What is the best sampling strategy during an outbreak to prevent overcapacity at labs?
4. What will be the role of the National Animal Health Laboratory Network (NAHLN) in regards to CSF surveillance?
5. If CSF is suspected, where do you send the samples? How long does it take for samples to arrive at the lab? Would there be potential problems in sending samples with certain weather events, such as hurricanes? How long could a diagnosis be delayed?
6. Are labs in Puerto Rico able to conduct CSF testing? If so, what tests are run, what is the turnaround time, what are the lab capacities?
7. What are our emergency/contingency plans?
8. What is the sequence of events that happens between a suspected isolated case compared to emergency reaction to an epidemic?
9. What are the lab's triage procedures?
10. Will there ever be a more rapid test that can substitute for Virus Isolation (VI)?
11. Where do you get positive/negative controls at? How long does it take to get the reagents? Will this change once the hub labs are established?

12. Do you know of current testing of feral swine for CSF from Puerto Rico/Costa Rica at the South Carolina lab; Canada/Europe at New York lab; slaughterhouse samples in Texas?

13. In your opinion, should we check all animals, or profile and test animals that have certain masking respiratory diseases/ just slaughter / or all imports?

14. Once a sample of a possible CSF case comes in, what are the procedures the lab goes through from receiving it to testing/recording results/notifying appropriate individuals? Would these procedures be different if a sample was sent in from the feral swine population?

15. Do samples go into containment, are they split up, how are they dispatched to Plum Island Diagnostic Lab? What is the current procedure and how will it change once hub labs are established? Who is able to run the different tests? Would teams be set up based on the tests to be run? Would these procedures be different if a sample was sent in from the feral swine population?

16. How many trained individuals do we have that can accurately diagnose CSF?

17. Do we have a centralized system for processing samples before they are sent to the lab during an outbreak to speed up turn around time or confirm a possible outbreak?

18. What happens if the sample is CSF positive?

19. For low and high pathogen CSF, how far can the virus disseminate? What is its survival in the environment?

20. Do you know of any difference in the virulence of the different genotypes for CSF?

    The Veterinary Record, 2003 explains that the virus was introduced in June of 2000, but the first diagnosis did not occur until August of 2000. Why was this so? Are the current diagnostic tests in use for CSF good enough to pick up the early infection of CSF or Low pathogen CSF or is this a problem with surveillance?

21. Do your swine diagnosticians and swine practitioners know how many swine diseases there are which could mimic the signs for CSF?

22. What are the signs, symptoms and pathology for a low pathogen CSF?

23. At which stage of the disease do sows start showing obvious clinical signs for the high pathogen CSF and the low pathogen CSF?

24. Were all 75,000 samples tested at Veterinary Laboratories Agency? How many individuals were involved in diagnosing this outbreak at the Laboratory level? What are the best sampling strategies, especially following an outbreak of CSF, to limit over-capacity concerns?

25. How many swine cases does Veterinary Laboratories Agency (VLA) report annually? Of these how many are Erysipelas, Salmonella, Septicemias, Porcine Respiratory and Reproductive Syndrome (PRRS), Porcine Dematotis and Nephropathy Syndrome (PDNS), and/or Post Weaning Multi-symptomatic Wasting Syndrome (PWMS)?

26. What diagnostic tests do you run for AI (artificial insemination) on boars?

27. How effective do you feel the marker vaccines are for CSF? How specific/sensitive are the ELISA's toward these vaccines? Would the U.K. use marker vaccines if there was another outbreak of CSF?

28. Do you feel there is an international market to make new vaccines and diagnostic tests for large animals? (i.e. Classical Swine Fever)

29. Can the strains for CSF be modified? Do you have monoclonal antibodies against surface proteins or the virus? If so, are you using these antibodies to classify isolates?

30. Do any of your labs have mobile labs that can go into the quarantine zone? What would be the pros and cons of having such a lab?

31. Are there any drawbacks to using real time PCR during and outbreak situation?

32. What do you feel is industry's role in disease prevention, especially in regards to foreign animal diseases?

33. Do you know of any new technologies for border surveillance or on-farm diagnosis using pen-side assays for CSF? Do you know of any other countries working on this?

34. How effective do you feel the marker vaccines are for CSF? How specific/sensitive are the ELISA's toward these vaccines?

35. Do you feel there is an international market to make new vaccines and diagnostic tests for large animals? (i.e. Classical Swine Fever)

36. Are there true low virulent strains of CSF or is what we see as low virulent strains more of a function of CSF being in an endemic area? Would a strain seen as low virulent, such as from Mexico, become the classic high virulent CSF strain if introduced into the United States?

37. How long can people carry the CSF virus? Do other species act as vectors/carriers besides swine? What is the carrier state of the vaccinated animal?

38. For low and high pathogen CSF, how far can the virus disseminate? What is its survival in the environment?

39. Are there any drawbacks to using real time PCR during and outbreak situation?

40. What tissue samples would be most effective for diagnosing CSF?

41. Is there any new type of vaccine research occurring for marker vaccine or prophylactic use?

42. What are the problems between the state and federal labs besides the money issue for running the NAHLN? What happens if a state lab gets 14 out of 27 swine samples positive for CSF?

43. A list of all of the tests run, positive controls, protocols, cell lines used, reagents etc.

44. How much communication is there between state and national labs?

45. Will all hub labs be standardized in equipment? What are you opinions on ring vaccination? Do you feel the USDA will ever move away from depopulation? Why or Why not? If we got CSF into the U.S. would we vaccinate?

46. Where do you feel the USDA is the most short staffed for detecting a foreign animal disease?

47. How easy could low virulence CSF go undetected at a slaughter plant? How much testing is done on condemned swine at slaughter plants?

48. Do you feel CSF has come into the U.S. since it has been eradicated, but has not found the right pathway to become established?

49. Do you feel that real-time PCR would be a feasible approach for border surveillance? How confident are you in using real-time PCR for CSF diagnosis? How many samples would be required to confirm a positive herd?

50. What conditions would be required before state veterinarians in charge stop movement of animals or initiate slaughtering of swine? Would they wait for confirmation from PIADC first?

51. What are your concerns about low virulent strains of CSF? Does our current CSF surveillance take the possibility of low virulent CSF into account? Do you think there are truly low virulent strains out there, or is it just a function of the virus being in an endemic area? Would a "low virulent "CSF strain, such as from Mexico, become high virulent if introduced into a naïve population, such as in the United States?

52. What are your concerns about misdiagnosing CSF, especially if it is low virulent? How easy could low virulent CSF come into the U.S.?

53. What are your feelings on database integration in regards to CSF surveillance?

54. How often are ill/poor-doing pigs seen by practitioners? What are the common clinical signs seen (high fever, constipation, diarrhea, abortion, not eating, etc.)?

55. How much training do practitioners have in PR to identify CSF?

56. How easy could low virulence CSF go undetected at a slaughter plant? How much testing is done on condemned swine at slaughter plants?

57. What are the current procedures for diagnosing CSF in Mexico? Is it diagnosed at the state level, or is there a central lab? What is your role in this procedure? Do you select the reagents/strains? Where do they come from? Do you have a strain bank? What are the protocols?

58. What are current (new) diagnostics, research, etc, going on in Mexico regarding CSF?

Appendix 5.4: Laboratory survey

Classical Swine Fever Survey

1. Assuming that FADDL has given you all of the reagents to run Classical Swine Fever (Hog Cholera) in your laboratory, please fill the following table.

Test	Number of samples that could tested per day.	Test would be done manually (M)/using robots (R) or both (B)	Turnaround time manually(M)/using robots (R) or both (B)	Number of individuals trained to diagnose CSF
FAT		• M: • R: • B:	• M: • R: • B:	
PCR		• M: • R: • B:	• M: • R: • B:	
VNT		• M: • R: • B:	• M: • R: • B:	
ELISA		• M: • R: • B:	• M: • R: • B:	
VI		• M: • R: • B:	• M: • R: • B:	

2. What diagnostic test(s) is the government going to allow you to run for Classical Swine Fever? Check all that apply.

______FAT
______PCR
______Virus Neutralization (NPLA, FAVN)
______ELISA
______Virus Isolation (VI)

3. Is your lab able to run real time PCR for classical swine fever?

A) Now:

Yes___________

Number of individuals trained to run the test__________

No_________

B) Once your lab receives the reagents from Plum for Classical Swine Fever
Yes___________
Number of individuals trained to run the test__________
Expected date reagents for CSF are to be received from FADDL_________
No__________

4. Do you feel that the current real-time PCR machine is currently the best diagnostic tool to use in the face of a CSF outbreak to handle a large volume of samples?
Yes__________
Why____
____
____
____

No___________

Why____
____
____
____

5. Do you feel the current real-time PCR machines would be a feasible diagnostic tool for use by practicing veterinarians?
Yes__________
No__________

Why____
____
____
____
____

6. Is your lab planning on building a bio-level 3 Lab, or does it already have one?
________Yes, we already have a bio-level 3 Lab
________Yes, we are in the process/planning of building a bio-level 3 lab
Expected date of completion:_____________
________ No, we will not have a bio-level 3 lab

7. A sample from a diseased pig comes in for regular testing (i.e. Erysipelas, Salmonella, Pseudorabies) that is CSF infected, but not realized at the time. What would be the sequence of events that would take place before CSF is suspected?

____
____
____
____
____
____

8. Do you feel there is any need/possibility for a surveillance program for the feral swine population within the United States?

Yes_______

Why____
____
____
____

No_______

Why____
____
____
____

9. Do you have any suggestions for increasing the education/awareness of practitioners and the public of the consequences and economic impacts of foreign animal diseases (i.e.Classical Swine Fever) as well as their role in foreign animal disease detection?

____
____
____
____

10. What are the lab's emergency/contingency plans for a foreign animal disease (i.e. CSF)?

____
____
____
____

This survey will be used anonymously in our report to the USDA and we will provide you a draft of the report before it is submitted. Please feel free to contact us if you have any questions concerning this project.

Appendix 5.5 National Animal Health Laboratory Network Laboratory Test Capacity and Turnaround Time

		Laboratories within the National Animal Health Laboratory Network (NAHLN)							
		1	2	3	4	5	6	7	8
Direct Flourescent Antibody Test (FAT)	Number of Samples	NR[1]	25	NR	100	NR	NR	30	100
	Mode of diagnosis (M/B/R)[2]	NR	M	NR	M	NR	M	M	M
	Turnaround time per sample	NR	2 days	NR	12 hours	0	NR	1 day	1-2 days
	Individuals Trained	NR	0	NR	5	NR	NR	2	3
Reverse Transcriptase (RT)- PCR	Number of Samples	NR	40	NR	1300	NR	NR	80	400
	Mode of diagnosis (M/B/R)	NR	M	NR	B	NR	B	R	B
	Turnaround time per sample	NR	2 days	NR	8 hours	NR	NR	1-2 days	1-2 days
	Individuals Trained	NR	0	NR	5	0	NR	4	2
Virus Neutralization Test (VNT)	Number of Samples	NR	20	NR	1200	NR	NR	NR	20
	Mode of diagnosis (M/B/R)	NR	M	NR	M	NR	M	NR	M
	Turnaround time per sample	NR	4 days	NR	5 days	NR	NR	NR	2-3 days
	Individuals Trained	NR	0	NR	8	0	NR	NR	2
Enzyme Linked immunosorbent Assay (ELISA)	Number of Samples	NR	200	NR	2000	NR	NR	50	1000
	Mode of diagnosis (M/B/R)	NR	B	NR	B	NR	B	R	B
	Turnaround time per sample	NR	2 days	NR	5 hours	NR	NR	NR	1-2 days for both
	Individuals Trained	NR		NR	12	0	NR	0	NR
Virus Isolation (VI)	Number of Samples	NR	20	NR	100	NR	NR	20	20
	Mode of diagnosis (M/B/R)	NR	M	NR	M	NR	B	M	M
	Turnaround time per sample	NR	14 days	NR	9 days	NR	NR	7-14 days	3-5 days
	Individuals Trained	NR	0	NR	8	0	NR	0	NR

1.) NR- No Response
2.) (M/B/R)- Manually/Both/Robotic Automation

Appendix 5.6
Classical Swine Fever (CSF) Surveillance Fiscal Year (FY) 2004 and Beyond

Revision 2

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Veterinary Services' (VS) Objectives for CSF Surveillance

Should CSF be introduced into the United States, enhanced surveillance will:

- Allow for the early identification of the disease;
- Interrupt its transmission; and
- Facilitate its eradication and control.

Serology and Its Drawbacks

The last available national CSF surveillance approach is described in VS Notice 99-13. That Notice directs that "a sample of 10 percent of the specimens collected for Pseudorabies virus testing at the lab will be submitted to APHIS' NVSL FADDL for CSF testing as well." While serology allows the detection of surviving animals beyond the viremic stage, that method of identification of CSF in domestic slaughter swine surveillance has drawbacks:

- This method of surveillance does not target high risk swine or those animals most likely to be infected first. Thus, the identification of the introduction of CSF into the United States could be delayed until the disease has spread. Because of routinely high standards of production and accompanying biosecurity, domestic slaughter surveillance may have very little importance in CSF surveillance. Therefore, the focus should be on other areas deemed to be at greater risk for CSF introduction.
- Serological surveillance does not target domestic swine displaying clinical signs consistent with CSF.
- Serological surveillance does not meet the objective of early detection. Previous studies suggest that using serology could delay the detection of a CSF introduction by several months or more.
- Current surveillance methods at slaughter plants only target sows and boars, so market swine are not tested for CSF titers. Market swine are believed to be a more sensitive indicator of CSF virus (CSFV) exposure.
- Better tag retention and compliance with tagging regulations for transported animals is necessary for appropriate surveillance. Tagging and traceback are only as good as tag retention and compliance will allow.

Working Smarter

How will VS enhance and improve CSF surveillance? How will we work smarter than we have in the past? The following steps are necessary for more effective surveillance:

1. *Focus on High Risk Populations*

USDA APHIS VS will seek to focus its surveillance efforts on the swine populations at highest-risk for CSF. Using the high risk swine populations for targeted surveillance will involve searching out premises characterized by management practices that allow CSFV pathways to be unprotected. Targeted surveillance provides an early warning notification of open pathways for CSFV into the United States. Non-targeted (scanning) surveillance is also useful for verification of targeted surveillance despite sampling in a lower risk swine population.

If a low pathogenic strain of CSF should gain entry to the U.S. and not be detected via antigen-based sampling of clinically ill swine, it is important that a back-up system of serological testing be in place to detect infection. Conversely, limited serological sampling would ensure that our aggressive antigenic surveillance program is effective. It is important that epidemiologists evaluate how swine populations, particularly from high risk areas, might be validly sampled on an ongoing basis for freedom from CSF.

A combined effort of targeted and scanning surveillance provides the most comprehensive assurance of freedom from CSF in the United States. Collections of targeted surveillance samples provide for better surveillance reliability compared to scanning surveillance collections due to the difference in the risk factor exposure in the sampled populations. Area Veterinarians in Charge (AVICs) are urged to place the greatest collection efforts and resources on targeted surveillance, but not to disregard the importance of scanning surveillance.

Scanning surveillance utilizing statistical sampling procedures and assuring that an array of many different producers from various areas is collected would enable better surveillance in slaughter plants rather than a large number of samples from just a few producers. AVIC's need to assure that surveillance strategies enable a wide ranging view of swine production within the state keeping sampling priorities focused on high risk animals for CSF introduction.

In some cases, State law may prevent VS from collecting samples we deem essential. For example, Florida law states that all swine in the State shall be available for bleeding should State or Federal officials deem it necessary. In contrast, current New Jersey law does not allow blood sampling if a premises owner declines our request to enter and bleed animals. This presents difficulties given the high concentration of immigrant labor in that State; many swine premises should be sampled to test for the possible entry of the CSFV brought in by the immigrant labor force from CSF-affected countries like Cuba and Mexico.

AVICs in each State should work cooperatively with the state veterinarian and the state veterinary staff to insure authority exists to collect samples targeted for appropriate high risk surveillance in that state. Given the current focus on food security and the risks of intentional introduction of agents, communications regarding protocol and procedure for surveillance sampling should be established as quickly as possible.

2. Concentrate Resources in High Risk States

VS will concentrate its surveillance testing resources on high risk States; lesser resources will be devoted to low risk States. VS Notice 99-13 (currently inactive) addresses the criteria for determining a high risk State. High risk areas for CSF include those with garbage feeding operations, backyard swine operations, feral swine hunting clubs, military bases, international air or sea ports, farming operations utilizing an international labor force, corporations engaging in international movement of swine, etc. Many avenues for CSFV entry exist beyond what is suggested here. Adequate CSF Surveillance is dependent upon the AVIC and state veterinarian knowing what risks exist in his/her state and ensuring that targeted surveillance is carried out in those swine populations. Scanning surveillance (non-targeted in its methods) is not sufficient as a stand-alone surveillance strategy to accomplish early detection, but would compliment targeted surveillance.

The following territories will be identified as **very high risk:**

Puerto Rico (total = 1)

The following states will be identified as **high risk**:

Eastern Region: total = 8 **Western Region: total = 10**

Florida	Arizona
Georgia	California
Illinois	Hawaii
Indiana	Iowa
Minnesota	Kansas
New Jersey	Nebraska
New York	New Mexico
North Carolina	Oklahoma
	Texas
	Washington

The remaining unlisted states will be designated low risk. (total = 32)

High risk is partly a function of the number of swine in each state and the number of swine imports in each state. The number of swine is important because that affects the risks and consequences of exposure. Swine imports are important because they directly control a pathway for CSF virus. Funding levels, as shown in Appendix 2, are determined by the swine population levels and the number of annual swine imports in each state. The pathways for exposure of a susceptible population of swine to CSFV in any state are the substantial variables in the funding equation to determine risk level.

3. Develop a Targeting Strategy for Each State

AVICs will be tasked with developing a plan appropriate to CSF high risk sampling for their respective States. The current serological testing methodology should be gradually enhanced by emphasis on clinical surveillance (sampling of animals displaying clinical signs consistent with CSF) and high risk non-clinical surveillance (CSF infections can range in clinical signs from non-clinical to generalized unthriftiness). Examples of high risk non-clinical surveillance might include swine production areas surrounding illegal boat landings in Puerto Rico and swine production units using an immigrant labor force. Scanning serology remains our stop-gap identification measure in case low path CSF escapes diagnosis based on clinical signs (diagnostic tests can pick up low and high virulent strains), albeit slower to alert us through positive tests due to seroconversion. Base-line serology should be enhanced by testing in high risk populations using virus detection techniques. These statements are not intended to suggest that double sampling of animals is necessary. Virus detection methods remain the recommended first choice for testing in high risk animals, however serology should continue in other groups of swine not readily lending themselves to sampling by tissue harvest, nasal swabbing, or tonsil scraping.

In instances where facilities are inadequate and/or the safety of personnel is a concern, sampling from high risk premises by purchase of piglets may be the best option.

Sampling regimens should be oriented toward nasal swabs, tonsil scraping, whole blood buffy coat virus isolation/detection from sick animals, or tissues from slaughter, euthanasia, or diagnostic laboratory animal submissions, and should be given first priority purposely to facilitate the early detection of CSF. Serology will continue to be used for surveillance when nasal swab, tissue sample submissions, or whole blood collection is not possible after exhausting all of these other options. *Appendix 1* provides more detail on sampling procedure and shipping of samples to a Foreign Animal Disease Diagnostic Lab (FADDL).

AVICs and State Veterinarians must continue to develop good working relations with private practice veterinarians, diagnostic laboratories, and swine producers to gain their trust and increase sample collection possibilities. Public awareness through teaching sessions should become a routine part of VS' foreign animal disease prevention mission. It is important to discuss with industry, producers, and veterinarians the fact that sampling does not automatically lead to quarantines and swine movement restrictions. Rather, traces through the proper identification of positive animals to infected premises are essential to locating and removing infected animals in the interest of protecting the security of our nation's food supply and viability (profitability) of the industry. Drs. Don Rush and Mark Schoenbaum will consult with Eastern and Western Region AVICs on surveillance activities as needed.

Targeted surveillance utilizes a 2-step process as described below. Step 1 targets high risk animals or herds by asking the following questions:

1. Is the farm a garbage feeding premise?
2. Does the farm employ foreign workers?
3. Have any employees traveled internationally in the previous 2 weeks?
4. Have there been any foreign visitors or contract laborers on the farm in the previous 2 weeks?
5. Is the consumption of foreign meat products allowed on the farm?
6. Is the farm located near a military or cruise ship base?

An affirmative answer to any one or more of the Step 1 questions leads to Step 2. Step 2 provides screening criteria to narrow our focus in the attempt to find CSF.

Step 2: A combination of two or more of the following signs/lesions can be consistent with CSF infection: (two or more signs may be found in a number of other diseases, as well)

1. Persistent high fever
2. Conjunctivitis – crusty eyes
3. Constipation, occasionally followed by diarrhea
4. Staggering gaits, often followed by posterior paresis
5. Purple discoloration over the skin of the abdomen, snout, ears and inner side of limbs
6. Multiple hemorrhages with various sizes throughout the body, commonly in the lymph nodes and kidneys.
7. Multiple necrotic foci in tonsil and splenic infarcts are indicative of CSF infection, but not consistently present
8. Growth retardation-runted pigs
9. Not eating or responding to antibiotics
10. Abortion in pregnant sow or neonatal death / mummification
11. Low white blood cells or platelets counts
12. History of high mortality and sudden death

Other clinical signs that might be associated with CSF infection:

1. Coughing and respiratory problem
2. Dullness, reluctant to move and reduced appetite
3. Convulsion
4. Raised hair
5. Vomiting

With positive responses to both Step 1 and Step 2, clinical signs consistent with CSF are tied to international connections. Forwarding of targeted CSF tissue and blood samples to FADDL is important to the early detection effort of the CSF Surveillance in every state and territory.

Although generalized unthriftiness ranging to sub-clinical illness is part of the CSF variability seen with infections depending upon strain virulence, the consensus of opinion is that a targeted approach is more efficient for early detection. AVICs and State Veterinarians will make the ultimate decision as to the necessity of capturing samples with clinical signs suggestive of CSF. The other limiting factor is FADDL's ability to process samples. Should FADDL become overwhelmed, some adjustments in lab resources at FADDL and state sampling regimes may be necessary. The team members previously listed will assist as necessary.

4. Work with State and University Diagnostic Laboratories

In light of our recommendations to concentrate resources on high risk populations, AVIC's are encouraged to seek agreements with State and university veterinary diagnostic laboratories. The veterinary diagnostic laboratories in many States process large numbers of swine samples for the commercial swine industry (a sizable proportion do not receive a conclusive diagnosis). Some Midwestern laboratories (like those in Iowa, Kansas, Minnesota, and Missouri) may receive samples from nearly 40 States. Clearly, these laboratories have wide coverage. Agreements with State and university laboratories to make a percentage of their samples available for testing at FADDL on Plum Island is an appropriate avenue to sample domestic swine with suggestive CSF clinical signs. Targeting swine demonstrating clinical signs consistent with CSF enables the earliest possible detection while theoretically keeping samples at a manageable level. AVICs in high risk areas should negotiate agreements with the laboratories to provide free or low-cost post-mortem examinations on sick or dead back-yard or transitional animals.

5. Coordinate with the Food Safety and Inspection Service (FSIS) and non-inspected slaughter/rendering establishments

USDA APHIS VS will coordinate with FSIS regarding the forwarding of condemned swine tissues to FADDL for virus detection. This coordination will become part of the new cooperative effort between FSIS and VS. Facilitation of custom kill, state inspected slaughter plant, or rendering plant collections by the AVIC will target appropriate high risk CSF surveillance in certain states.

The sow-boar blood sampling program most likely samples a sub-optimal population for CSF testing. Market swine are killed relatively quickly after potential exposure to CSF or other regulatory diseases of concern (e.g. PRV), making them a more appropriate sample population versus sows. Identification issues are minimized because producer payment is based on carcass tattoos in most cases.

AVIC's may be able to facilitate market swine collections with packing plant management depending upon line speeds, available plant facilities and personnel, and cooperative agreements with local FSIS personnel. Meat juice testing (MJT) of market swine for CSF will be an available option in the future.

6. Coordinate with APHIS, Wildlife Services (WS)

Wildlife Services is implementing a wildlife disease monitoring and surveillance system that will include conducting biological sample collection in coordination with existing operational and research activities. Sampling in coordination with other organization's activities will also occur. Wildlife Services personnel work with feral swine is often conducted in States that are considered high risk States. This provides additional opportunity for testing in high risk populations of swine.

7. Improve Swine Tagging

USDA APHIS VS will work on swine tagging to achieve better retention and more complete identification of swine in transport vehicles and arriving at slaughter establishments. Currently, better tagging compliance and tag retention methods are being pursued by Dr. John Wiemers.[1] This effort does not affect the current budget, but contributes to the overall objective of making the entire slaughter population available for sampling and traceable to source premise.

8. Conduct a Formal Pathway Assessment

The Centers for Epidemiology and Animal Health (CEAH) has contracted with a consortium[2] to conduct a formal pathway assessment for the risk of the introduction of CSF. The objective is to prioritize our focus and funding so that potential avenues of entry for CSFV are most targeted. Dr. Ken Forsythe and Mr. Tim Clouse will take the lead and provide information to better direct VS' CSF surveillance program. CEAH will cover the

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[1] Animal identification efforts will start in 2004-2005. See http://www.usaip.info/ for details.
[2] Kansas State University, Texas A&M University, Purdue University, and Sandia National Laboratories.

necessary budgeting for this activity. It will, therefore, not draw funding from the CSF surveillance plan dedicated funds. A draft of the report will be available in December 2003 – January 2004, and the final report should be published in August 2004 (or earlier).

Determining High Risk Groups:

Sampling priorities in each State will be determined by the AVIC and State Veterinarian. The following suggestions on sampling priorities should be modified depending on the unique circumstances and environment in each State. CEAH will work with AVIC's to develop a county-level listing by state that will rank counties by using various criteria, such as:

- International water and air landings: passengers and fomites with viable CSFV or illegal transport of live swine from CSF-affected areas. Swine farms with immigrant farm laborers;
- Sick swine calls (foreign animal disease investigations would involve sampling, but are funded under a different category);
- Illegal garbage feeders and legal feeders with inadequate biosecurity and unhealthy swine;
- Feral/backyard swine;
- Domestic swine: veterinary diagnostic laboratories and condemned slaughter swine tissues.

Facilitating better surveillance activity in very high risk areas

In Puerto Rico, special efforts need to be made to assist Animal Health Technicians (AHTs) in providing non-FAD diagnoses to area producers to engender team-building concepts with the local waste-feeding producers in a very high risk environment. Local veterinary service is non-existent, leaving producers without means of veterinary support outside of cooperative program contact.

Determining Funding Levels:

Currently, the CSF Surveillance Plan is funded for fiscal year (FY) 2004. Funding levels (except for Puerto Rico) are based on a formula that allocates funds based on the number of swine in each State and the number of swine imports. However, each State will get at least $2,000. See ***Appendix 2*** for the funding schedule.

Why This Surveillance Plan Works:

This Surveillance Plan is more appropriate for early detection of CSF. Moreover, it demonstrates to our trading partners that the United States is free, and intends to remain free, of CSF. This Plan has the following specific advantages:

- Aggressively implements both targeted and non-targeted/scanning surveillance to demonstrate freedom from CSF;
- Emphasizes the collection of clinical and laboratory-related diagnostic information targeting swine at higher risk of CSF infection allowing ***earlier detection, containment, and elimination;***
- Maintains scanning serological surveillance at low levels as a secondary detection system.

Database Reporting

Surveillance sampling will be reported by state (quarterly for low risk and monthly for high and very high risk) into the CSF database in Lotus Notes. Access to this database and other operational details are shown in Appendix 3.

Future reporting of surveillance will occur in a yet-to-be named IT database that would ultimately collect all swine disease surveillance information. This database reporting for CSF would collect epidemiological information, lab submission data and results. As per Dave Kinker at NVSL, this is projected to be available in summer 2004.

Promoting Targeted and Non-targeted Surveillance of swine by contacts with swine producer groups and practitioners

Increased activity to raise awareness and promote practitioner, producer and youth group reporting. It is mandatory for AVIC's to provide an outreach program through their office. We are fully aware that practitioners, producers and others are unaware of whom to call and what will happen to them when they call. Field contact will mimic what the California Department of Food and Agriculture (CDFA) proposes for increased participation by practitioners. This involves periodic calling of practitioners to give an update of our programs (subject to the discretion of the AVIC), contribute to public relations between USDA and private practices, and initiate awareness of our concern for FAD's. It would also give us the opportunity to reduce the timidity involved when practitioners or producers pick up the phone to call us with information on sick swine to be sampled. The more we communicate, the easier it is for the practitioners to phone in possible FAD suspects. Due to the marked reduction in swine practitioners in most states except some Midwestern states, FAD teaching sessions also need to be held with producers and industry representatives, and with youth groups like FFA and 4-H. In each of these sessions, FAD materials, currently in the works at CEAH, will be handed out to provide information and point of contact phone numbers. All in all, we need to create public relations contacts such that we remove the fear in reporting and explain the substantial benefit we expect by reducing the spread of FAD's. Even though endemic disease look-alikes are going to be called in, we want to impart the value of those call-ins to people working around swine.

Future considerations

The surveillance for any foreign animal disease including CSF is a rapidly evolving project. As new technologies become available and are evaluated, the CSF Surveillance Plan will be modified to incorporate this technology in an effort to provide for reliable reporting and early notification. Testing strategies may change as new testing methods come on-line.

As the National Animal Health Laboratory Networks (NAHLN) phase-in begins and Real Time - Polymerase Chain Reaction (RT-PCR) testing becomes available to NAHLN labs following validation, national surveillance for CSF will evolve to new levels of efficiency. NAHLN capability for CSF RT-PCR testing may become available at some point in mid 2004. At the time the CSF Review Team is notified that the NAHLN labs are on-line and the RT-PCR testing is available, an addendum to this FY 2004 CSF Surveillance Plan will be provided to explain procedures, a protocol for confirmation of positive test results, and any necessary information related to sampling.

Revisions to the CSF Surveillance Plan are expected to occur on an annual basis. As the NAHLN labs come on-line and other mid-year revisions become necessary, an addendum to the current surveillance plan will be issued. It is expected that updates on animal identification, on the CSF pathways consortium recommendations and conclusions, and on database collaborative efforts will be provided in annual revisions.

Attachments:

Appendix 1: Samples for CSF Surveillance

Appendix 2: CSF Funding Allocations

Appendix 3: The CSF Lotus Notes database.

Appendix 1 of CSF surveillance document

Swine tonsil

Samples for CSF surveillance

Samples for CSF detection or isolation:

1. Tonsil is the primary organ for virus detection/isolation during acute and chronic infection. Tonsils will be screened by DFA/ABC, and virus isolation would follow to confirm suspect or positive DFA/ABC results
2. Nasal swab in 1.5 ml of DMEM broth with high antibiotics will be tested by VI and realtime PCR
3. Spleen and lymph node are secondary tissues for detection of CSF and **won't** be examined for a routine CSF surveillance unless the results on other samples are doubtful.
4. Whole blood in green (heparin anticoagulant) or purple (EDTA anticoagulant) top tube for PCR or green top (heparin anticoagulant) for VI. This sample will be considered for testing if no other organs can be submitted.

General instruction:

1. Tissue or swab is **preferably** stored at 4° C (39° F)(refrigerated) and shipped on ice packs within 1-2 days of collection.
2. If a tissue or swab cannot be shipped within 1-2 days, they can be stored at -70° C (-94° F)(diagnostic labs) or in a blast freezer (processing plants) for a maximum of 3-7 days. Frozen samples should be shipped on ice packs or dry ice (if available) by FedEx. Only VI will be conducted on tissues frozen prior to shipping.
3. Minimum amount of tissues should **not be less than 1 x 1 inch** in size or **not less than 1 gm** in weight. Tonsils from 2-3 animals from the same pen or farm can be pooled in one bag.

4. Tonsil scraping should be preserved in a minimum amount of transport media (DMEM or BHI). Store at 4° C (39° F) until shipped.
5. Minimum of 1 ml serum or 2 ml of red top tube (clot tube) of blood is required to conduct the serological tests. Store serum at 4 C (39° F) until shipped.
6. Minimum of 5 ml of whole blood (green top and/or purple top tube) is required to conduct virus isolation. Store at 4° C (39° F) until shipped.
7. All samples should be properly labeled.
8. Fill out the VS 10-4 form including history and lesion descriptions, definitive diagnosis (if determined by diagnostic labs) and contact number for the submitter.
9. Place a copy of the submission form on the outside and the inside of shipping container.
10. Ship samples by overnight FedEx, do **NOT** use regular UPS or postal service.

Materials:

Sterile dacron swabs are available through the supply network and are preferable for nasal swabbing. Cotton swabs do not maintain viral titers as well, thus less desirable for accurate results.

Nasal swab:

Type of swab:

Dacron swab is recommended for VI and PCR for a better chance of virus recovery.

Nasal swab collection:

The sterile dacron swab should be introduced no more than 1 inch into both nostrils making circular moves (five times) to wipe the surface of the nasal mucosa. Then, the swab is introduced into a refrigerated sterile tube containing 2 ml DMEM media. Swab can be discarded after it has been swirled in the media for 5-6 times.

Source for swab and media

Dacron swab and DMEM media will be provided in the FADD kit or they can be purchased from the following source:

Dulbecco's Minimal Essential Medium (DMEM) (Gibco, cat# 12430-054), phone 1-800-874-4226. This medium can be stored at 4 C (39^{o} F) for 12 months. Please do not freeze.

Sterile Dacron swabs polyester fiber tipped with plastic shafts (FisherBrand, cat#14-959-90), phone: 1 800 766-7000.

Sample for serology:

Serum or blood in red top tube. (minimum 1 ml serum / 2 ml whole blood)

Laboratory results:

All laboratory reports will be faxed to the AVIC's office of the submitting State.

Turn around time for test results:

Serology takes 3-10 days

Immunohistochemistry (DFA and ABC) on frozen sections takes 3 days

Virus isolation takes 3-7 days

Abbreviations:

ABC: avidin-biotin complex

BHI: brain-heart infusion

DFA: direct fluorescent antibody test

DMEM: Dulbecco/Vogt modified Eagle's minimum essential media for cell culture

PCR: polymerase chain reaction

VI: virus isolation

Special Notes applicable to sample collections:

1) Cotton swabs only suitable for virus isolation, not PCR.
2) Tonsil scrapings may be suitable in a live animal. Tonsil biopsy does not conform to animal welfare considerations.
3) Tissue and blood collection priorities for diagnostics.
    a. Slaughter / euthanasia / diagnostic lab necropsies:
        i. 1st. Tonsil is the primary tissue. Secondary tissues are lymph node, spleen, liver, kidney, distal ileum. Note: distal ileum is never to be enclosed in the same container as other tissues. Ship these tissues, and
        ii. 2nd. nasal swab, and
        iii. 3rd. whole blood (green or purple-topped tubes) and sera.
        iv. Note: It is expected that these animals be fully utilized by collecting <u>all</u> possible tissues. It may save a diagnosis that otherwise would not be possible. The laboratory can always discard unnecessary tissues.
    b. Live animal:
        i. nasal swab, and/or
        ii. tonsil scraping, and/or
        iii. whole blood, or
        iv. serum.
    c. Recently dead suspect animal (based on clinical signs and/or history):
        i. 1st. nasal swab, and
        ii. 2nd. unclotted blood, or
        iii. clotted blood if too much time has elapsed, and
        iv. tissues (especially tonsil) from necropsy specimen as above and as available.

Shipping address:

To: Tom McKenna
USDA, APHIS, VS, FADDL
Route 25, Orient Point Warehouse
579 Edwards Ave
Calverton, NY 11933

FADDL phone numbers:

Main: 631 323 3206/3256

Cell (after hours):

(631) 871-3112

(631) 375-5314

Appendix 2 of CSF surveillance document

CSF Funding Allocation

Budget is $500,000 - $60,000 (PR) - $3,000 (Misc) =	**$437,000**
Minimum of $2,000 / state	
Less $2,000 /state minimum (50 * $2,000) =	**$337,000**
No state gets more than $40,000	

	FY 02 Imports		1999 Population (Thousands)	% of Imports	% of Population	Total %/2	Funding
Alabama	8,618	AL	175	0.1%	0.3%	0.2%	$2,743
Alaska	436	AK	1	0.0%	0.0%	0.0%	$2,016
Arizona	1,362	AZ	140	0.0%	0.2%	0.1%	$2,436
Arkansas	532	AR	710	0.0%	1.2%	0.6%	$4,031
California	326,253	CA	190	5.5%	0.3%	2.9%	$11,839
Colorado	3,333	CO	910	0.1%	1.5%	0.8%	$4,679
Connecticut	37	CT	4	0.0%	0.0%	0.0%	$2,011
Delaware	31	DE	27	0.0%	0.0%	0.0%	$2,078
Florida	316	FL	40	0.0%	0.1%	0.0%	$2,123
Georgia	72	GA	480	0.0%	0.8%	0.4%	$3,365
Hawaii	7,782	HI	28	0.1%	0.0%	0.1%	$2,301
Idaho	44,599	ID	22	0.8%	0.0%	0.4%	$3,334
Illinois	122,128	IL	4,050	2.1%	6.8%	4.4%	$16,981
Indiana	170,057	IN	3,250	2.9%	5.5%	4.2%	$16,075
Iowa	2,255,322	IA	15,400	38.1%	26.0%	32.1%	$40,000
Kansas	1,786	KS	1,460	0.0%	2.5%	1.2%	$6,197
Kentucky	80,842	KY	460	1.4%	0.8%	1.1%	$5,610
Louisiana	0	LA	29	0.0%	0.0%	0.0%	$2,082
Maine	1,559	ME	7	0.0%	0.0%	0.0%	$2,064
Maryland	2,235	MD	55	0.0%	0.1%	0.1%	$2,220
Massachusetts	2,410	MA	20	0.0%	0.0%	0.0%	$2,125
Michigan	68,368	MI	980	1.2%	1.7%	1.4%	$6,731
Minnesota	1,087,353	MN	5,500	18.4%	9.3%	13.8%	$40,000
Mississippi	0	MS	280	0.0%	0.5%	0.2%	$2,795
Missouri	4,239	MO	3,150	0.1%	5.3%	2.7%	$11,065
Montana	9,842	MT	155	0.2%	0.3%	0.2%	$2,721
Nebraska	224,297	NE	3,000	3.8%	5.1%	4.4%	$16,911
Nevada	0	NV	8	0.0%	0.0%	0.0%	$2,021
New Hampshire	277	NH	4	0.0%	0.0%	0.0%	$2,018
New Jersey	160	NJ	15	0.0%	0.0%	0.0%	$2,047
New Mexico	29	NM	6	0.0%	0.0%	0.0%	$2,018
New York	3,554	NY	40	0.1%	0.1%	0.1%	$2,215
North Carolina	3,162	NC	9,500	0.1%	16.0%	8.0%	$29,065
North Dakota	101,630	ND	190	1.7%	0.3%	1.0%	$5,436

	FY 02 Imports		1999 Population (Thousands)	% of Imports	% of Population	Total %/2	Funding
Ohio	93,211	OH	1,480	1.6%	2.5%	2.0%	$8,859
Oklahoma	2,428	OK	2,260	0.0%	3.8%	1.9%	$8,486
Oregon	108,939	OR	30	1.8%	0.1%	0.9%	$5,190
Pennsylvania	62,467	PA	1,050	1.1%	1.8%	1.4%	$6,762
Rhode Island	180	RI	3	0.0%	0.0%	0.0%	$2,012
South Carolina	0	SC	245	0.0%	0.4%	0.2%	$2,696
South Dakota	767,882	SD	1,260	13.0%	2.1%	7.6%	$27,464
Tennessee	75,711	TN	250	1.3%	0.4%	0.9%	$4,868
Texas	12,982	TX	870	0.2%	1.5%	0.8%	$4,840
Utah	1,831	UT	520	0.0%	0.9%	0.5%	$3,529
Vermont	1,701	VT	3	0.0%	0.0%	0.0%	$2,057
Virginia	2,619	VA	370	0.0%	0.6%	0.3%	$3,125
Washington	21,834	WA	30	0.4%	0.1%	0.2%	$2,708
West Virginia	0	WV	12	0.0%	0.0%	0.0%	$2,034
Wisconsin	227,337	WI	570	3.8%	1.0%	2.4%	$10,098
Wyoming	0	WY	105	0.0%	0.2%	0.1%	$2,298
Totals	**5,911,743**		**59,342**			**1**	**$358,381**

Not Budgeted and Available $78,619

Appendix 3 of CSF surveillance document

The Lotus Notes CSF database

Access to the CSF database:

File ➔ database ➔ open ➔ set server to data 01 or data 02 ➔ allow time to load and then look for CSF folder under the database window ➔ double click CSF

How to enter information:

At the top, hit the 'Create New report' button.

Entries into the New Report:

1) Enter state from drop-down box
2) Enter date of report
3) Enter type of report as monthly or quarterly (low risk reporting is quarterly and high or very high risk reporting is monthly)
4) Enter reference number: example 2003KYCSF02. First enter the fiscal year as in 2003, enter the state postal code, enter CSF, and then enter the sequential numbering for reports made for that fiscal year (1 through 12 in high and very high risk states; 1 through 4 in low risk states).
5) Enter surveillance period dates
6) Under Surveillance Sampling: enter number of samples, type of sample from drop-down box, source of samples from drop-down box, and risk category of samples. Note: risk categories are determined by AVIC and state veterinarian based upon a CSF Surveillance Plan approved at the Regional Level.
7) Comments and e-mail information for notifying others of the report is available as needed.
8) When finished entering data, hit the 'save and close' button at the top of the document. The document will no be entered into the CSF database.

Additional information:

The CSF Surveillance activities can be viewed VS-wide by any person interested in looking at the surveillance activities nationally. It is in the best interest of the AVIC to assure that this documentation is up-to-date.

Appendix 5.7 Example CSF Surveillance Questions

1. What type of surveillance is going on in each state for CSF? (Samples collected/sampling methods, amount of samples sent to Plum, population sampled, turnover time, etc.)
2. What type of sampling strategy should we use within the USDA for CSF for domestic and feral swine? Should it be based on clinical reporting only? What are the relative merits of active vs. passive surveillance?
3. Are states receiving money for the surveillance they are doing?
4. Which states do you feel should participate in CSF surveillance?
5. What are the planned surveillance strategies for CSF? Any new surveillance methods, such as sentinel herds?
6. Is there any type of surveillance going on at the borders or ports of entry?
7. What is your view of programmatic decisions affecting the border? Do these decisions affect inspectors' ability to "sense" possible contraband (i.e. complacency due to profiling, decreased "sense")? How do you feel is the best way to educate veterinarians of FADs?
8. Do you feel that real-time PCR would be a feasible approach for border surveillance? How confident are you in using real-time PCR for CSF diagnosis? How many samples would be required to confirm a positive?
9. Are any states actively sampling the feral pig population? If so, which states, where are they sampling, and how often?
10. Do you feel there is a need to do surveillance for CSF in the feral population? What is the best way to sample feral swine? Do you think industry should play a role in this especially for trying to detect low virulence CSF?
11. What are your concerns about low virulent strains of CSF? Does our current CSF surveillance take the possibility of low virulent CSF into account? Do you think there are truly low virulent strains out there, or is it just a function of the virus being in an endemic are? Would a "low virulent "CSF strain, such as from Mexico, become high virulent if introduced into a naïve population, such as in the United States?

12. Do you feel CSF has come into the US since it has been eradicated, but just has not found the right pathway to become established?
13. Are results from the states testing for CSF kept in a national database? State database?
14. What are your feelings on database integration in regards to CSF surveillance?
15. What will be the role of the National Animal Health Laboratory Network (NAHLN) in regards to CSF surveillance?
16. How well to states know what other states are doing in regards to CSF surveillance?
17. Do you feel that there is enough communication between the federal, state and local government in regards to FAD's? How could this be improved?
18. What is the best sampling strategy during an outbreak to prevent overcapacity at labs?
19. What would you suggest is the best way to conduct surveillance for CSF?
20. If you could develop your own CSF surveillance program what areas would you target? What new types of surveillance strategies would you include in your program?
21. What preventative measures do you feel we should take in order to keep CSF out of the US?
22. Do you think we should target surveillance, such as in high risk areas, during certain times of the year, etc.? Where would you target and why?
23. Do you think there should be more surveillance in slaughterhouses for foreign animal diseases (FAD), specifically Classical Swine Fever (CSF)? What do you feel needs to improve? What is the best sampling strategy to detect FADs?
24. How do you prevent CSF instead of waiting and responding to it? Will we ever move away from making response the number one action to making prevention the number one action?
25. What do you feel are the advantages/disadvantages of using sentinel herds as part of surveillance?
26. In a country that is not endemic do you feel there should be CSF surveillance on animals that are being checked for swine diseases that can mask CSF?
27. How do you feel the US surveillance is compared to other countries that are endemic with CSF or are free of the disease?
28. What country is the best at CSF surveillance?
29. How long do you feel CSF could go undetected without the hogs showing any clinical signs for CSF? How often do you think heat stroke could mask CSF especially if it is in its low virulence form?

30. Is there a targeted type of surveillance for CSF going on in endemic countries/ non-endemic countries such as the feral population, high risk geographical areas, and garbage feeders etc? What are the relative merits of passive versus active surveillance for CSF, such as clinical reporting versus serological reporting? Are there new surveillance strategies for CSF being planned?
31. Is there a reporting system for smuggled goods into the US? Illegal goods? Is there an obligation to report this? Where do you think are the high risk areas for smuggled/illegal goods? Do you think the US should let the public know about an increase of confiscated goods, especially vets and interested parties, so that a "red flag" goes up if there is an increase?
32. Do you feel FSIS is ready for a CSF outbreak? Where do you FSIS is vulnerable in detecting Foreign Animal Diseases?
33. What is the process of when inspectors see a diseased carcass? Is it tested right away? How is the diseased carcass disposed of? What is done with suspicious carcasses?
34. What is the overall ethnicity of workers in slaughterhouses in the US?
35. How do you feel about the training of inspectors for identifying diseased carcasses?
36. Where do you feel the USDA is the most short staffed for detecting a foreign animal disease?
37. How often are ill/poor-doing pigs seen by practitioners? What are the common clinical signs seen (high fever, constipation, diarrhea, abortion, not eating, etc.)?
38. Do you think sick feral swine are reported?
39. Do you think veterinarians have a false sense of security regarding CSF since it has been eradicated from the US for so long?
40. How well educated is industry in regards to CSF? What are producer's attitudes/concerns towards CSF?
41. What do you think is industries responsibility in FAD prevention? How do you feel government and industry should work together in disease prevention?
42. How often are pigs transported across the US…is this monitored?
43. How well do farms follow biosecurity measures? What do we need to improve?
44. What are your feelings about biosecurity in pig operations? Should we have a standard swine health program? What would be your suggestions as to what should be included in this with regards to foreign animal disease prevention and surveillance?
45. Do you think there should be collaboration between the US and other countries to eradicate CSF in these countries?

46. What do you feel is the best eradication method for CSF?
47. How often do you feel feral pigs are moved between states (such as for hunting purposes?
48. Is there seasons when you feel feral hogs are hunted or trapped more often? When people catch feral hogs what do they do with them?
49. How often do feral swine come through slaughterhouses (legally and illegally)?
50. Where do you feel our knowledge is lacking in regards to the feral swine population?
51. If we had CSF in the feral population in Florida, how long do you feel it would take to eradicate? If just domestic? What about this same scenario in Texas?
52. If CSF got into our feral population, especially in Texas, Florida, or in North/South Carolina, how would you go about eradicating? How would we kill 1000s of feral swine if needed?
53. Do you think our feral swine population needs to be better controlled? How do you do this?
54. In ten years where do you see our feral population increasing/decreasing? In 20 years?
55. What do feel needs to be done with garbage feeding regulations?
56. What are your feelings about unregulated markets such as flea markets selling variety of animals?
57. What conditions would be required before state veterinarians in charge stop movement of animals or initiate slaughtering of swine? Would they wait for confirmation from Plum first?
58. If CSF came into the US, do you think pig owners would let their pigs free?
59. How well is our trace back for swine (commercial versus garbage and backyard operations)?
60. How well is trace back at the Southern Wild Game slaughter plant in Devine, TX that slaughters feral swine (about 95-99% of which gets shipped to Europe)? Would we know which feral swine came from Texas and which came from Florida or another state? Why are we not surveying for CSF at this slaughter plant and should we be?
61. Is there a distinction between commercial, backyard and feral swine recognized by government? How does government define swine in backyard operations and would government reimburse owners if these swine were to be slaughtered for CSF?
62. Puerto Rico (PR) is considered the highest risk for Classical Swine Fever (CSF) introduction into the United States. What are the reasons for this?
63. What are the high risk areas in PR for CSF introduction?

64. What are the most likely ways CSF will come into PR?
65. How often are small boats found along the coasts of PR? How significant of a threat is this? Where do most of the immigrants originate from (Dominican Republic, Haiti, etc.)? What do the immigrants bring with them (pig meat, live pigs, etc.)? Are there seasons where more boats are found?
66. What agency is responsible for regulating small boat traffic around PR? If immigrants are caught coming to PR, what happens? Are there records kept regarding the number of immigrants in the boat, what the immigrants had on them (i.e. pig meat, live pigs, etc.)?
67. Do you think it is likely CSF has come into Puerto Rico but has not found the pathways within PR to establish?
68. How do you think the first case of CSF will be diagnosed in PR?
69. How many pig operations/backyard pig operations/garbage feeders/pig owners/slaughterhouses are in PR?
70. How much training do practitioners have in PR to identify CSF?
71. Is there active sampling of the feral pig population? If so, where are they sampling, and how often?
72. Are there food inspectors in PR? Where do you think they are vulnerable in detecting Foreign Animal Diseases?
73. How well do farms follow biosecurity measures in PR? What do we need to improve?
74. Do you think there should be collaboration between the US and other countries to eradicate CSF in these countries?
75. What are your concerns about misdiagnosing CSF, especially if it is low virulent? How easy could low virulent CSF come into PR undetected? What are the clinical signs of low virulent CSF?
76. If CSF came into PR/US, do you think pig owners would let their pigs free?
77. Are there FADD in PR? How many?
78. If CSF suspected, where do you send the samples? How long does it take for samples to arrive at the lab? Would there potential problems in sending samples with certain weather events, such as hurricanes? How long could a diagnosis be delayed?
79. Do you think CSF prevalence is underreported in the Caribbean?
80. What current surveillance program is in place right not to ensure CSF is not in north Mexico? How is CSF being kept out of the north?

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Chapter 6

Control Measures

CHEMICAL DISINFECTION

Veterinarians and animal health officials recommend the use of a variety of chemical disinfects to aid in the control of CSF. These chemical disinfectants are utilized for a variety of different environments and surfaces, such as transport vehicles, facilities, workers, and other possible fomites of the virus. These disinfectants include chlorine based compounds, phenols, aldehydes, quaternary ammonium compounds, and strong oxidizing agents (reviewed in Edwards, 2000; Quinn, 1987; & Russell and Hugo, 1987). Effective concentrations of disinfectants registered by the Environmental Protection Agency for use in the U.S include a 0.1% solution of a 5.25% bleach stock concentration, Sodium hydroxide (2%) (Van Oirschot 1992), substituted phenolic compounds such as One-Stroke Environ© at a 1% concentration, and the oxidizing agent potassium peroxymonosulfate (Virkon S©) at a 1% concentration. Acidified+ iodophors (e.g. Vanodine©, FAM 30©, and Biocid©) effective against CSFV at a 0.02% concentration are not labeled for use in the U.S. (http://www.antecint.co.uk). Figures 6.1 & 6.2 provide a summary of the characteristics and spectrum of activity for some commonly used disinfectants.

There is limited research on disinfectants that are effective in decontaminating facilities, vehicles, and other items contaminated with CSFV. Specific research needs to be conducted to investigate the efficacy of disinfectants on CSFV in the presence of organic matter. In addition, research needs to be conducted to document the kill time and log reductions of virus titer.

CONTROL & ERADICATION OF CSF

Introduction

Currently, several options exist to control outbreaks of foreign animal diseases such as CSF. The first option for control of foreign animal diseases is to cull the affected herd and introduce strict quarantine in the region of the affected herd to prevent inter-herd transmission. The risk with this method is that the quarantine measures may not be sufficient to prevent spread, particularly if there is potential for the disease to be spread by mechanical or biological pests or vectors or if there is an aerosol component. In a study of the 1997 CSF outbreak in the Netherlands, Stegeman et al. (2002) identified the presence of an infectious herd within a 500 meter radius as a significant risk factor for disease occurrence in susceptible herds.

A commonly used method for disease control in an outbreak situation is stamping-out, where animals in infected and neighboring herds are preemptively culled. Culling is done to reduce the likelihood of infection of new herds in the area (European Commission, 2003). Although stamping-out has been used in containing outbreaks, control of CSF in non-vaccinated populations through stamping out is expensive, especially in areas with high pig densities (Koenen et al., 1996 and Meuwissen et al., 1999). Furthermore, preemptive culling has become debatable because of animal welfare issues; as seen in the 1997/98 outbreak of Classical Swine Fever in The Netherlands when a total of 1286 herds with approximately 1.1 million pigs were culled and only 61 of the herds (4.7%) were infected (Terpstra and De Smit, 2000).

The final phase for the control of CSF in the face of an outbreak is the implementation of an emergency vaccination strategy. Theoretically, the same goal of reduced viral transmission can be achieved by emergency vaccination instead of stamping-out if the vaccination results in one or both of the following:

1) Decreased viral shedding by vaccinated pigs if they become infected, and

2) Protection for pigs from clinical manifestation of the disease (European Commission, 2003).

While a vaccination strategy can serve efficiently in the place of a stamping-out policy, a non-vaccination strategy may be more economically appropriate in the long-term. This is due to the restriction of international trade of pigs with titers to CSFV regardless of the origin of the titer (vaccination or exposure to virus) (DeSmit, 2000).

Vaccination Technologies

Through novel technologies in genomics and proteomics there have been significant improvements made in the field of vaccination technologies for Classical Swine Fever within the last century. In 1903 glycerine was added to defibrinated blood from CSFV infected pigs, and the mixture was heated to kill the virus (USDA-ARS, 1962). Today, full length infectious complimentary DNA clones of CSF are used to aid in the animal's ability to produce an immunogenic response to various antigens found in CSFV. With the wealth of new information discovered each year immunotherapy is rapidly evolving.

Oral Vaccination

Kaden, et al. (2000) studied oral vaccination efficacy for the control of CSF in Eurasian wild boar in Germany from 1993-1995. The study was conducted on three military training grounds (1 uninfected, 2 infected ranges) encompassing 270 km^2. In the 9 months preceding the study, 38 of 411 (9.2%) wild boars tested were CSF positive for Lothringen '92 strain. Strain type was determined by use of monoclonal antibodies and reverse transcription PCR (RT-PCR). The oral vaccine was formulated using CSFV "C" strain propagated in swine fetal kidney cells and placed into a cereal-based bait tablet (4 cm x 4 cm x 1.5 cm) at a vaccine dose of $10^{5.5}$ protective dose (PD^{50}) marked with 150 mg of oxytetracycline (OTC) to establish uptake rates. These bait tablets were then distributed into demarcated wild boar feeding areas in all three locations that had been previously baited with maize to establish a feeding routine within the herd. The prepared vaccine baits were two times at an interval of 7-14 days and repeated 5 months later. In 1993, 7639 vaccine baits were distributed and in the spring and fall of 1994 approximately 12,000 baits were distributed to maize baited feeding areas chosen by hunters with the purpose of establishing one feeding per Km^2. At the end of each immunization cycle wild boar were shot and blood and tissue samples were taken to establish the effectiveness of the oral immunization program. The blood and tissue samples were analyzed using monoclonal antibodies, enzyme linked immunosorbent assay, and indirect immunofluorescence to detect virus and antibody levels present. After each cycle they found that a high correlation between OTC in bones and high antibody rates in the population after the 2 year vaccination cycle was complete After the fall 1993 immunization cycle by cereal based vaccine bait in all three areas, 72% of the harvested animals marked with OTC were serologically positive and more than 80% of the harvested animals antibodies against CSFV with 81% of the harvested animals having antibodies to CSF after the two year study cycle. In the area previously uninfected by CSFV they found approximately 32% of the wild boar sampled were serologically positive after the immunization program, which indicated that antibodies were being produced within a previously uninfected naïve population. The antibody production within the previously unvaccinated/uninfected herd indicated that the oral vaccine campaign had been successful as in delivering vaccine to a large part of the experimental population within the three areas. Using the oral vaccine program in the study areas CSF eradication was reached 6 months quicker when compared to neighboring areas with naïve population not participating in the experimental study where control was reached using conventional stamping out techniques. However, they also found the use of oral vaccination was heavily dependent on other factors such as population density and presence of endemic virus presence.

First Generation Vaccinations

The first generation vaccines available for prophylactic use against CSFV fall into the categories of either killed/inactivated or attenuated vaccines (fig. 6.3). Killed or inactivated vaccines consist of complete, but chemically or physically inactivated microorganisms. These vaccines, when compared with attenuated vaccines are more stable and safer. However, they usually induce a reduced immune response by CD 4+ lymphocytes, and lessened antibody production (Sanchez-Vizciano, 2001). The most widely used forms of inactivation are chemical or physical substances added to the virus for purposes of inactivation. To be effective they must not alter the immunogenic properties responsible for inducing an immune response. An example of a once widely used killed vaccine is the crystal violet vaccine which has the advantages of being safe and inexpensive to produce, therefore it is easily produced and used in unindustrialized nations. However, it does not provide efficacious protection from CSFV infection. These killed/inactivated vaccines were widely used as the first forms of vaccination against CSF and are considered to be the predecessors of the attenuated vaccines that followed.

Attenuated vaccines use one (or several) live attenuated viral agent(s). Attenuated or modified live vaccines (MLVs) are produced from CSFV strains that have been attenuated by passage either in cell cultures or in a suitable host species not belonging to the family Suidae. Production is carried out in cell cultures, or in non-Suidae animals, based on a seed-lot system (OIE, 2003). These methods result in the agent preserving its capability of replication and inducing an immune response, but loosing the ability to produce clinical disease. Also, attenuated agents multiply within the animal providing further immunological stimulus. The most commonly used attenuated/modified live vaccines (MLVs) available are based on the Chinese (C) Strain, Japanese GPE-Strain, French Thiverval Strain, and the Mexican PAV strain. The C-Strain has been found to be highly efficacious. In most studies it induced a virtually complete protection against challenge at approximately 4-7 days post-vaccination. Vaccinates showed neither marked clinical signs nor shedding in response to challenge. This protection was demonstrated to last more than a year (Aynaud, 1988 and Terpstra *et al*., 1990).

Along with clinical protection from disease and blocked horizontal transmission, vaccines should provide protection from vertical transmission that could result in congenital infections with field virus. Congenital infections result in persistently infected piglets which are immunologically tolerant to CSFV, may carry high titers of virus for life, and continually shedding virus (Gregg, 2002). Data on this aspect of the C-Strain or other MLVs are not available or have not been documented. Due to the wealth of information portraying the ability of modified live vaccines to prevent replication of challenge virus, it appears that MLVs could potentially provide protection from congenital infections (European Commission, 2003). Nevertheless, this is an informational deficit which could prove beneficial to investigate.

The Chinese (C) Strain (PESTIFFA® by Merial) is the most widely used vaccine in the world and is highly efficacious. While these modified live vaccines are the most efficacious of the commercially available vaccines for CSF, their disadvantages include their relative safety because of the possibilities of reverting to virulent form and potential harmful affects to the fetus in pregnant swine. Also, it can be difficult to discriminate serologically between vaccinated (MLV and killed) animals and those which have been exposed to a field-strain virus (European Commission, 2003). The inability of serological testing to differentiate between vaccinated and unvaccinated swine is the main reason why many countries chose the stamp out method of eradication over a method involving vaccination.

Second Generation Vaccinations

The second generation vaccination strategies can be categorized into live recombinant vaccines, chimeric vaccines, DNA vaccines, or sub-unit marker vaccines. Live recombinant vaccines are based on the use of a live microorganism that acts as a vector for the expression of genes from another organism. This new recombinant microorganism can then be used as a vaccine for both organisms and in many instances allows for the discrimination of vaccinated animals from animals that have been exposed to a field strain. There are currently two live recombinant vaccines produced by inserting CSFV E2 (gp55), the most immunodominant protein within CSFV, into a heterologous virus genome used as a vector. Porcine adenovirus (PAV) (Hammond et al., 2000) and pseudorabies virus (PRV) (Peeter, Bienkowska-Szewczyk, Hulst, Gielkens, & Kimman, 1997) have been used as the viral vector. The low pathogenicity of PAV and the proven efficacy of adenoviruses as vaccine and gene therapy vectors led to interest in the development of PAV as a vaccine vector (Hammond et al., 2000). In a study performed to determine the efficacy of a recombinant vaccine such as rPAV w/E2, 3 pigs vaccinated with 1 x with 10^7 $TCID_{50}$, were challenged with 1000 $TCID_{50}$ of the virulent strain Weybridge, and were completely protected against clinical manifestations (Hammond et al., 2000). Experimentally, a live recombinant vaccine composed of a pseudorabies virus vector (PRV) that has a glycoprotein gpD essential for transmissibility removed and CSFV gp55 inserted into its genome displayed protection from both PRV and CSFV clinical symptoms and transmission (Hooft van Iddekinge et al., 1996; Peeters et al., 1997; & Van Zijl et al., 1991). Both live recombinant vaccines (rPAV and rPRV) have been proven effective in protection from clinical manifestations of CSF. However, their disadvantage lies in the possible reversion to virulent form, or creation of a "new virus" with the transfer of foreign genes and their associated phenotypes to a virulent wild-type virus (Peeters et al., 1997). As promising as these new recombinant vaccination technologies appear, further analysis is needed regarding the safety and efficacy of the vaccines before field trials or commercial application begins.

Two chimeric vaccination strategies, which are still in the developmental stages and have only been used experimentally, consist of genetically modified C-Strain CSFV in which the authentic E2 or E^{rns} glycoprotein has been replaced with an analogous genome fragment from BVDV (De Smit et al., 2000; De Smit et al., 2001; & van Gennip et al., 2001). In a study done by De Smit et al. (2000), the chimeric viruses, flc9 and flc11 were generated by replacing the E2 (flc9) or the E^{rns} (flc11) gene in the full length copy of the C-Strain with those of the BVDV strain 5250. Flc9 and Flc11 were used in a vaccination protocol and were found to provide complete clinical protection and allowed for discrimination between vaccinated animals and animals exposed to field strain. Another genetically modified pestivirus was assembled by Reimann et al. (2003) by replacing the E2 portion of a BVDV strain with the E2 gene from CSFV strain Alfort/187. This chimeric strategy displayed potential for future vaccination applications. These recombinant-chimeric strategies are novel technologies and are not yet commercially applicable. However, they may prove to be beneficial in the future.

Recently, the possibility of using a purified fraction of DNA containing the gene of the protein able to induce an effective immune response has been studied (Sanchez-Vizciano, 2001). Briefly, a fraction of purified DNA is inserted into a plasmid, which is then injected intramuscularly into the animal. The cells from the vaccinated animal then capture the plasmid and incorporate it into the nucleus. While it is not known exactly how this incorporation takes place, the cell subsequently begins expression of a foreign gene and ultimately produces the desired recombinant protein. This protein is then secreted into the extra-cellular matrix and recognized by the immune system in the same manner as when presented by the infectious agent, which in turn should elicit an active immune response. According to a study performed by Andrew *et al.* (2000) a naked DNA vaccination with two doses of 25 µg DNA or a single dose of 200 µg of the gene encoding gp55 provided protective immunity against a virulent Weybridge strain of CSF. Furthermore, the DNA can be delivered intramuscularly by simple spring-loaded needleless inoculators or gene guns (Andrew et al., 2000). Experimentally, 10 piglets vaccinated with the E2 (gp55) gene of CSFV were protected when challenged, and 10 piglets that were vaccinated with the DNA of the whole gene of gp55 glycoprotein were not protected (Markowska-Daniel et al., 2001 and Xinglong et al., 2001). Although it seems that the current applications of a DNA-E2 vaccination strategy are safe, the efficacy may be limited and high dosages of recombinant DNA are needed to provide complete resistance to clinical manifestation (Andrew et al., 2000). One currently promising vaccination routine is the prime boost strategy that uses naked DNA-E2 to prime the animals and then subsequently boosts the animals with rPAV-

E2 to provide 100% protection from challenge. The same experiment with only rPAV-E2 showed a slight increase in body temperature post-challenge (Hammond et al., 2001). Although relatively new, like many other second generation vaccination strategies, naked DNA vaccination is promising and could potentially provide a safe, efficacious manner to protect swine without the concern of reversion to virulent forms that are associated with modified live vaccinations.

Recently, a subunit marker vaccine based on the baculovirus-expressed E2 glycoprotein of CSFV has been developed in an attempt to generate a vaccine which is safe, efficacious and provides the ability to serologically discriminate between swine which have been vaccinated and those that have been exposed to a field CSFV strain (Sanchez-Vizciano, 2001). This subunit marker vaccine, one of the only vaccines commercially produced (Porcilis Pesti ®, Intervet), contains Classical Swine Fever virus E2 immunogen incorporated in an emulsion to prolong stimulation of the immune system of the target species (Sanchez-Vizciano, 2001). As a consequence of the subunit nature of the vaccine, vaccination does not induce production of antibodies against CSFV antigens, other than E2, and allows diagnostic test discrimination between vaccinated and wild type virus exposed pigs. After a lethal challenge at 3 weeks with a single application the vaccine dosage that protected 95% of the pigs (PD_{95}) against mortality was 32 μg/pig (Bouma et al., 1999). In studies on emergency vaccination against CSF, it was shown that C-strain induced protection and prevented transmission 3-6 days after challenge and the subunit marker vaccine prevented transmission of CSFV beginning 10 days after vaccination. This suggests that the E2 subunit vaccine may be an efficacious tool in reducing the severity of an outbreak, even though there is a 10 day period for immunity to develop following vaccination (Bouma et al., 2000). Duration of immunity studies have shown that pigs can be protected against lethal challenge of CSFV for up to 13 months after a single vaccination with an E2 subunit marker vaccine while C-strain vaccinations demonstrated possible life-long protection (De Smit et al., 2001). There have been many conflicting studies about the subunit vaccine's ability to prevent the vertical transmission of CSFV from pregnant sow to unborn fetus. One study demonstrated that a single vaccination of the E2 subunit vaccine significantly reduced vertical transmission and double vaccinated sows were protected against trans-placental transmission when challenged 4 weeks subsequent to a booster vaccination (De Smit et al., 2000). However, another study demonstrated that 3 out of 8 vaccinated pregnant gilts vertically transmitted the virus, resulting in infected offspring (Dewulf et al., 2002).

Compared to modified live vaccines, subunit vaccines are composed of a single protein and are not as effective at stimulating the immunological response as quickly or for the duration that MLVs display (Dewulf, et al., 2002). While there appears to be conflicting views about the efficacy of the E2 subunit vaccination regime, the safety of subunit vaccines is unparalleled because there is minimal possibility of clinical manifestation, transmission, or reversion to virulent form, as exists when using a MLV (De Smit et al., 2000). These benefits, along with the E2 subunit's ability for discrimination of infected animals within vaccinated populations, may be important when deciding on which vaccination procedure to utilize.

Future Generation Vaccinations

Future generation vaccination strategies include the utilization of synthetic peptide and anti-idiotype vaccines. The basis for these strategies is the identification of the specific protein(s), or fragments of the protein(s) associated with the infectious agent that are responsible for the induction of a host-mediated immune response. When the epitopes or antigenic determinants are identified in the complex structure of the protein responsible for inducing an immune response, it is possible to chemically generate a synthetic peptide identical to that associated with the live intact virus (Sanchez-Vizciano, 2001). Although synthetic peptides are still in development for CSF, there is currently one produced for foot-and-mouth disease that has a 50% efficacy among experimentally challenged animals (Sanchez-Vizciano, 2001). Finally, a novel vaccination strategy exists which utilizes an anti-idiotype vaccine. Although this particular strategy has never been attempted within the porcine species it may play an important role in future swine immunotherapy. Based upon the immunoglobulin binding site (idiotype) of the variable region, which recognizes the antigen, the idiotype can be extracted from a previously infected animal and inoculated into another animal. This animal will elicit an immune response and produce antibodies induced against the idiotype (anti-idiotype) that would have the same structure as the original antigen, and thus could be useful as a stimulus to elicit an immune response against the first antigen that originated the reaction. Anti-idiotype antibodies can be either polyclonal antibodies or monoclonal antibodies, and could be used as vaccines, especially in those cases in which attaining the immunogenic proteins or decoding their genes is very complicated (Sanchez-Vizciano, 2001).

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List of Figures

Chapter 1 Figures

Figure 1.1

Dendrogram depicting the phylogenetic relationship among the various identified genotypes and their geographic origin of isolation (Kitching, 2002).

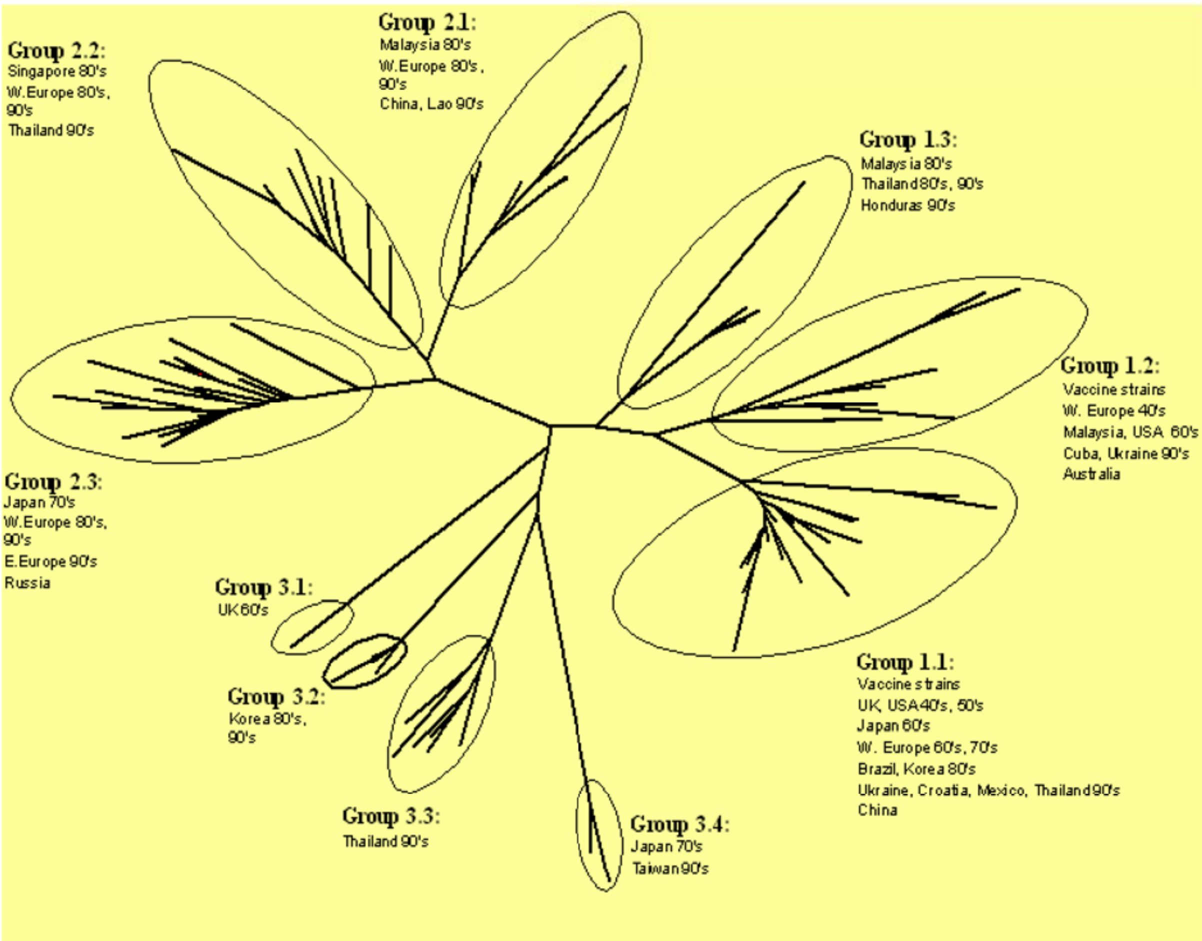


Figure 1.2

Global- reports of CSF genotype 1.1 since 1990. Genotype 1.1 has largely been isolated within the Americas, Russia and China. Strains among this particular genotype were common within the United States in the 1940's and are now often used for vaccination purposes (Kitching, 2002).

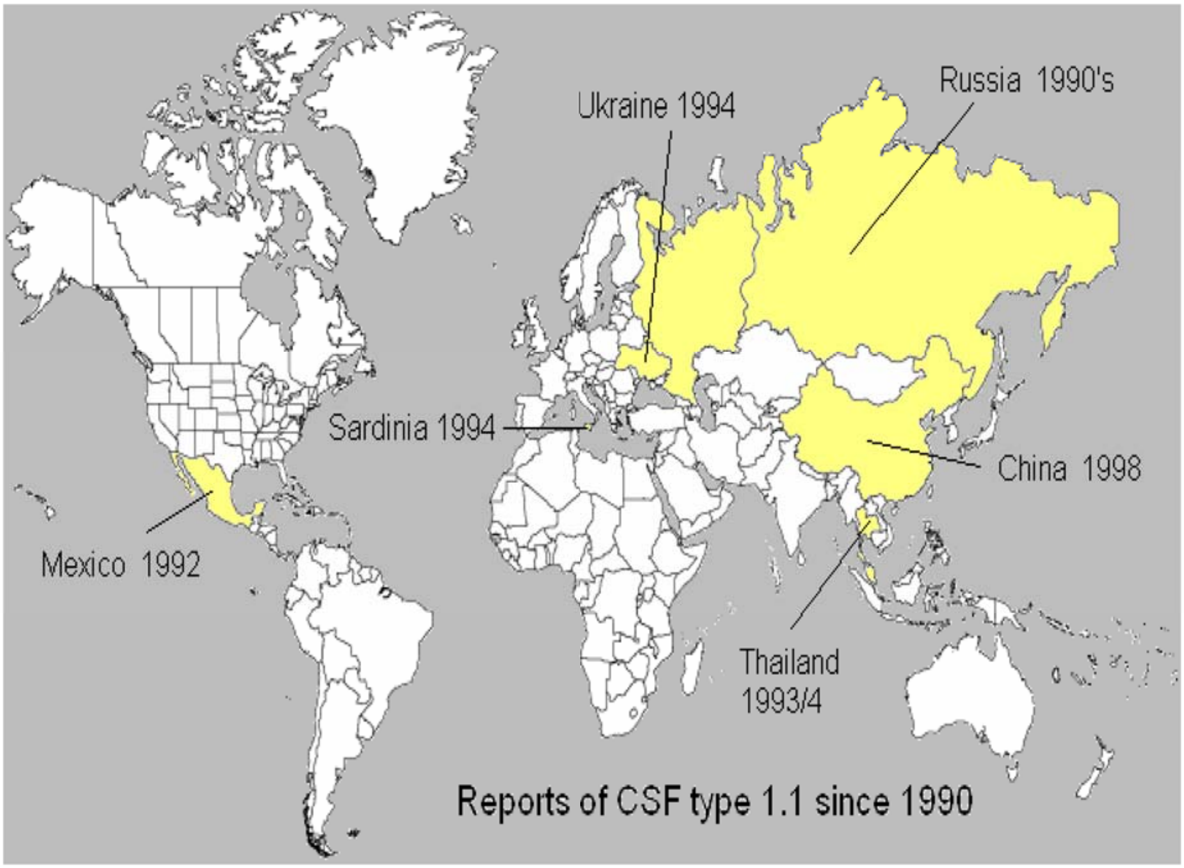


Figure 1.3
Global reports of CSF genotype 1.2 since 1990. Strains among this particular genotype were common within the United States in the 1960's and are now often used for vaccination purposes (Kitching, 2002).

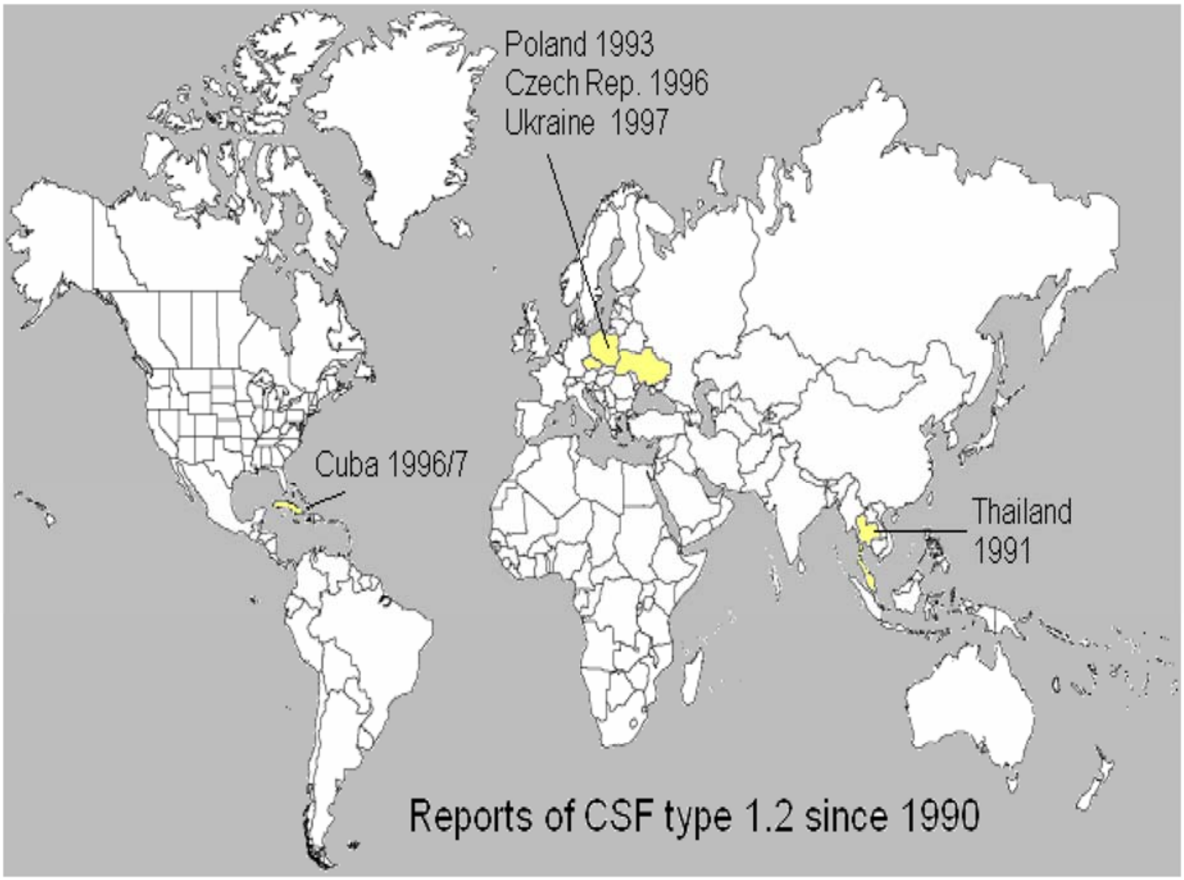


Figure 1.4
Global reports of CSF genotype 1.3 in the years 1990-2002. This genotype of CSF has commonly been found within Central America and the Caribbean Islands as well as areas within Thailand (Kitching, 2002).

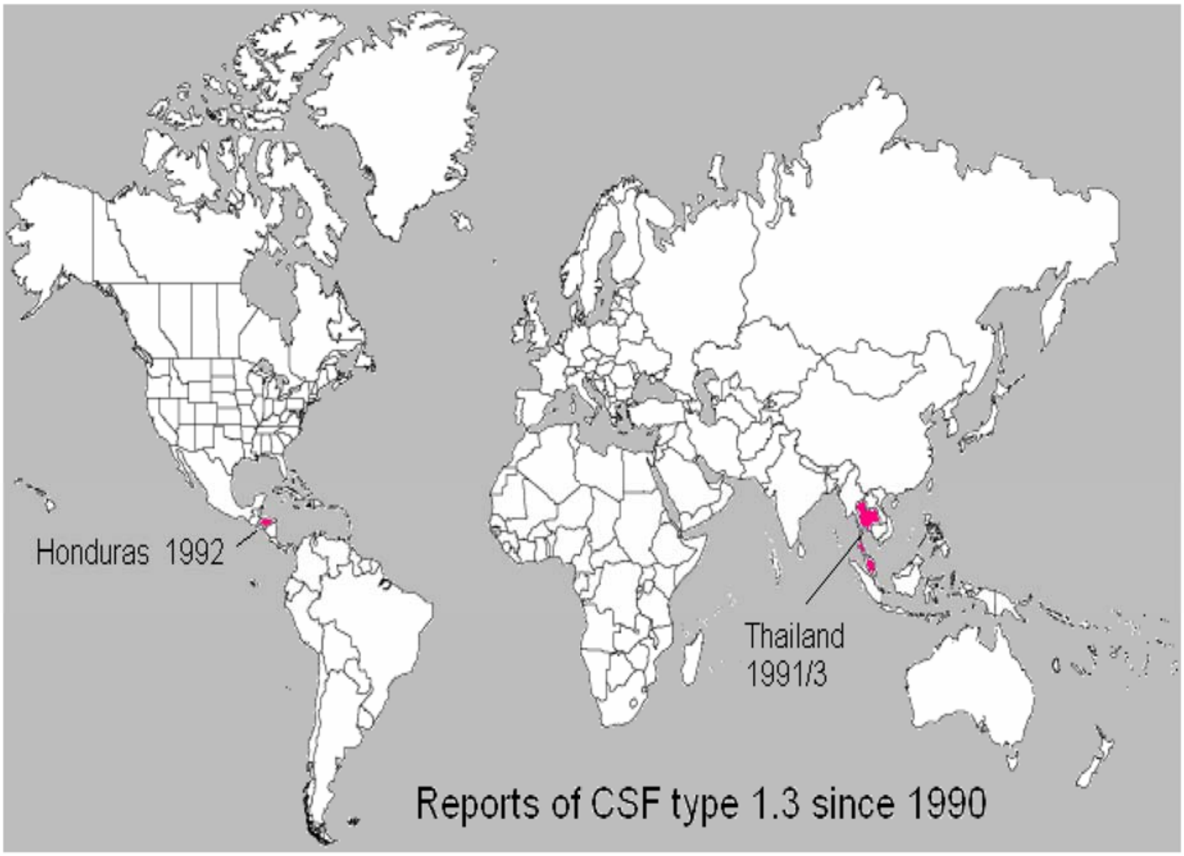


Figure 1.5
Global reports of CSF genotype 2.1 in the years 1990-2002. This genotype has been isolated in Western Europe, China, and Laos in the 1980's and 1990's. This genotype was responsible for the epidemic in The Netherlands in 1997 (Kitching, 2002).

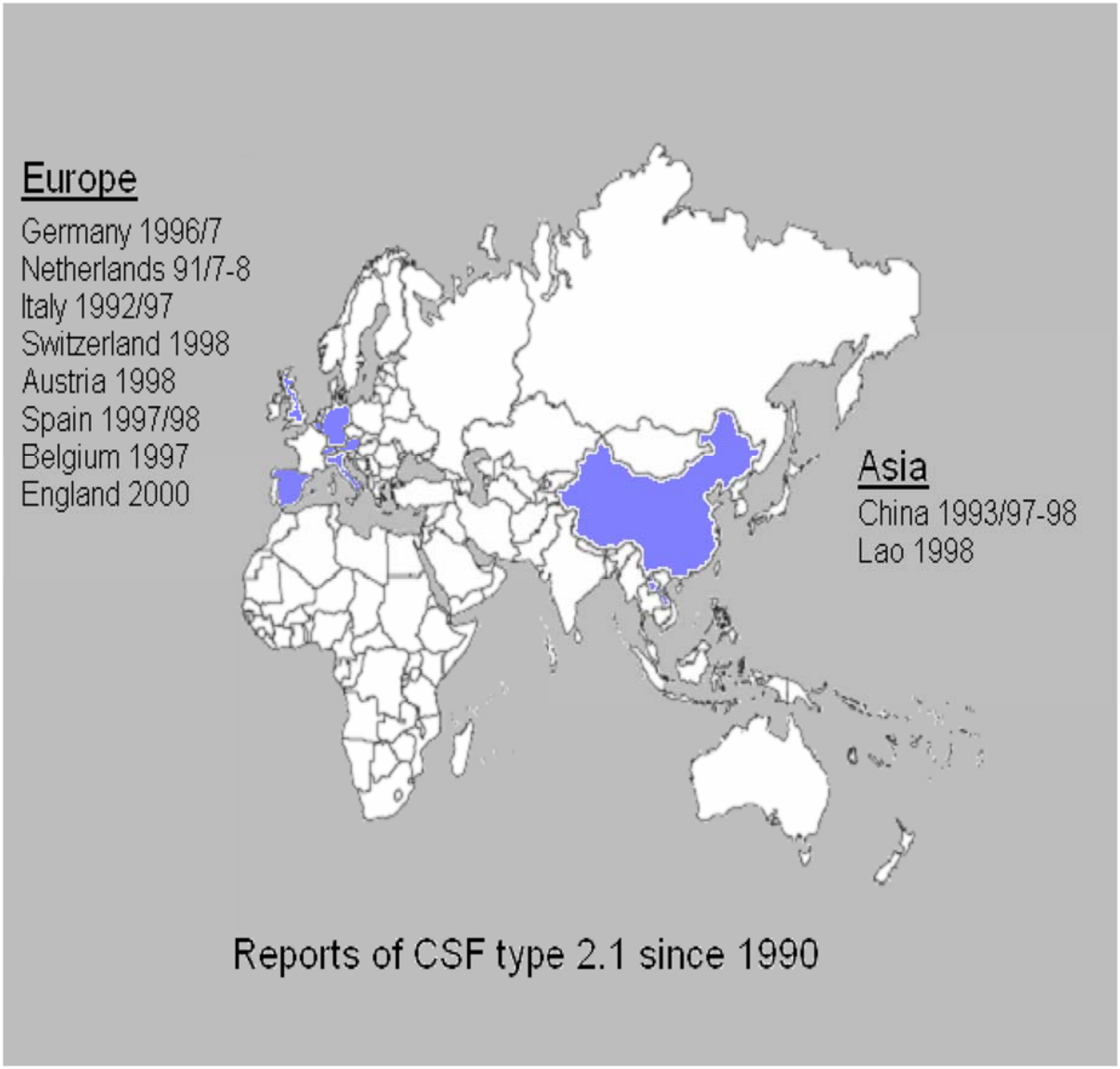


Figure 1.6
Global reports of CSF genotype 2.2 in the years 1990-2002. This genotype is found within Central Europe and areas such as China, Thailand and Laos (Kitching, 2002).

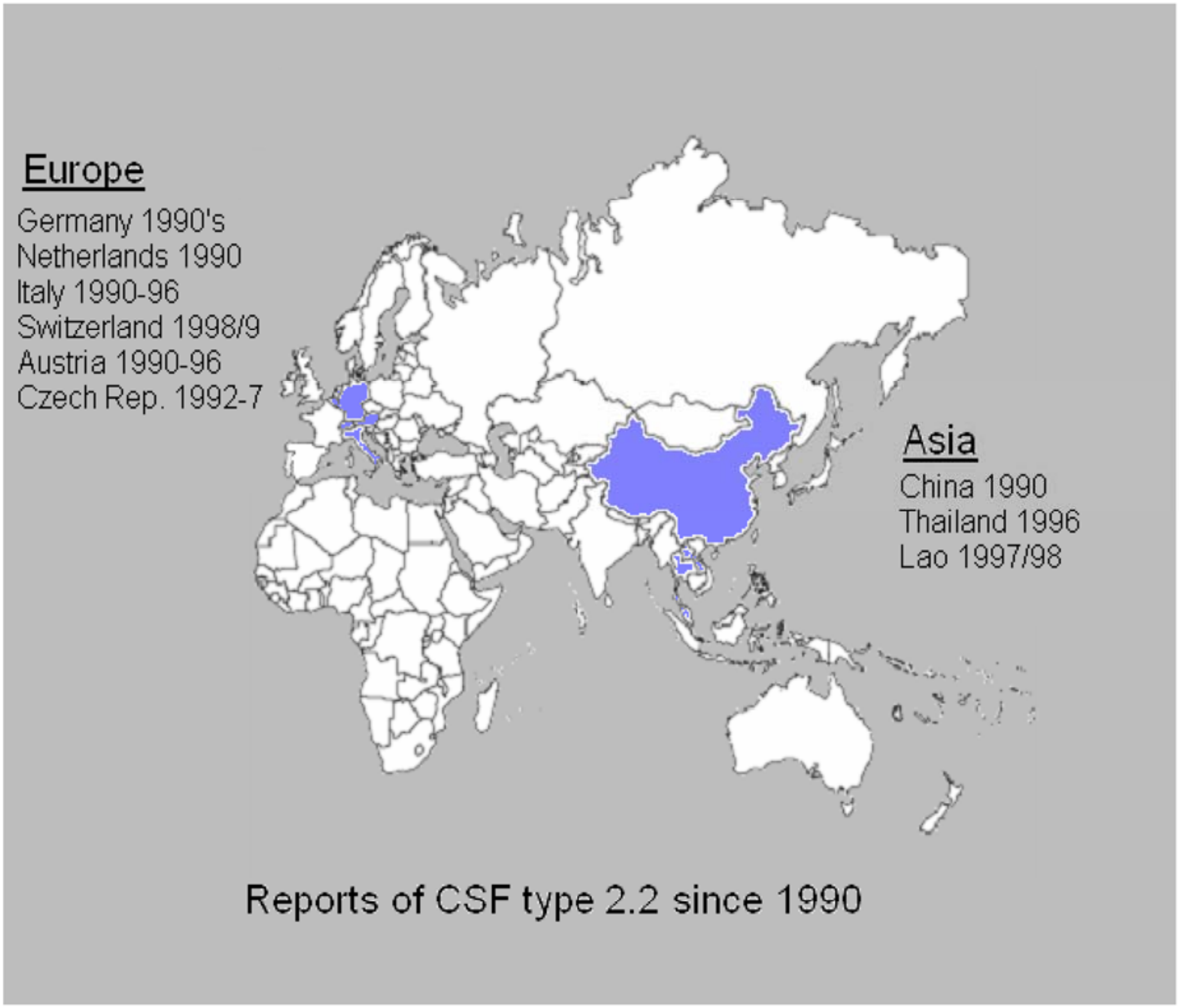


Figure 1.7
Global reports of CSF genotype 2.3 in the years 1990-2002. This particular genotype might be the most widely proliferated strain throughout Europe and Asia and is commonly associated with populations of feral pigs (Kitching, 2002).

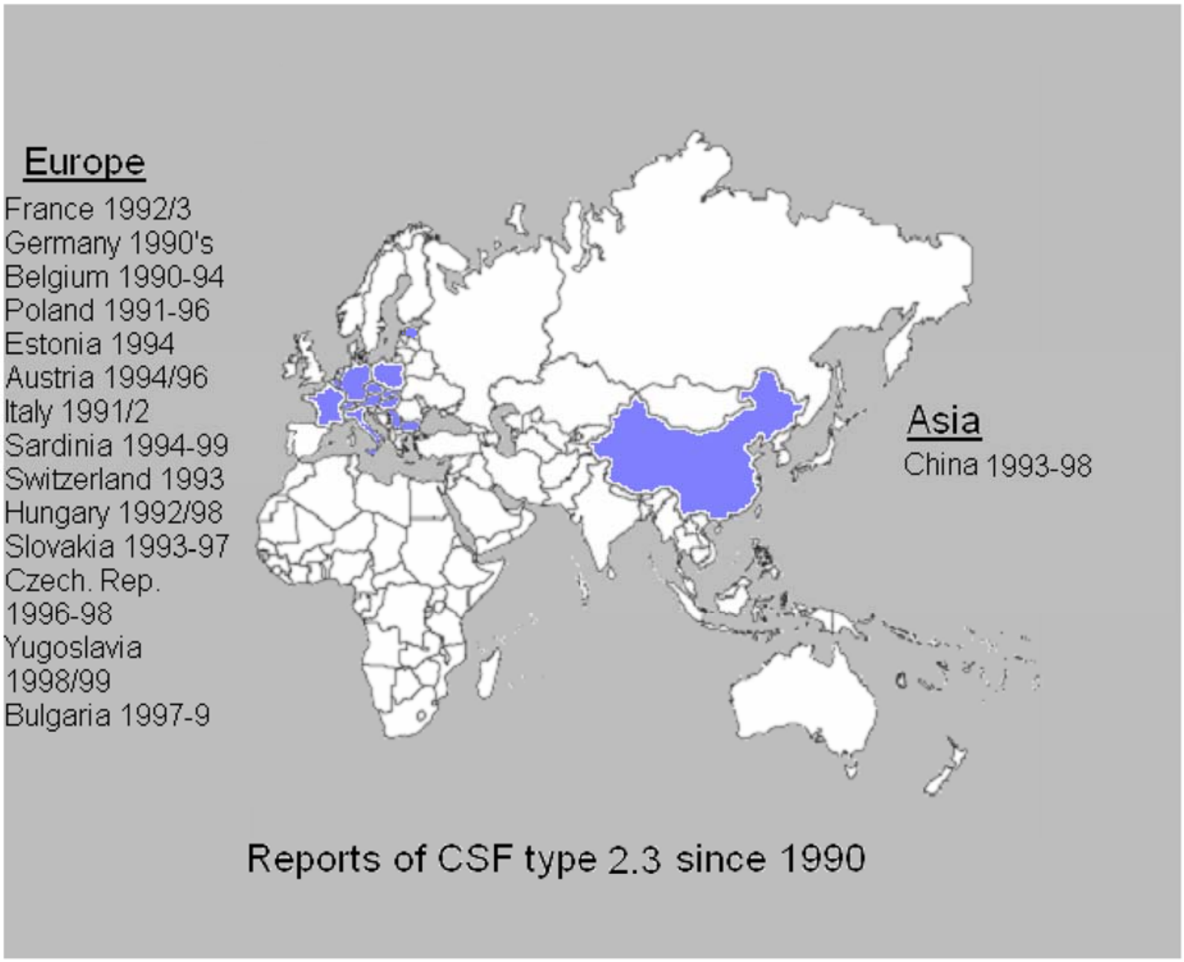


Figure 1.8
Global reports of CSF genotype 3 in the years 1990-2002. The sub-types isolated that fall into Genotype 3 have only been isolated in parts of the far-east such as Korea, Thailand, and Taiwan (Kitching, 2002).

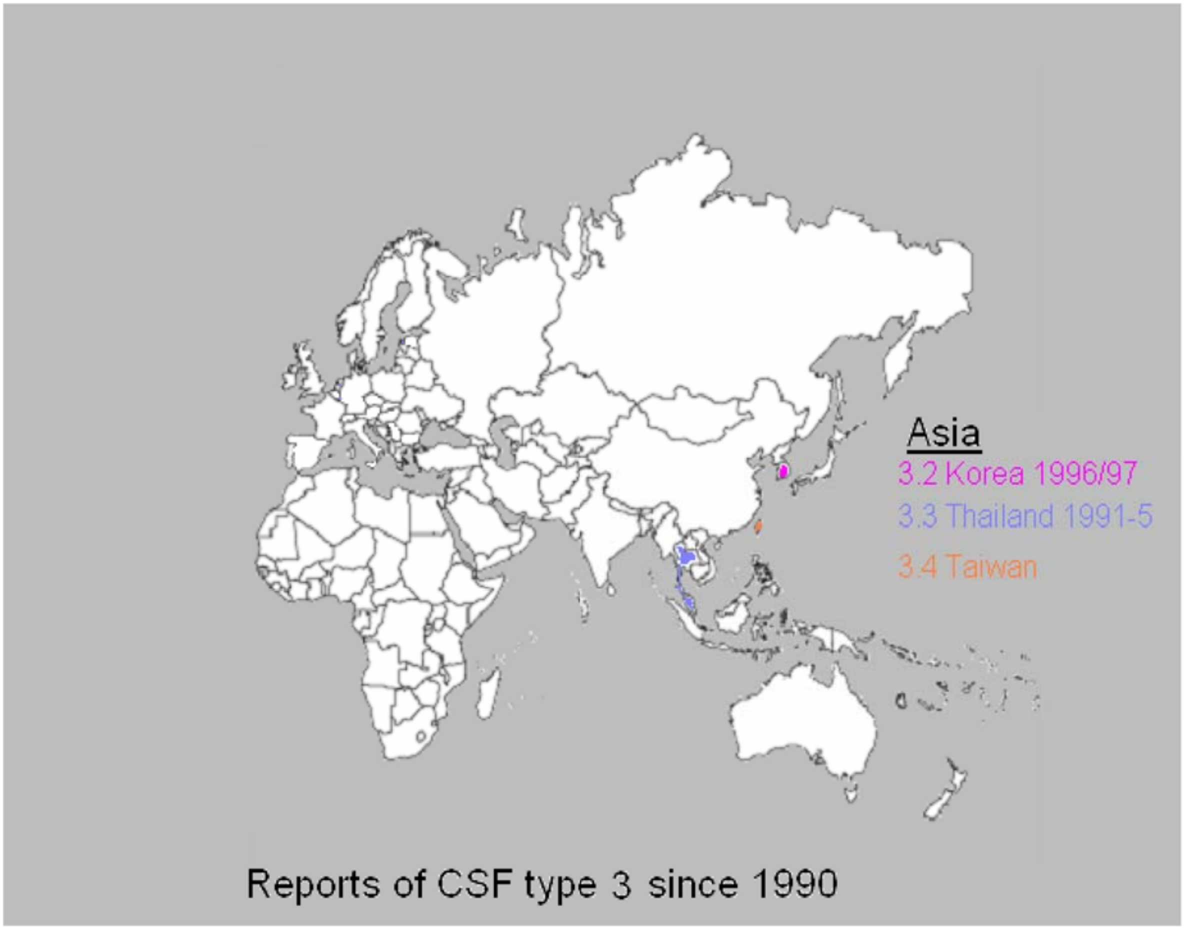


Figure 1.9

A summary of CSF isolates from 1997-2001 including the genotype and host information. Wild boar populations have been responsible for the endemic status and perpetual infection of domestic populations within certain geographic regions (wb=wild boar and dp=domestic pig) (Moennig et al., 2002).

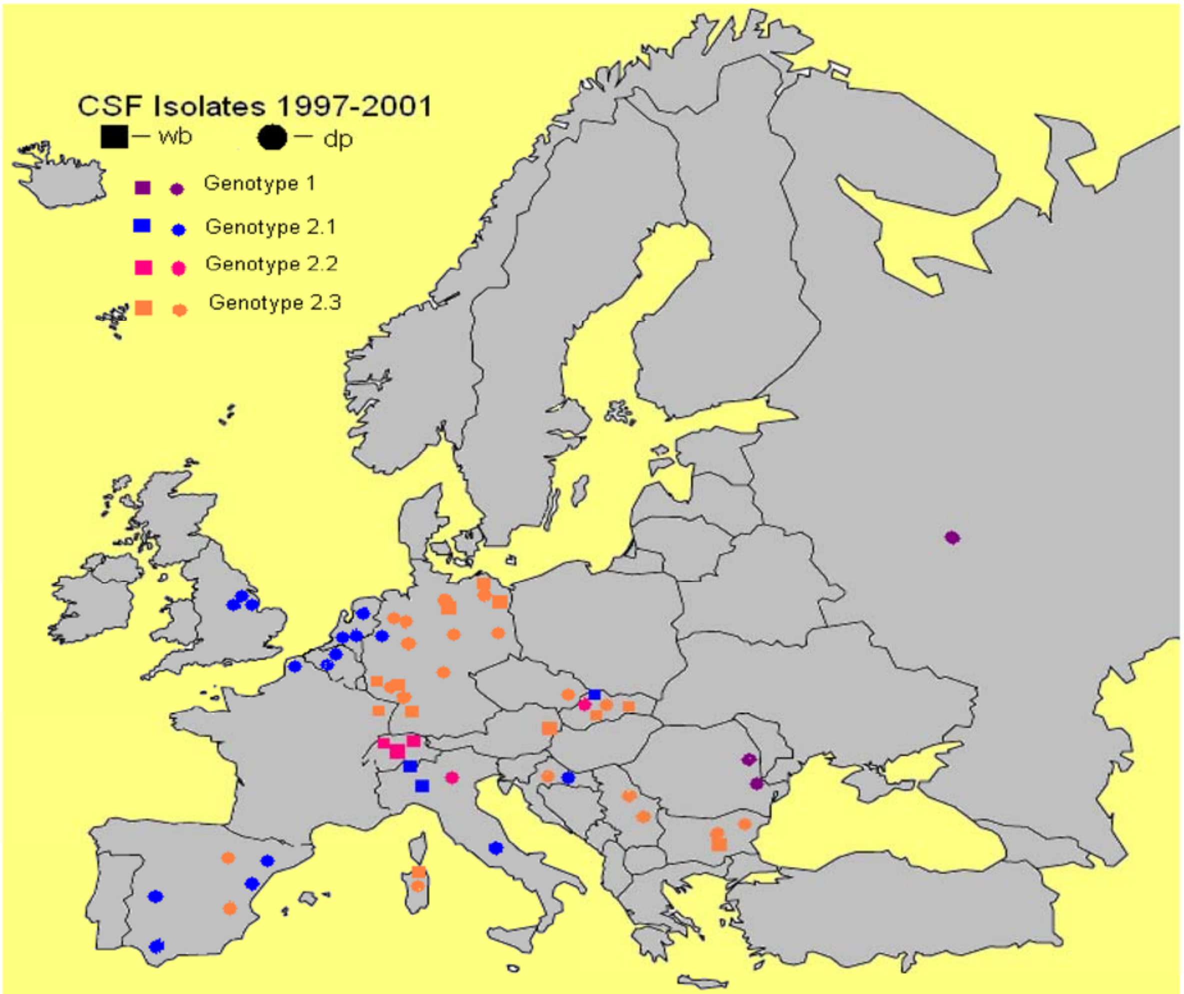


Figure 1.10

Symptoms of Acute Classical Swine Fever (United States Animal Health Association, 1998).

Figure 1.11
Late onset of CSF.

Upper: Circling and in-coordination indicates central nervous system damage due to CSF (http://www.vet.uga.edu/vpp/gray_book).

Lower: “Goose stepping” gait – a sign of CSF (http://www.fao.org).

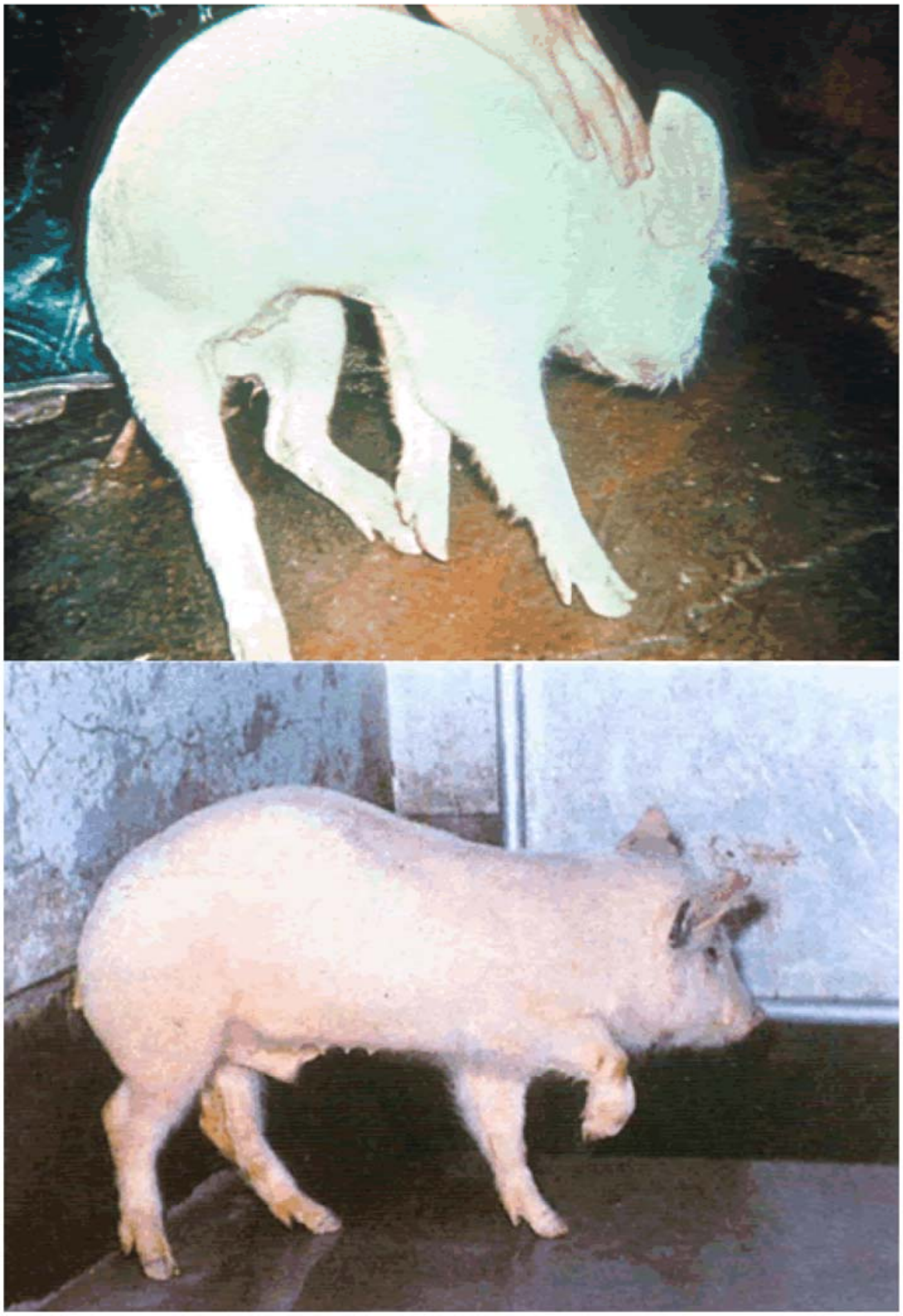


Figure 1.12
Infection at early gestational stages may result in embryonic death, abortion, and absorption (http://www.vet.uga.edu/vpp/gray_book).

Figure 1.13

Differential diagnosis of CSF from other diseases of swine with similar clinical symptoms. Note that not all symptoms occur in every clinically affected individual (Straw et al., 1999).

Signs	CSF	ASF	PDNS	Eperythrozoonosis	Erysipelas	Salmonellosis	Salt
Fever (> 40ºC)	Y	Y	Y	Y	Y	Y	Y
Conjunctivitis	Y	N	N	N	N	N	N
Skin Lesions	Y	Y	Y	Y	Y	Y	Y
Incoordination	Y	Y	N	N	N	Y	Y
Diarrhea	Y	Y	N	N	Y	Y	N
Huddling	Y	Y	N	N	N	N	N
Abortion	Y	Y	Y	Y	N	N	N

Figure 1.14
PDNS Legions (courtesy of Dr. Stan Done, Veterinary Laboratories Agency UK).

Upper left: Hemorrhagic skin lesions typically on hind quarters.

Lower left: Hemorrhagic swollen lymph node - medial retropharyngeal

Right: Widespread petechial hemorrhages on visceral surfaces

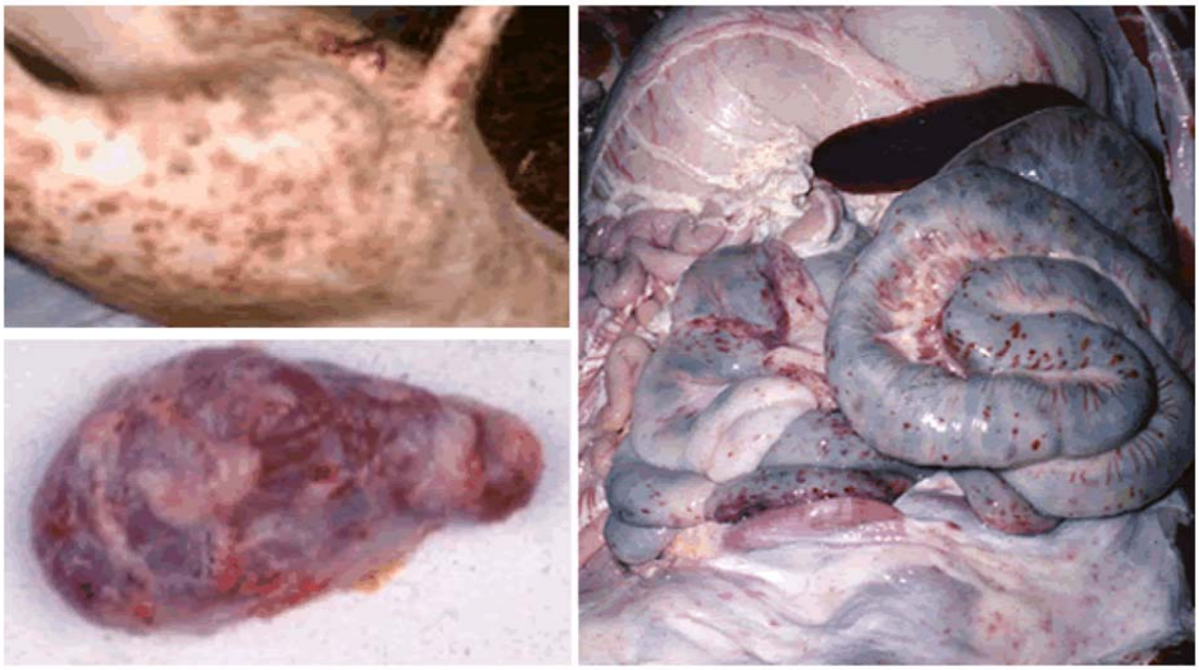


Figure 1.15
African Swine Fever.

Upper left: Infected Swine.

Upper right: A hemorrhagic gastro-hepatic lymph node seen in African swine fever.

Lower left: Pulmonary edema and hemorrhages in African swine fever

Lower right: *Ornithodorus spp.* can act as a vector

Figure 1.16
Erysipelas Symptoms.

Upper left: Diffuse cyanosis of both ears

Lower left: Necrosis of skeletal muscle

Right: Diamond skin lesions associated with infection by *Erysipelothrix rhusiopathiae*

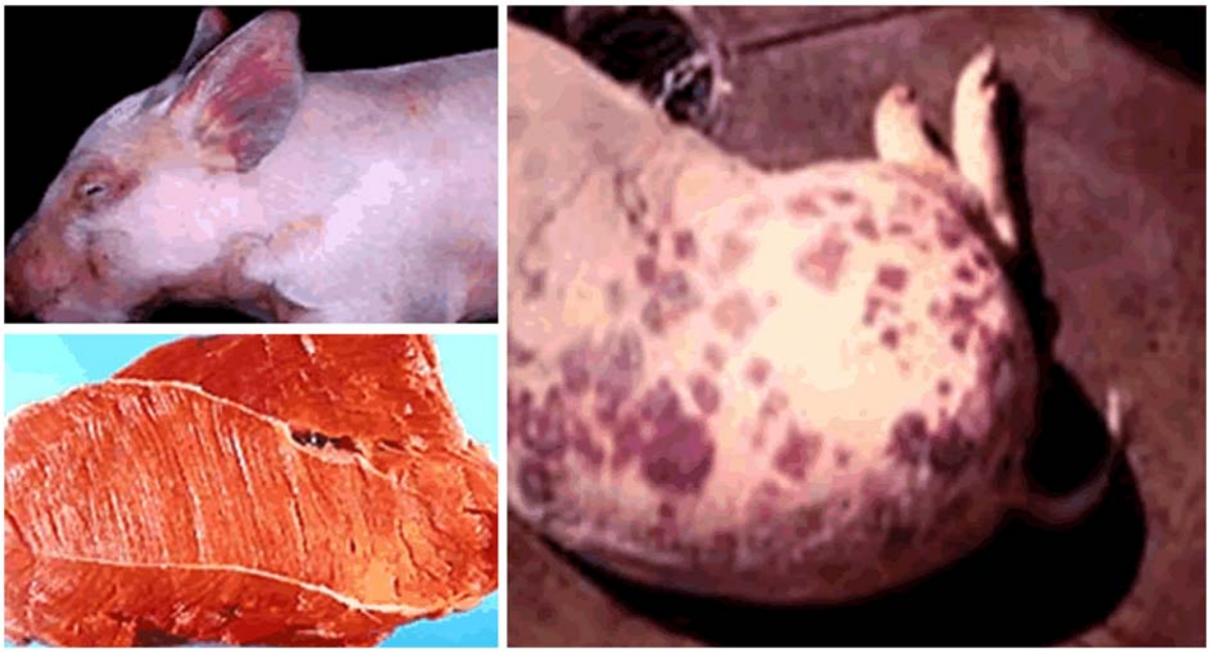


Figure 1.17
Swine infected with Salmonellosis (www.vetmed.iastate.edu/.../diseases/ chest/salmonellosis/).

Chapter 2 Figures

Figure 2.1

A summary of the countries from which CSF has been isolated within swine populations since 1990. This illustration depicts this disease's wide-spread prevalence throughout Central America and the Caribbean Islands. The United States and Canada have been free of CSF since 1976 and 1963, respectively (www.oie.int).

Figure 2.2
A summary of the countries from which CSF has been isolated within swine populations in S. America since 1990 (www.oie.int).

Figure 2.3

A summary of the countries from which CSF has been isolated within swine populations in Europe since 1990 (www.oie.int).

Figure 2.4

A summary of CSF isolates from 1997-2001 including the genotype and host information. Wild boar populations have been responsible for the endemic status and perpetual infection of domestic populations within certain geographic regions (wb=wild boar and dp=domestic pig) (Moennig et al., 2002).

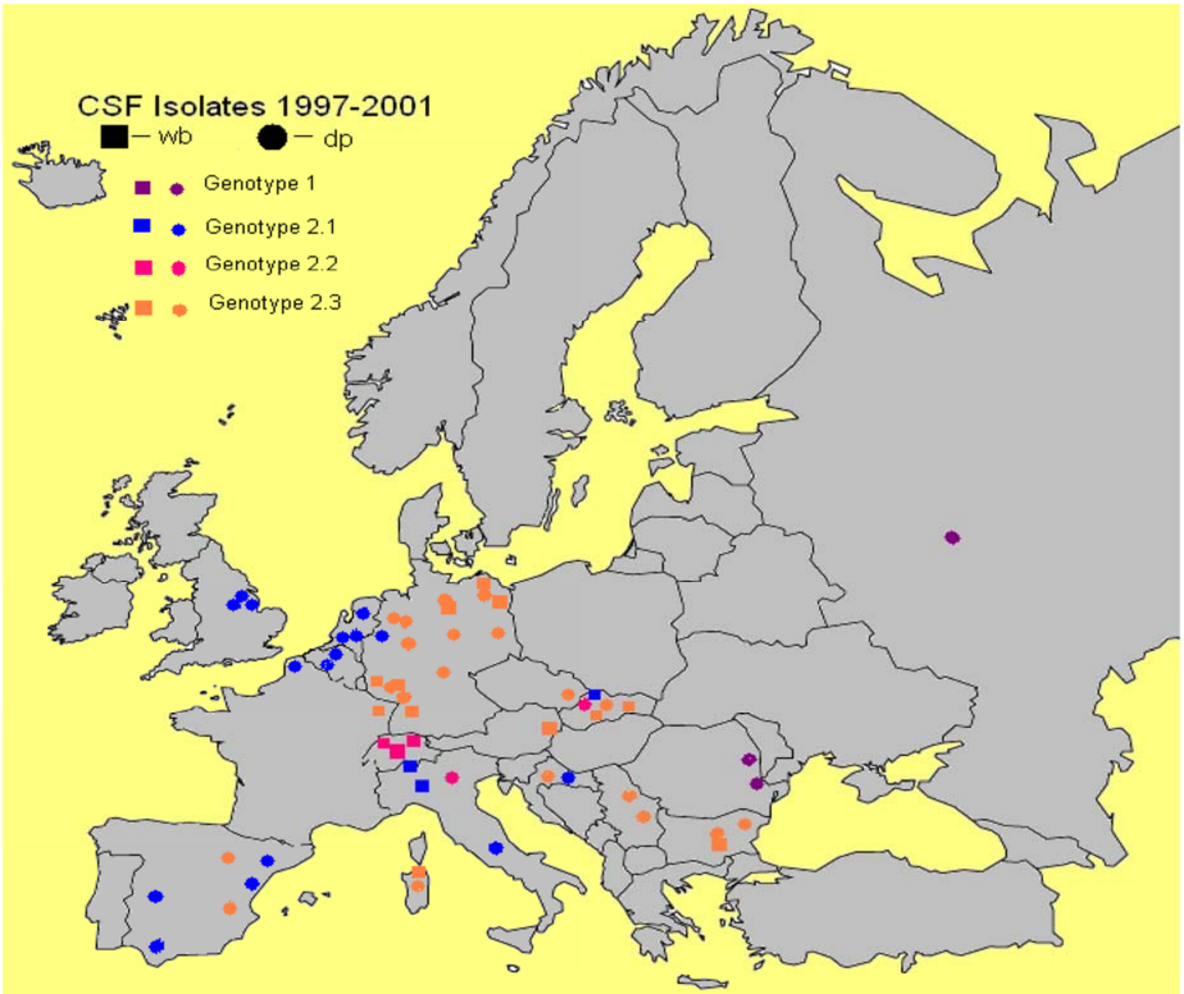


Figure 2.5
A summary of the countries considered free of Classical Swine Fever by USDA-APHIS. CSF Free countries include Australia, Canada, Denmark, England (except East Anglia), Fiji, Finland, Iceland, New Zealand, Northern Ireland, Norway, the Republic of Ireland, Scotland, Sweden, Trust Territory of the Pacific Islands, Wales, and a single region in the European Union consisting of Austria, Belgium, Germany (excluding some parts), Greece, portions of Italy, The Netherlands, and Portugal (data provided by USDA-APHIS)

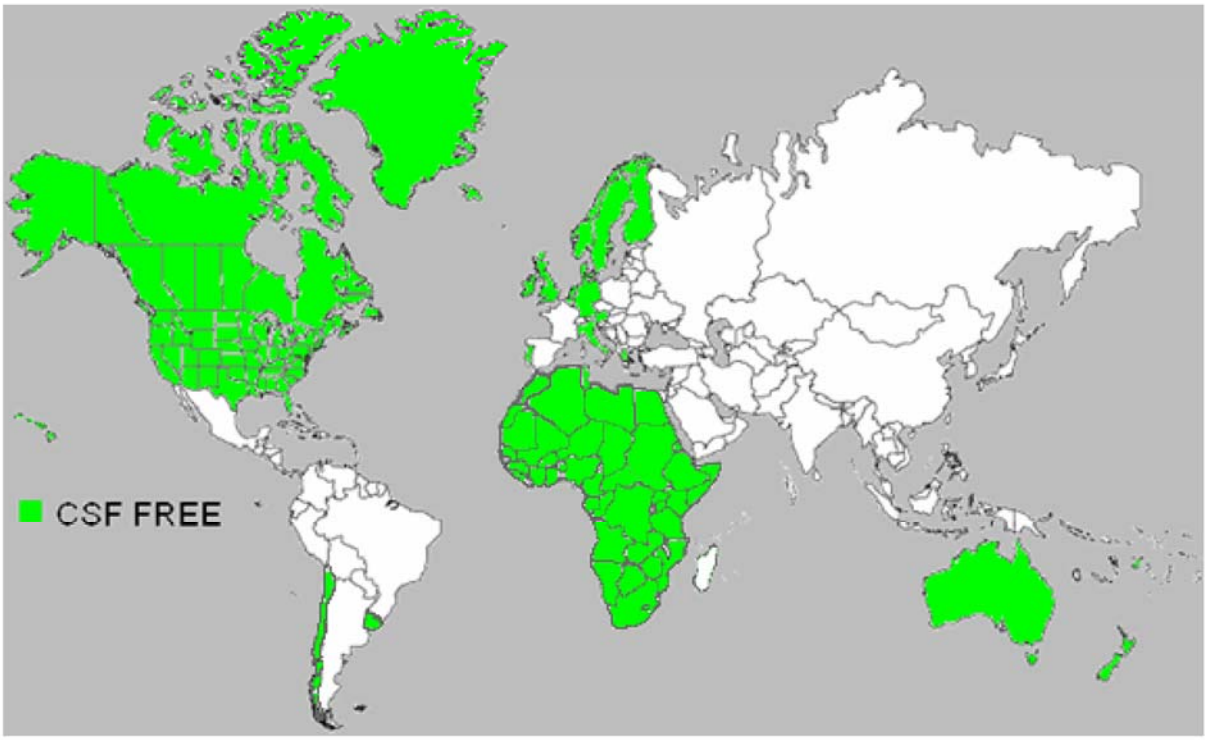


Figure 2.6
A summary of the countries in Africa from which CSF has been isolated within the swine populations since 1990. CSF has only been recorded on continental Africa twice, in Namibia and South Africa in 1917 and 1918, respectively (www.oie.int).

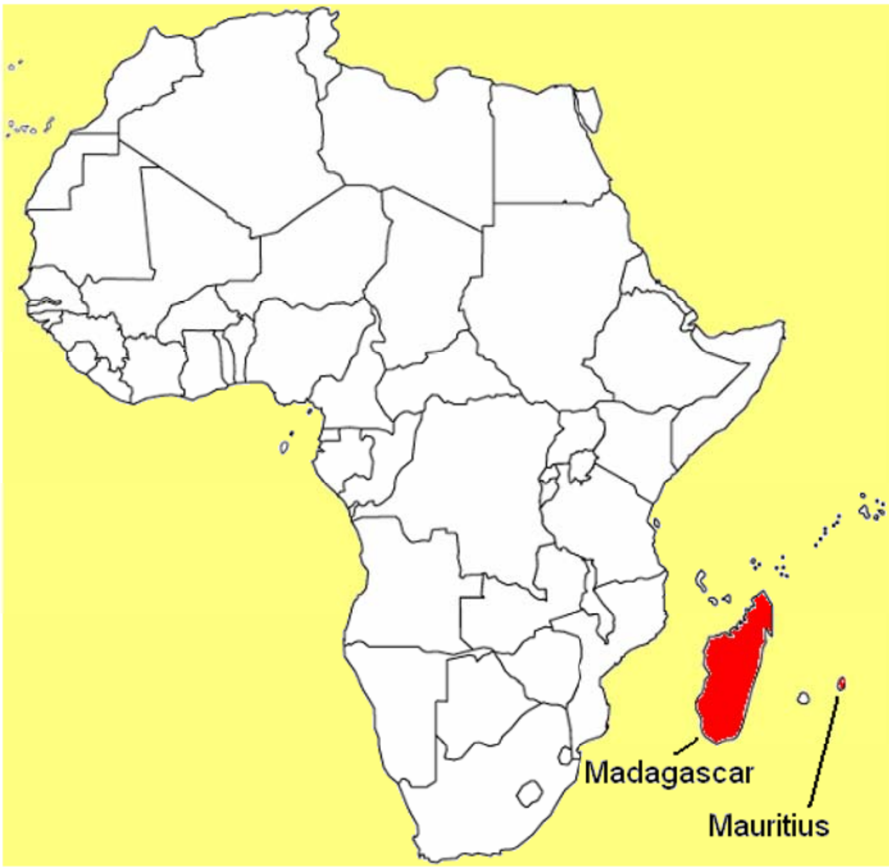
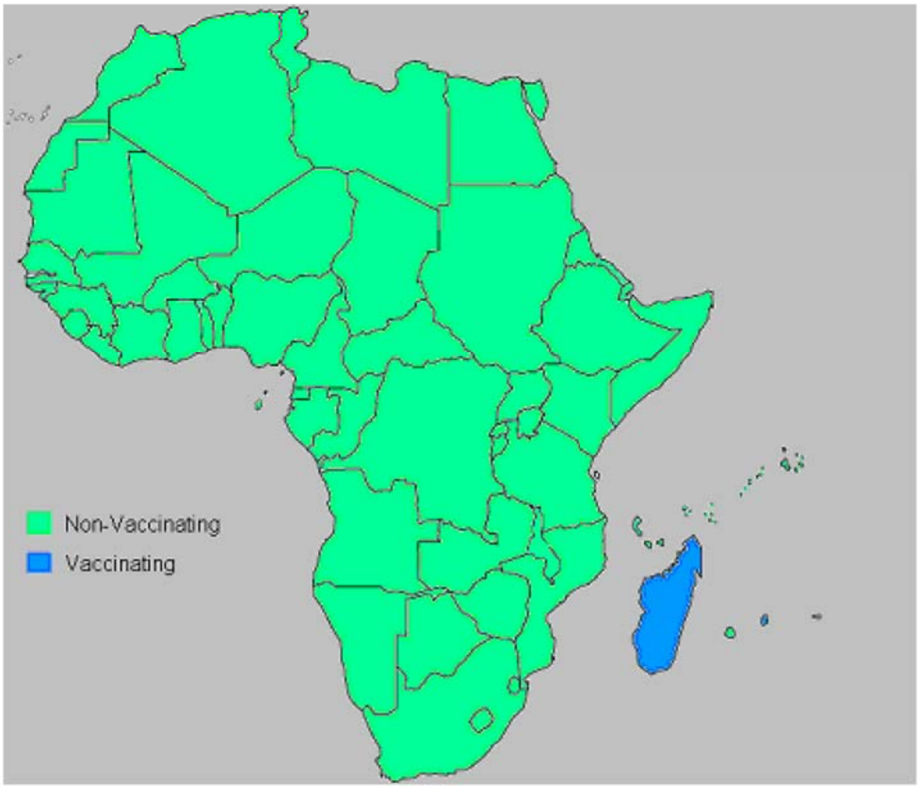


Figure 2.7

Vaccination strategies for CSF within Africa between the years 1996 and 2002. Vaccination programs are not practiced widely within Africa because there has not been an outbreak on the mainland since 1918 in S. Africa (www.oie.int).



Vaccinating countries within Africa are: Madagascar and Mauritius

Figure 2.8

A summary of the countries from which CSF has been isolated within swine populations in Asia since 1990. CSF is endemic in many countries in Southeast Asia while many countries in the middle-east are considered to be historically free (www.oie.int).

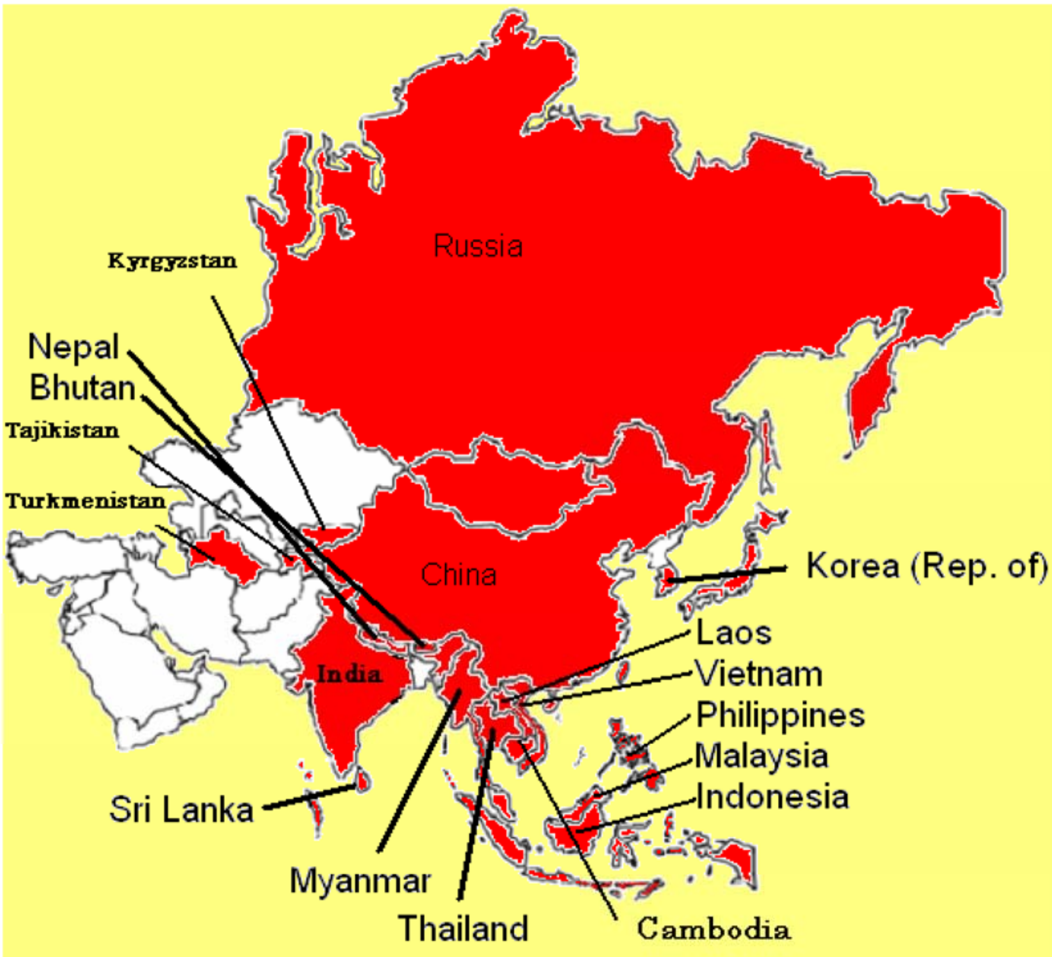


Figure 2.9

Vaccination strategies for CSF within Oceania between the years 1996 and 2002. Because Oceania is free of CSF vaccination programs are not routinely utilized (www.oie.int).

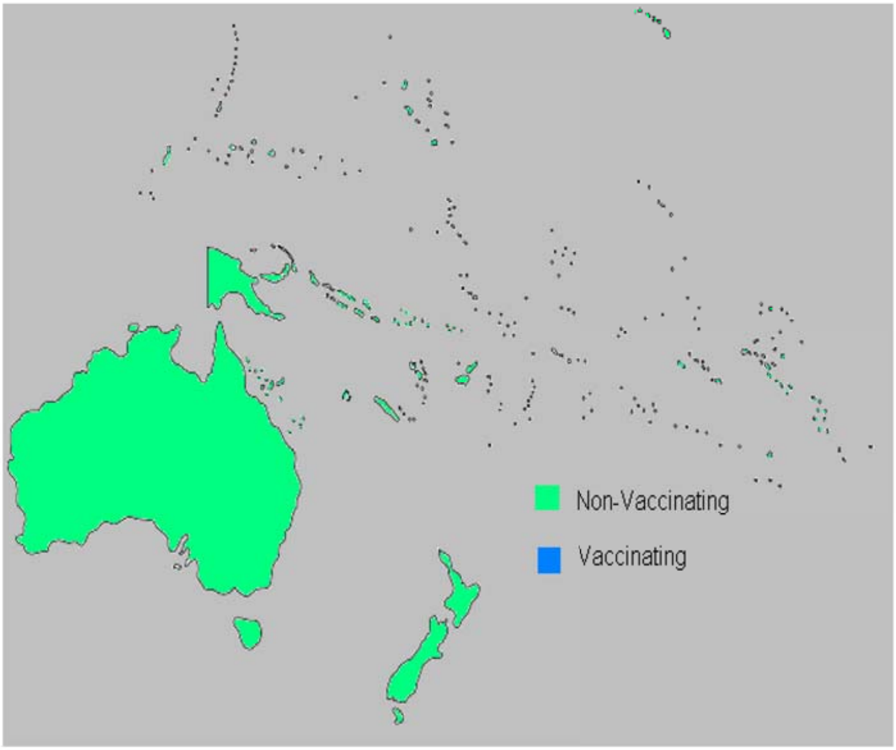


Figure 2.10
CSF activity reported yearly by the OIE (1998-2002) (www.oie.int).

	Year	Occur.	Spe				Control measure	Number of animals		
Country				Out-brks	cases	deaths		destr	slaught	vacc
Albania	2003	+	sui	0	40	0		40	0	
Argentina	2001	(05/1999)	sui	0	0	0	S * Su Qf M V		0	
Argentina	2000	(05/1999)		0	0	0			0	
Argentina	1999	+	sui	3	64	64	S * Te Qi V Z		0	1910
Argentina	1998	+	sui	7	107	50	* Te Qi V Z		0	1051301
Argentina	1997	(04/1995)	***	0	0	0	* Qi Su V		0	1900000
Argentina	1996	(04/1995)	sui	0	0	0	* Pn Qf S V		0	
Austria	2001	+	fau	1	7	4		86	0	
Austria	2000	(07/1996)	fau	0	0	0	Sp Cr * Te Vp Z		0	
Austria	1999	(07/1996)	fau	0	0	0	* S Te Vp		0	
Austria			sui	0	0	0	* S Vp		0	
Austria	1998	(07/1996)	fau	0	0	0	* S Te Vp		0	
Austria			sui	0	0	0	* S Vp		0	
Austria	1997	(07/1996)	fau	0	0	0	* S Te Vp		0	
Austria			sui	0	0	0	* S Vp		0	
Austria	1996	+	fau	2	0	24	* Pa Q S Vp		0	
Austria			sui	0	0	0	* Pa Q S Vp		0	
Brazil	2003	+	sui	1	50	0		0	0	
Brazil	2001	+()	sui	12	268	159	* Qf Qi M V Z		0	707773
Brazil	2000	+()	sui	4	168	119	S * Te Su Qf Qi M Vp Z	15	0	
Brazil	1999	+()	sui	1	111	111	S * Te Qf Qi Vp	79	0	
Brazil	1998	+()	sui	1	8	8	Qf * Te Qi S V		0	91261
Brazil	1997	+()	sui	9	974	291	Qf * Qi S V Su	1807	0	119540
Brazil	1996	+()	sui	16	71	55	* Pa Qf S te		0	
Cambodia	1996	+	sui	0	0	0			0	
Belgium	2002	+	fau	1	1	0		12	0	0
Belgium	2001	(07/1997)	sui	0	0	0	* M Qi S Su Te Vp Z		0	
Belgium	2000	(07/1997)	sui	0	0	0	S * Te Su Qi M Vp Z		0	
Belgium	1999	(07/1997)	sui	0	0	0	* Qi S Te Vp		0	
Belgium	1998	(07/1997)	sui	0	0	0	S * Te Qi Vp	10426	0	
Belgium	1997	+	sui	8	10426	10426	S * Te Su Qi M Z	10426	10426	

Belgium	1996	(11/1994)	sui	0	0	0	P Pn Qi S te Vp *		0	
Bhutan	2001	(05/2000)		0	0	0			0	
Bhutan	2000	+	fau	0	0	0	* Qf Qi		0	
Bhutan			sui	1	0	0	* Qf Qi M V		0	2306
Bhutan	1999	+	fau	0	0	0			0	
Bhutan			sui	0	0	0	* Te Qf V		0	2023
Bhutan	1998	+	fau	0	0	0	Qi * Qf		0	
Bhutan			sui	0	0	0	M Qi * Qf V		0	1934
Bhutan	1997	+	sui	1	0	0	Qi * Qf V	0	0	2323
Bhutan	1996	+	sui	3	0	0	* P Pn Q T V		0	2693
Bosnia & Herzegovina	2001	+	sui	52	57	0			0	
Bosnia & Herzegovina	2000	+	sui	1	1	0			0	
Bosnia & Herzegovina	1999	+	sui	0	0	0			0	
Bosnia & Herzegovina	1997	+	sui	43	0	0			0	
Bosnia Herzegovina	1996	+	sui	0	0	0			0	
Bulgaria	2003	+	sui	3	30	10		103	39	
Bulgaria	2001	+	sui	1	16	6	S Cr * Te Su Qf Qi M V Z	157	0	2933860
Bulgaria	2000	+	sui	1	19	15	* Cr M Qf Qi S Sp Su Te V Z	33	56	3499957
Bulgaria	1999	+	sui	4	65	28	* Cr M Qf Qi S Sp Su Te V Z	97	12	5185192
Bulgaria	1998	+	sui	8	442	294	* Cr M Qf Qi S Sp Su Te V Z	1321	1849	5456311
Bulgaria	1997	+	sui	8	347	323	* Cr M Qi S Su V	1930	561	4.9M
Bulgaria	1996	+	sui	1	30	12	* Pn Q S V	870	0	7722100
China	2001	+	sui	56	34245	18467			0	
China	2000	+	sui	72	41901	29117		3482	0	
China	1999	+	sui	672	415000	165000			80000	
China	1998	+	sui	45	0	0			0	
China	1997	+	sui	104	0	0			0	
China	1996	+	sui	0	0	0			0	
Colombia	2001	+	sui	2	2	2	Su Qf Qi V		0	
Colombia	2000	+	sui	7	93	67	Su Qf Qi V		0	
Colombia	1999	+	sui	23	220	163	* Su Qf Qi V		0	
Colombia	1998	+	sui	6	141	42	Qf * Qi V Su		0	
Colombia	1997	+	sui	0	137	110	Qf * Qi V Su		0	
Colombia	1996	+	sui	5	0	0	* Pn Q V		0	
Costa Rica	2001	(09/1997)	sui	0	0	0	* M Qf Su Te Vp		0	

Costa Rica	2000	(09/1997)		0	0	0			0	
Costa Rica	1999	(09/1997)	sui	0	0	0	* Te Su Qi Vp		0	
Costa Rica	1998	(09/1997)		0	0	0			0	
Costa Rica	1997	+	sui	0	0	0			0	
Costa Rica	1996	(07/1995)	sui	0	0	0	* P Pn Vp		0	
Croatia	2002	+	sui	1	10	7		14	0	
Croatia	2001	(07/1999)		0	0	0			0	
Croatia	2000	(07/1999)		0	0	0			0	
Croatia	1999	+	sui	2	5	5	S Cr * Qf Qi V	4	0	232849
Croatia	1998	(10/1997)	sui	0	0	0	V		0	2500000
Croatia	1997	+	sui	10	40	15	Cr M Qi * Qf Te S V	45	0	1559172
Croatia	1996	+	fau	0	0	0			0	
Croatia			sui	7	45	37	Cr P Pn Q S te V		0	1559172
Cuba	2001	+	sui	99	5703	1493	* Qf S V	22867	22928	3684286
Cuba	2000	(05/1997)	***	0	0	0	* Qf S V		0	3162924
Cuba	1999	(05/1997)	sui	0	0	0	* Qf S V		0	303601
Cuba	1998	(05/1997)	sui	0	0	0	Qf * S V		0	2713148
Cuba	1997	+	sui	7	36	23	* Qf S V	164	0	2320054
Cuba	1996	+	sui	257	11343	2082	* P Qf V	40627	0	2772197
Czech Rep	2001	(11/1999)		0	0	0			0	
Czech Rep	2000	(11/1999)		0	0	0			0	
Czech Rep	1999	+	fau	13	17	12	Cr *		0	
Czech Rep			sui	0	0	0	* Te Qf Vp Z		0	
Czech Rep	1998	+	fau	21	42	20	Cr *	22	0	
Czech Rep			sui	0	0	0	* Qf Te Vp Z		0	
Czech Rep	1997	+()	fau	0	75	0	Cr * Z		0	
Czech Rep			sui	2	43	5	* Qf Te S Vp Z	3716	0	
Czech Rep	1996	+	fau	0	0	0	Cr		0	
Czech Rep			sui	2	100	10	P Pn Qf te Vp *		0	
Dominican Republic	2001	+	sui	87	0	0	* Qi Su Te V		0	857577
Dominican Republic	2000	+	sui	49	0	0	* Qi Su Te		0	644535
Dominican Republic	1999	+()	sui	58	0	0	* Qi S Su Te V		0	498430
Dominican Republic	1998	+()	sui	232	0	13674	* Qi S Su Te V		8744	895807
Dominican Republic	1997	+()	sui	22	0	0	* Qi S Su Te V		8499	30302
Dominican	1996	-1981	sui	0	0	0	* P Qf Vp		0	

Republic										
Ecuador	2001	(02/2000)		0	0	0			0	
Ecuador	2000	+	sui	1	1	1	* Su Qf Qi V		0	26944
Ecuador	1999	+	sui	1	4	0	* Su Qf Qi V		0	27000
Ecuador	1998	+	sui	11	11	0	Qf * Qi V Su		0	34000
Ecuador	1997	+	sui	0	0	0			0	
Ecuador	1996	+	sui	12	48	12	* Pn Qf V		0	29597
El Salvador	2001	+	sui	1	55	51	Sp * Te Su Qf M V	4	0	18403
El Salvador	2000	+	sui	4	38	18	S * Qf V	18	20	33823
El Salvador	1999	+	sui	20	120	89	* Qf Te V Z		0	
El Salvador	1998	+	sui	18	0	0			0	
El Salvador	1997	+	sui	26	188	100	Qf * V Z	0	0	27869
El Salvador	1996	+	sui	8	11	0	* te V		0	
Macedonia	2001	+	sui	32	35	27	S * Qf Qi V	58	0	209142
Macedonia	2000	+	sui	15	122	0	* Qf Qi S V	600	0	328137
Macedonia	1999	+	sui	19	19	19	* Qf Qi S V		0	
Macedonia	1998	-1994		0	0	0			0	
Macedonia	1997	-1994	sui	0	0	0	* Qf		0	
Macedonia	1996	-1994	sui	0	0	0	P Pn Q S V *		0	108853
France	2002	+	sui	1	5	5		390	0	
Germany	2003	+	sui	1	1	17		5	0	
Germany	2002	+	sui	4	156	37		1762	0	
Germany	2001	+	fau	373	373	53	S Cr * Te Qf Qi Vp Z		0	
Germany			sui	5	882	41	S Cr * Te Qf Qi Vp Z	6369	0	
Germany	2000	+	fau	174	174	38	S Cr * Te Qf Qi Vp Z		0	
Germany			sui	2	20	0	S Cr * Te Qf Qi Vp Z	1045	0	
Germany	1999	+	fau	409	409	157	S Cr * Te Qf Qi Z		0	
Germany			sui	6	214	199	S Cr * Te Qf Qi Vp Z	5174	0	
Germany	1998	+	fau	0	219	0	Cr Qi * Qf Te S		0	
Germany			sui	11	4379	1794	Cr Qi * Qf Te S Vp	77062	0	
Germany	1997	+	sui	44	2081	427	Cr Qi * Qf Te S Vp	40815	0	
Germany	1996	+	sui	4	154	41		6788	0	
Guatemala	2001	+	sui	33	378	280	* M Qf Qi Su Te V Vp Z	195	0	
Guatemala	2000	+	sui	81	0	0	* M Qf Qi S Su V Z		0	
Guatemala	1999	+	sui	55	0	0			0	
Guatemala	1998	+	sui	38	304	243	* Sp V	131	60	310
Guatemala	1997	...		0	0	0			0	
Haiti	2000	+	sui	0	0	0	Qf V		0	250000
Haiti	1999	+	sui	0	0	0	Qf V		0	227000
Haiti	1998	+	sui	0	0	0	V		0	

Haiti	1997	...		0	0	0			0	
Haiti	1996	+	sui	0	0	0	V		0	270000
Honduras	2001	+	sui	0	0	0			0	
Honduras	2000	+	sui	0	0	0			0	
Honduras	1999	+	sui	7	0	0			0	
Honduras	1998	+	sui	5	0	0			0	
Honduras	1997	+	sui	1	150	150	V	0	3	1500
Honduras	1996	+	sui	4	0	0			0	
Hong Kong	2001	+	sui	1	40	0			0	
Hong Kong	2000	+	sui	0	0	0			0	
Hong Kong	1999	+	sui	3	0	0	V		0	
Hong Kong	1998	-1997		0	0	0			0	
Hong Kong	1997	+	sui	0	0	0			0	
Hong Kong	1996	+	sui	0	0	0	V *		0	
India	2001	+()	sui	236	13224	1195	* Qi Sp Te V		0	
India	2000	+()	sui	53	1305	75	* Qi Sp Te V		0	
India	1999	+	sui	142	8800	1424	* Qi Sp Te V		0	
India	1998	+	sui	142	5669	1633	* Qi Sp Te V		0	
India	1997	+	sui	58	2656	539	* Sp V		0	
India	1996	+()	sui	93	1860	426	* S V		0	
Indonesia	2001	+	sui	0	4302	1332	* Sp V		5	
Indonesia	2000	+	sui	0	3874	0	* Sp Su V		0	86000
Indonesia	1999	+	sui	0	37111	0			0	
Indonesia	1998	+	sui	0	286	0	V		0	26780
Indonesia	1997	+	sui	0	29614	0			0	
Indonesia	1996	+	sui	0	0	0			0	
Italy	2001	+()	sui	5	58	25	* Cr M Su Te Vp Z	164	0	
Italy	2000	+	sui	3	29	7	S Cr * Te M Z	71	71	
Italy	1999	+	sui	9	232	89	S Cr * Te M Z	9125	9036	
Italy	1998	+()	sui	18	323	130	Cr Qf * Te Qi S Vp	2262	0	
Italy	1997	+()	fau	11	11	10	S Cr * Te Su Qf Qi Vp	1	0	
Italy			sui	44	799	436	S Cr * Te Qf Qi Vp	3635	0	
Italy	1996	+()	fau	3	3	2	*	1	0	
Italy			sui	46	4	215	P S Vp *	1247	0	
Korea(Rep. of)	2003	+	sui	1	5	2		798	0	
Korea(Rep. of)	2002	+	sui	6	6	21		15887	0	
Korea(Rep. of)	2001	(07/1999)		0	7	0			0	
Korea(Rep. of)	2000	(07/1999)	sui	0	8	0	S * Te Su Qf M V Z		0	
Korea(Rep. of)	1999	+	sui	5	9	404	Sp * Te Su Qf M V Z	1279	0	

Korea(Rep. of)	1998	+	sui	6	10	509	M * Qf Te Sp V	476	0	11000000
Korea(Rep. of)	1997	+	sui	20	11	799	M * Qf Te Sp V	1113	0	900000
Korea(Rep. of)	1996	+	sui	39	12	3094	Pn Qf S V *	174	0	...
Laos	2001	+	sui	14	13	368			0	
Laos	2000	+	sui	0	14	0			0	
Laos	1999	+	sui	0	15	0			0	
Laos	1998	+	sui	0	16	0			0	
Laos	1997	+	sui	0	17	0			0	
Laos	1996	+	sui	0	18	0			0	
Latvia	2001	(04/1996)	fau	0	19	0	Cr * Su M V		0	50000
Latvia			sui	0	20	0	* Su M Vp		0	
Latvia	2000	(04/1996)	fau	0	21	0	* Cr M Su V		0	40000
Latvia			sui	0	22	0	* M		0	
Latvia	1999	(04/1996)	fau	0	23	0	Cr * Te M		0	
Latvia			sui	0	24	0	*		0	
Latvia	1998	(04/1996)	fau	0	25	0	Cr M * Te V		0	15115
Latvia			sui	0	26	0	*		0	
Latvia	1997	(04/1996)	sui	0	27	0	* V		0	432993
Latvia	1996	+	sui	2	28	10	* P Q S V	15	0	580300
Luxembourg	2003	+	sui	1	29	0	Sp Cr * Te Su M Vp	256	0	
Luxembourg	2002	+	sui	8	30	0	Sp Cr * Te Su M Vp	6558	0	
Luxembourg	2001	+()	fau	7	31	7	Sp Cr * Te Su M Vp	7	7	
Luxembourg			sui	0	32	0			0	
Luxembourg	2000	+?	fau	0	33	0	* Cr M S Su Te Vp Z		15	
Luxembourg	1999	+?	fau	0	34	0	S Cr * Te Su M Vp Z		1	
Luxembourg	1998	(04/1987)	sui	0	36	0	S * Te Su Qf Qi Vp		0	
Luxembourg	1997	(04/1987)	sui	0	37	0	* Qf Qi S Su Te Vp		0	
Luxembourg	1996	(04/1987)	sui	0	38	0	* Pn Q S te Vp		0	
Madagascar	2001	+	sui	0	39	0			0	
Madagascar	2000	+	sui	3	40	7	* Qi Su V		0	20089
Madagascar	1999	+	sui	5	41	4	* Qi S Su V Z		0	46805
Madagascar	1998	+	sui	10	42	5748	S * Su Qi V Z		0	23461
Madagascar	1997	+	sui	4	43	35	V		0	103463
Madagascar	1996	+	sui	12	44	373	V		0	
Malaysia (Peninsular)	2001	-1999	sui	0	45	0	*		0	
Malaysia (Peninsular)	2000	-1999		0	46	0			0	
Malaysia	1999	+	sui	1	47	14	Sp * V		0	3000000

(Peninsular)										
Malaysia (Peninsular)	1998	+	sui	10	48	363	* Sp V		0	4000000
Malaysia (Peninsular)	1997	+	sui	2	49	118	* Sp V	0	0	5000000
Malaysia (Peninsular)	1996	+()	sui	7	50	332	* P Q S V		0	
Malaysia (Sarawak)	2001	+	sui	0	51	0	M Qf S V		0	
Malaysia (Sarawak)	2000	+	sui	0	52	0	Qf S V		0	
Malaysia (Sarawak)	1999	+	sui	0	53	0	Qf S V		0	
Malaysia (Sarawak)	1998	+	sui	1	54	1	* Qf S V		0	
Malaysia (Sarawak)	1997	+	sui	1	55	1	* Qf S V	0	0	0
Malaysia (Sarawak)	1996	+	sui	0	56	0	* P Q Sp V		0	300000
Mauritius	2001	+	sui	1	57	15			0	
Mauritius	2000	+	sui	2	58	13	S * Te Su Qi M V		0	12000
Mauritius	1999	-		0	59	0			0	
Mauritius	1998	...		0	60	0			0	
Mauritius	1997	-1994		0	61	0			0	
Mauritius	1996	-1994	sui	0	62	0			0	
Mexico	2001	+()	sui	12	63	935	* Te Su Qf Qi M V Z		0	13030450
Mexico	2000	+()	sui	12	64	935	* M Qf Qi Su Te V Z		0	10617000
Mexico	1999	+()	sui	44	65	3802	* Te Su Qf Qi M V Z		0	
Mexico	1998	+()	sui	107	66	1515	Qf Qi Su Te V Z		0	7385575
Mexico	1997	+()	sui	150	67	5977	* M Qf Qi S Su Te V Z	10727	10727	1300000
Mexico	1996	+()	sui	24	68	326	* P Pn Qi S te V		0	...
Moldavia	2002	+	sui	2	69	17		5	2	
Moldavia	2001	(08/1998)	sui	0	70	0	* Cr Qf Qi S Su Te V		0	415344
Moldavia	2000	(08/1998)	sui	0	71	0	* Cr Qf Qi S Te V Z	31	13	642214
Moldavia	1999	(08/1998)	sui	0	72	0	* Cr Qf Qi S Te V Z		0	886639
Moldavia	1998	+	sui	7	73	8	* Cr Qf Qi S Te V Z	31	13	1450044
Moldavia	1997	(03/1996)	sui	0	74	0	* Cr Qf Qi S Te V Z		0	1249741
Moldavia	1996	+	sui	1	75	5	* Cr P Pn Q Sp te V	18	0	1581000
Myanmar	2001	+	sui	10	76	18	Qi V		0	
Myanmar	2000	+	sui	4	77	103	Qi V		0	

Myanmar	1999	+	sui	5	78	5	V	3	0	
Myanmar	1998	(10/1997)	sui	0	79	0	Qf V		0	707357
Myanmar	1997	+	sui	4	80	4	Sp V		0	433205
Myanmar	1996	+	sui	2	81	10	V		0	
Nepal	2001	+	sui	12	82	21	* V		0	169
Nepal	2000	+	sui	5	83	0			0	
Nepal	1999	+	sui	39	84	42	V		0	221
Nepal	1998	+	sui	18	85	30	V		0	116
Nepal	1997	+	sui	30	86	449		0	0	312
Nepal	1996	+	sui	0	87	0			0	
Netherlands	2001	(03/1998)	sui	0	88	0	* Vp		0	
Netherlands	2000	(03/1998)	sui	0	89	0	* Vp		0	
Netherlands	1999	(03/1998)	sui	0	90	0	*		0	
Netherlands	1998	+	sui	5	91	0	* Qf S Su Te Vp Z	4942	0	
Netherlands	1997	+	sui	424	92	0	M * Qf Te S Su Vp Z	681759	0	
Netherlands	1996	(06/1992)	sui	0	93	0	Qi S Vp *		0	
Nicaragua	2001	+	sui	53	94	68	Sp * Te Su Qf M Z	49	25	
Nicaragua	2000	+	sui	4	95	52	* Su V		0	4397
Nicaragua	1996	+	sui	3	96	40	* Pa Q V		0	81000
Peru	2001	+()	fau	1	97	1	Sp * Qf V		8	
Peru			sui	8	98	43	* Qf V		0	
Peru	2000	+()	sui	6	99	14	* Qf V		0	119292
Peru	1999	+	sui	7	100	0			0	
Peru	1998	+()	sui	16	101	134	* V		0	92822
Peru	1997	+()	sui	7	102	583	Qf * Qi V		0	131702
Peru	1996	+()	sui	9	103	0	* Pa Q V		0	46577
Philippines	2001	+	sui	0	104	4769	V		0	309727
Philippines	2000	+	sui	0	105	245			0	
Philippines	1999	+	sui	0	106	4918	V		0	234431
Philippines	1998	+	sui	0	107	3250	V		0	255723
Philippines	1997	+	sui	0	108	5997	* V		0	234240
Philippines	1996	+	sui	0	109	3885	Pn V		0	150332
Romania	2002	+	sui	19	110	131		265	148	
Russia	2001	+	...	14	111	1866	* Cr M Qf Sp Te V	311	13500	26.8M
Russia	2000	+	sui	16	112	531	* Cr Qf Sp Te V	1529	2000	28.6M
Russia	1999	+	sui	14	113	1919	* Cr Qf Sp V	387	0	27.5M
Russia	1998	+	sui	11	114	1026	* Cr Qi Sp Te V		144	25200
Russia	1997	+	sui	10	115	7759	* Qi S Te V		5260	25.7M
Russia	1996	+	sui	26	116	2162	* Qi S te V		0	32.4M
Serbia	2001	+	sui	128	117	428	* Qf Qi S Su V Z	883	0	5752165

Serbia	2000	+	sui	172	118	1943	* Qf Qi Su V Z	2372	0	6339081
Serbia	1999	+	sui	69	119	680	* Qf Qi Su V Z	2935	0	7583205
Serbia	1998	+	sui	62	120	360	* Qf Qi Su V Z	877	0	7332106
Serbia	1997	+	sui	73	121	333	* Qf Qi Su V Z	481	0	7443401
Serbia	1996	+	sui	118	122	957	* P Pn Qf Qi S te V	1650	0	9657511
Slovakia	2001	+	fau	39	123	1	S Cr * Su Qf M Vp Z	42	0	
Slovakia			sui	1	124	14	S Cr * Te Su Qf Qi M V Z	598	0	3734
Slovakia	2000	+	fau	20	125	1	S Cr * Su Qf M Vp Z	20	0	
Slovakia			sui	1	126	0	S Cr * Te Su Qf Qi M V Z	4	0	2000000
Slovakia	1999	+	fau	14	127	1	S Cr * Te Su Qf Qi M	16	0	
Slovakia			sui	0	128	0	S * Su Qf Qi V		0	1000000
Slovakia	1998	+	fau	70	129	6	Cr M Qi * Qf S Su	101	0	
Slovakia			sui	20	130	117	Cr Qi * Qf Te S Su V	24023	0	750000
Slovakia	1997	+	fau	78	131	10	* Cr M Qf Qi S Su Te	120	0	0
Slovakia			sui	18	132	146	* Cr M Qf Qi S Su Te V Z	33898	0	129598
Slovakia	1996	+	sui	25	133	752	Cr P Q S *		0	
Slovenia	2001	(05/1996)		0	134	0			0	
Slovenia	2000	(05/1996)		0	135	0			0	
Slovenia	1999	(05/1996)		0	136	0			0	
Slovenia	1998	(05/1996)	sui	0	137	0	* Qf Qi S V		0	
Slovenia	1997	(05/1996)		0	138	0			0	
Slovenia	1996	+	sui	1	139	1	* Qf Sp V	24	0	210000
Spain	2002	+	sui	2	140	1		0	0	
Spain	2001	+()	fau	0	141	0			0	
Spain			sui	33	142	1752	S Cr * Te Su Qi M Vp Z	38948	0	
Spain	2000	(07/1998)		0	143	0			0	
Spain	1999	(07/1998)	sui	0	144	0	* Te Qf M Vp		0	
Spain	1998	+	sui	21	145	816	Qf * Te Qi S M Vp Z	67812	0	
Spain	1997	+	sui	78	146	1440	* Te Qi S Vp Su	124124	124124	
Spain	1996	-1985	sui	0	147	0	te Vp *		0	
Sri Lanka	2001	(06/1999)	sui	0	148	0	* Qf V		0	16921
Sri Lanka	2000	(06/1999)	fau	0	149	0			0	
Sri Lanka			sui	0	150	0	* Qf V		0	2237
Sri Lanka	1999	+	sui	1	151	1	* Qf Qi V		0	19654
Sri Lanka	1998	+	sui	5	152	66	* Qf V		0	13083
Sri Lanka	1997	+	sui	4	153	23			0	
Sri Lanka	1996	+()	sui	9	154	80	* S V		0	17687
Switzerland	2001	(09/1999)	fau	0	155	0	Te Qf Qi Z		0	
Switzerland			sui	0	156	0	S * Qf Qi Vp Z		0	
Switzerland	2000	(09/1999)	fau	0	157	0	* Te Qf Qi		0	

Switzerland			sui	0	158	0	S * Qf Qi Vp Z		0	
Switzerland	1999	+	fau	49	159	92	* Te Qf Qi		0	
Switzerland			sui	0	160	0	S * Qf Qi Vp		0	
Switzerland	1998	+	fau	47	161	0	*	125	0	
Switzerland			sui	0	162	0	* Qf Qi S Vp		0	
Switzerland	1997	(12/1993)	sui	0	163	0	Qi * Qf Vp		0	
Switzerland	1996	(12/1993)	sui	0	164	0	P Pn Q S Vp *		0	
Taipei China	2001	+	sui	11	165	783	S * Te M V	1528	0	16052043
Taipei China	2000	+	sui	2	166	11	Sp * Qi M V	12	0	174646
Taipei China	1999	+	sui	3	167	144	Sp * Qi M V	58	0	
Taipei China	1998	+	sui	5	168	248	Qi * Qf Sp V	241	0	
Taipei China	1997	+	sui	29	169	1373	* Qf Sp V	1769	0	
Taipei China	1996	+	sui	60	170	3183	* Pn Q S V	3933	0	
Thailand	2001	+	sui	30	171	2383	Sp * Su Qf V	3929	0	
Thailand	2000	+	sui	53	172	1308			0	
Thailand	1999	+	sui	18	173	0			0	
Thailand	1998	-1996		0	174	0			0	
Thailand	1997	-1996		0	175	0			0	
Thailand	1996	+	sui	0	176	0	P Q te V *		0	2733191
Ukraine	2001	+	fau	2	177	13	Cr * Te Qf Qi		0	
Ukraine			sui	0	178	0	Cr * Te Qf Qi V		0	7208000
Ukraine	2000	(01/1996)	fau	0	179	0	* Qf Qi		0	
Ukraine			sui	0	180	0	* Qf Qi V		0	7512000
Ukraine	1999	(01/1996)	fau	0	181	0	* Qf Qi		0	
Ukraine			sui	0	182	0	* Qf Qi V		0	9278000
Ukraine	1998	(01/1996)	fau	0	183	0	Qi * Qf		0	
Ukraine			sui	0	184	0	Qi * Qf V		0	10223060
Ukraine	1997	(01/1996)	fau	0	185	0	Qi * Qf		0	
Ukraine			sui	0	186	0	Qi * Qf V		0	12257250
Ukraine	1996	+	sui	1	187	71	* P Pn Q S te V	77	0	17169000
Venezuela	2001	(02/2000)		0	188	0			0	
Venezuela	2000	+	sui	1	189	392	* Su V		0	1925645
Venezuela	1999	(11/1996)	sui	0	190	0	* Su Qi V		0	1393010
Venezuela	1998	(11/1996)	sui	0	191	0	* Qi V Su		0	1188413
Venezuela	1997	(11/1996)	sui	0	192	0	* Qi V Su		0	884808
Venezuela	1996	+	sui	3	193	0	Qi V *		0	791134
Vietnam	2001	+	fau	0	194	0			0	
Vietnam			sui	0	195	15483	Sp * Te Cn M V	1869	995	
Vietnam	2000	+	fau	0	196	0			0	
Vietnam			sui	0	197	17587	Sp * Te Cn M V	1623	881	

Vietnam	1999	+	fau	0	198	0		0	0	
Vietnam			sui	0	199	18776	Sp * Te Cn M V	0	0	3615000
Vietnam	1998	+	sui	0	200	0	Cn Qi Qf S V	0	0	13813
Vietnam	1997	+	sui	0	201	13829	Cn Qf	0	0	
Vietnam	1996	+	sui	0	202	0		0	0	

S=Stamping Out, Q=Quarantine, Su= Surveillance, Tr= Tracing, V= Vaccination, Cr= control of wildlife vectors, Sui= domestic swine, Fau=wild swine

Figure 2.11

CSF activity reported to OIE within the last 18 months (put dates in). Information was obtained from archived OIE weekly publications regarding disease activity. Shaded rows are initial outbreaks while white rows that follow were subsequently tied to the initial outbreak (www.oie.int).

~~EPIZOOTICLEVEL~~~~~~~~~~														
					~~OUTBREAKLEVEL~~~~~~									
Region	Spec	Most Recent Epizootic	Date of Previous Epizootic	Outbr	Outbreak Location	Date of outbreak report	Estimated Date of Infection	cases	deaths	destr	slaught	Source	Control	Description of Affected Population
Europe - Non EU	sui	12/1/02	12/1/96	3	Laç (in the NW part of Albania)	12/1/96	12/1/96					?	S	Backyard
					Lezhe (in the NW part of Albania)	12/1/96	12/1/96					?	S	Backyard
					Mirdite (in the NW part of Albania)	12/1/96	12/1/96	40		40		?	S	Backyard
Europe - EU	fau	11/13/02	7/1/97	1	Belgium - Büllingen district	11/13/02		1		12		?	S Su	11/12 swine were -/- while infected swine was virologically (+), serologically (-)
South America	sui	3/1/03	8/1/01	1	Brazil - State of Ceará (NE Brazil)	8/1/01		50	0	0	0	?		58 susceptible swine
Europe - Non EU	sui	3/26/02	2/1/01	25	Bulgaria - Kalipetrovo	3/26/02	3/19/02	3	3	35	0	swill	S Q V Su	38 backyard fattening pigs

					Bulgaria - Rastnic	4/11/02						swill	S Q Su	backyard fattening pigs
					Bulgaria - Meshtitca	4/11/02		3	0	3	0	swill	S Q Su V	5 backyard fattening pigs
					Bulgaria - Razlog	4/17/02						contact	S Q Su V	backyard fattening pigs
					Bulgaria - Bistritza	4/17/02						contact	S Q Su V	backyard fattening pigs
					Bulgaria - Balanovo	4/17/02						contact	S Q Su V	backyard fattening pigs
					Bulgaria - Dupnitza	4/17/02						contact	S Q Su V	backyard fattening pigs
					Bulgaria - Resilovo	4/17/02						contact	S Q Su V	backyard fattening pigs
					Bulgaria - Granitza	4/17/02						contact	S Q Su V	backyard fattening pigs
					Bulgaria - Govedare	4/17/02						contact	S Q Su V	backyard fattening pigs
					Bulgaria - Topolovo	4/17/02						contact	S Q Su V	backyard fattening pigs
					Bulgaria - G. Cherkovishte	4/17/02						contact	S Q Su V	backyard fattening pigs
					Bulgaria - Nikjup	4/17/02		23	8	242	0	contact	S Q Su V	250 backyard fattening pigs
					Bulgaria - Stoevtsi	4/22/02						contact	S Q Su V	backyard fattening pigs
					Bulgaria - Cherven Briag	4/22/02						contact	S Q Su V	backyard fattening pigs
					Bulgaria - Ouchartsi	4/22/02						contact	S Q Su V	backyard fattening pigs
					Bulgaria - Lehcevo	4/22/02						contact	S Q Su V	backyard fattening pigs

					Bulgaria - Bistrentsi	4/22/02						contact	S Q Su V	backyard fattening pigs
					Bulgaria - Kostenets	4/22/02						contact	S Q Su V	backyard fattening pigs
					Bulgaria - Krapets	4/22/02						contact	S Q Su V	backyard fattening pigs
					Bulgaria - Manastirishte	4/22/02						contact	S Q Su V	backyard fattening pigs
					Bulgaria - Varbeshnitsa	4/22/02		28	5	52	5	contact	S Q Su V	62 backyard fattening pigs
					Bulgaria - Mihalkovo	5/14/02						contact	S Q Su V	backyard fattening pigs
					Bulgaria - Devin	5/14/02						contact	S Q Su V	backyard fattening pigs
					Bulgaria - Biala	5/14/02		8	2	14	0	contact	S Q Su V	16 backyard fattening pigs
Europe - Non EU	Sui	12/2/02	5/1/02	4	Bulgaria - Haskovo	11/27/02		5	2	18	27	swill	S Q Su V	47 backyard fattening pigs
					Bulgaria - Haskovo	12/19/02						contact	S Q Su V Cr	pigs in small private farms
					Bulgaria - Haskovo	12/19/02						contact	S Q Su V Cr	pigs in small private farms
					Bulgaria - Haskovo	12/19/02		11	3	153 4	0	contact	S Q Su V Cr	1537 pigs in small private farms
Europe - Non EU	Sui	12/20/02	12/2/02	1	Bulgaria - Kirilovo	12/29/02		3	2	142	28	unknown	S Q Su V Cr	172 pigs in small private farms
Europe - Non EU	Sui	1/29/03	12/20/0 2	1	Bulgaria - Brestnik	1/29/03		9	2	12	0	unknown	S Q Su V Cr	14 pigs in small private farms
Europe - Non EU	Sui	2/25/03	1/29/03	2	Bulgaria - Sliven	2/25/03						swill	S Q Su V Cr	backyard fattening pigs
					Bulgaria - Kermen	2/25/03						contact	S Q Su V Cr	backyard fattening pigs

Europe - Non EU	Sui	2/25/03	1/29/03	1	Bulgaria - Yasna Polyana village	2/25/03		30	10	103	39	congenital	S Q Su V Cr	152 pigs in small private farms
Europe - Non EU	Sui	3/1/03	2/25/03	1	Bulgaria - Bourgas								S Q Su V Cr	pigs in small private farms
				4	Bulgaria - Kustendil								S Q Su V Cr	pigs in small private farms
				1	Bulgaria - Sliven			16	1	99	0	?	S Q Su V Cr	100 pigs in small private farms
Europe - Non EU	Sui	4/1/03	3/1/03	1	Bulgaria - Bourgas	4/1/03		8	2	24	0	?	S Q Su V Cr	26 pigs in small private farms
Europe - Non EU	Sui	6/20/02	7/1/99	1	Croatia - Rajic	6/19/02	6/12/02	10	7	14	0	Feral contact	S Q Su Cr	21 backyard fattening pigs
Europe - EU	fau	4/22/02	2/1/93	2	France - Moselle	4/10/02		21	1	20	…	?	S Q Su Cr	1 (+) dead boar led to testing of 173 wild boar, 21 proved to be either virological or serologically (+)
					France - Moselle	4/29/02	4/20/02	5	5	390	0	Feral contact	S Q Su Cr	395 domestic piglets in a cooperative rearing unit
Europe - EU	sui	3/14/02	2/19/02	1	Germany - Rhineland-Palatinate	3/14/02			17	117 0	0	?	S Q Su Tr	1,187 pigs in holding for fattening
Europe - EU	sui	4/8/02	3/14/02	1	Germany - Rhineland-Palatinate	4/8/02		4	0	13	0	?	S Q Su Tr	13 pigs in holding for fattening
Europe - EU	sui	4/29/02	4/8/02	1	Germany - Rhineland-Palatinate	4/29/02		150	20	253	0	importation of 150 piglets	S Q Su Tr	273 pigs in holding for fattening
Europe - EU	fau	5/1/02	4/29/02	1	Germany - Rheinland, Lüneburg, Köln	5/1/02		26	10	16	0	?	S Q Su Tr Cr	26 feral swine
Europe - EU	sui	5/1/02	4/29/02	1	Germany - Rhineland-Palatinate	5/1/02		30	12	685	0	?	S Q Su Tr	697 pigs in holding for fattening
Europe - EU	fau	6/1/02	5/1/02	4	Germany - Köln	6/1/02							S Q Su	feral swine

													Tr	
					Germany - Lüneburg	6/1/02							S Q Su Tr	feral swine
					Germany - Rheinland-Pfalz	6/1/02							S Q Su Tr	feral swine
					Germany - Saarland	6/1/02		42	12	30	0	?	S Q Su Tr	42 feral swine
Europe - EU	fau	7/1/02	6/1/02	2	Germany - Köln	7/1/02							S Q Su Tr	feral swine
					Germany - Rheinland-Pfalz	7/1/02		51	22	29	0	?	S Q Su Tr	51 feral swine
Europe - EU	fau	8/1/02	7/1/02	39	Germany - Rheinland-Pfalz	8/1/02							S Q Su Tr	feral swine
				3	Germany - Köln	8/1/02		42	7	35	0	?	S Q Su Tr	42 feral swine
Europe - EU	fau	9/1/02	8/1/02	6	Germany - Rheinland-Pfalz	9/1/02							S Q Su Tr	feral swine
				30	Germany - Köln	9/1/02		34	6	26	0	?	S Q Su Tr	34 feral swine
Europe - EU	sui	9/1/02	8/1/02	2	Germany - Rheinland-Pfalz/ Köln	9/1/02		185	0	169 9	0	?	S Q Su Tr	1699 susceptible pigs
Europe - EU	fau	10/1/02	9/1/02	1	Germany - Köln	10/1/02							S Q Su Tr	feral swine
				14	Germany - Rheinland-Pfalz	10/1/02		15	6	9	0	?	S Q Su Tr	15 feral swine
				30	Germany - Rheinland-Pfalz	11/1/02		30	6	24	0	?	S Q Su Tr	30 feral swine
				20	Germany - Rheinland-Pfalz	1/1/03		20	3	17	0	?	S Q Su Tr	20 feral swine
				8	Germany - Rheinland-Pfalz	2/1/03		7	5	2	0	?	S Q Su Tr	7 feral swine
				1	Germany - Rheinland-Pfalz	3/1/03		1	0	1	0	?	S Q Su Tr	1 feral swine
				1	Germany - Rheinland-Pfalz	5/1/03		1	1	0	0	?	S Q Su Tr	1 feral swine
Europe - EU	sui	9/22/03	9/1/01	1	Italy - Sardinia	9/12/03	9/12/03	7	6	7	0	?		13 susceptible pigs
Asia	sui	4/16/02	7/1/99	2	KOREA (REP. OF ~) Chulwon-goon	4/16/02	4/4/02	108	108	246	0	?	S Q Su Tr	40 sows, 94 piglets, 220 fattening pigs

					KOREA (REP. OF ~) Chulwon-goon	5/1/02		8	8	2123	0	?	S Q Su Tr	1,055 fattening pigs, 261 sows, 811 piglets and 4 boars
Asia	sui	10/8/02	4/16/02	11	Korea (REP. OF ~) Incheon Metropolitan City	10/7/02		30	3	1297	0		S Q Su Tr	1,175 fattening pigs and 125 sows
					Korea (REP. OF ~) Incheon Metropolitan City	10/14/02						contact	S Q Su Tr	
					Korea (REP. OF ~) Incheon Metropolitan City	10/14/02		55	13	1300	0	contact	S Q Su Tr	874 fattening pigs, 295 piglets, 137 sows and 7 boars
					Korea (REP. OF ~) Gimpo (Kimp'o) city	10/21/02		50	5	939	0	contact	S Q Su Tr	944 in pig-fattening holding 2 km from previous outbreaks
					Korea (REP. OF ~) Gimpo (Kimp'o) city	12/2/02						contact	S Q Su Tr	
					Korea (REP. OF ~) Gimpo (Kimp'o) city	12/2/02		10	5	2663		contact	S Q Su Tr	2668 in 2 pig fattening holdings
					Korea (REP. OF ~) Incheon Metropolitan City	12/2/02						?	S Q Su Tr	
					Korea (REP. OF ~) Incheon Metropolitan City	12/2/02		8	0	1915		?	S Q Su Tr	1,915 susceptible pigs in 2 fattening holdings
					Korea (REP. OF ~) Incheon Metropolitan City	12/2/02		3	3	1160		?	S Q Su Tr	1160 susceptible pigs in fattening holding
					Korea (REP. OF ~) Gimpo (Kimp'o) city	1/2/03		5	0	1520		contact	S Q Su Tr	1520 susceptible pigs in fattening holding
					Korea (REP. OF ~) Incheon Metropolitan City	1/2/03		120	2	1786		contact	S Q Su Tr	1788 susceptible pigs in fattening holding

					Korea (REP. OF ~) Iksan city	3/19/03		34	2	798	0	?	S Q Su Tr	800 pigs susceptible located 100 km from previous outbreak
Europe - EU	fau	4/2/02	2/24/02	4	Luxembourg , Diekirch	4/2/02								
					Luxembourg , Echternach	4/2/02								
					Luxembourg-Campagne	4/2/02								
					Luxembourg , Mersch	4/2/02		6	0	6	0	?	S Q Su Tr Cr	feral swine
Europe - EU	Sui	4/2/02	2/24/02	16	Luxembourg , Mersch canton (central-eastern part of the country)	4/2/02				137 1	0	Feral contact?	S Q Su Tr Cr	1371 pigs in fattening farm
					Luxembourg , Hoscheid in the north-east part of the country	5/30/02				240	0	contact	S Q Su Tr Cr	180 piglets and 60 breeding sows in susceptible population
					Luxembourg , Lullange district	6/5/02				106 0	0	contact	S Q Su Tr Cr	360 breeding sows and 700 piglets
					Luxembourg , Remich canton (south-eastern part of the country)	6/14/02				180		contact	S Q Su Tr Cr	Breeding farm comprising 40 sows and 140 piglets
					Luxembourg , Munsbach locality, in the central-eastern part of the country	6/14/02				650	0	contact	S Q Su Tr Cr	Fattening farm comprising 650 pigs
					Luxembourg - Capellen	7/2/02						Feral contact?	S Q Su Tr Cr	
					Luxembourg - Clervaux	7/2/02						Feral contact?	S Q Su Tr Cr	
					Luxembourg - Diekirch	7/2/02						Feral contact?	S Q Su Tr Cr	

					Luxembourg-Campagne	7/2/02						Feral contact?	S Q Su Tr Cr	
					Luxembourg - Vianden	7/2/02			8	120 7	0	Feral contact?	S Q Su Tr Cr	1215 susceptible pigs
					Luxembourg , Mersch canton (central-eastern part of the country)	8/2/02						Feral contact?	S Q Su Tr Cr	
					Luxembourg-Campagne	8/2/02						Feral contact?	S Q Su Tr Cr	
					Luxembourg - Vianden	8/2/02		5	4	155	0	Feral contact?	S Q Su Tr Cr	164 susceptible pigs
					Luxembourg, Diekirch	9/1/02		3		3		?	S Q Su Tr Cr	3 feral swine
					Luxembourg - Clervaux	10/1/02						Feral contact?	S Q Su Tr Cr	
					Luxembourg - Diekirch	10/1/02						Feral contact?	S Q Su Tr Cr	
					Luxembourg-Campagne	10/1/02		11	9	333	0	Feral contact?	S Q Su Tr Cr	342 susceptible domestic pigs
Europe - EU	Sui	8/12/03	10/1/02	1	Luxembourg, County of Redange (central-western part of the country)	8/12/03	…			123 1		Feral contact?	S Q Su Tr Cr	breeding/fattening farm with 1,095 pigs, a pig farm with 122 pigs, located within the 1-km-radius zone, as well as on a contact farm with 134 pigs
Europe - Non EU	sui	7/5/02	8/1/98	1	Moldavia Tighina district (in the eastern part of the country)	7/5/02	7/1/02	24	17	5	2	vaccinal origin?	S Q Su Tr Cr V	660 piglets aged 2 to 4 months and pigs aged over 4 months
Europe - Non EU	sui	4/9/02	4/1/01	1	Romania, Arad County (in the western part of the country)	4/9/02	4/7/02	61	30	132	120	swill	S Q Su Tr Cr	282 pigs susceptible in a small holding

Europe - Non EU	sui	7/3/02	4/9/02	1	Romania, Bihor county (in the western part of the country)	7/2/02	6/22/02	10	8	2	0	?	S Q Su Tr Cr	10 piglets in small holding
Europe - Non EU	sui	8/29/02	7/3/02	5	Romania, Salaj county (in the western part of the country)	8/28/02	8/14/02	54	8	28	18	?	S Q Su Tr Cr	smallholdings (4 sows, 18 pigs for fattening, 32 piglets)
Europe - Non EU	sui	9/6/02	8/29/02	1	Romania, Timis County (in the western part of the country)	9/4/02	8/30/02	11	8	3	0	?	S Q Su Tr Cr	11 smallholding (piglets)
Europe - Non EU	sui	9/19/02	9/6/02	4	Sarmasag, Salaj County (in the north-western part of the country) Romania	9/19/02						…	S Q Su Tr Cr	
					Nusfalau, Salaj County (in the north-western part of the country) Romania	9/19/02						…	S Q Su Tr Cr	
					Bulbucata, Giurgiu County (in the southern part of the country) Romania	9/19/02						…	S Q Su Tr Cr	
					Crampoia, Olt County (in the southern part of the country) Romania	9/19/02	…	144	73	63	8	?	S Q Su Tr Cr	198 sows, boars, piglets (smallholdings).
Europe - Non EU	sui	10/4/02	9/19/02	1	Asezata, Satu Mare county (in the north-western part of the country) Romania	10/4/02	…	3	1	2	0	?	S Q Su Tr Cr	sow and piglets in a smallholding
Europe - Non EU	sui	10/15/02	10/4/02	1	Simleul Silvaniei, Salaj county (in the north-western part of the country) Romania	10/15/02	…						S Q Su Tr Cr	

				2	Sag, Salaj county (in the north-western part of the country) Romania	10/15/02	…						S Q Su Tr Cr	
				2	Mesesenii de Jos, Salaj county (in the north-western part of the country) Romania	10/15/02	…						S Q Su Tr Cr	
				1	Bocicau, Satu Mare county (in the north-western part of the country) Romania	10/15/02	…	39	3	35	2	?	S Q Su Tr Cr	sows, boars and piglets in smallholdings
Europe - Non EU	sui	11/2/02	10/15/02	6	Romania - Bihor	11/2/02	…						S Q Su Tr Cr	
					Romania - Giurgiu	11/2/02	…						S Q Su Tr Cr	
					Romania - Olt	11/2/02	…	302	62	222	18	?	S Q Su Tr Cr	302 susceptible sows, boars and piglets in smallholdings
Europe - Non EU	sui	12/1/02	11/2/02	8	Romania - Arad	11/2/02	…						S Q Su Tr Cr	
					Romania - Bihor	11/2/02	…						S Q Su Tr Cr	
					Romania - Giurgiu	11/2/02	…						S Q Su Tr Cr	
					Romania - Ialomita	11/2/02	…						S Q Su Tr Cr	
					Romania - Satu Mare	11/2/02	…	270	87	176	7	?	S Q Su Tr Cr	270 susceptible sows, boars and piglets in smallholdings
Europe - Non EU	sui	1/1/03	12/1/02	12	Romania - Arad	1/1/03	…						S Q Su Tr Cr	

					Romania - Bihor	1/1/03	…						S Q Su Tr Cr	
					Romania - Brasov	1/1/03	…						S Q Su Tr Cr	
					Romania - Caras-Sevein	1/1/03	…						S Q Su Tr Cr	
					Romania - Satu Mare	1/1/03	…						S Q Su Tr Cr	
					Romania - Timis	1/1/03	…	196	65	116	43	?	S Q Su Tr Cr	196 susceptible pigs
Europe - Non EU	sui	2/1/03	1/1/03	6	Romania - Bihor	2/1/03	…						S Q Su Tr Cr	
Europe - Non EU	sui	2/1/03	1/1/03	3	Romania - Caras-Sevein	2/1/03	…						S Q Su Tr Cr	
Europe - Non EU	sui	2/1/03	1/1/03	13	Romania - Cluj	2/1/03	…						S Q Su Tr Cr	
Europe - Non EU	sui	2/1/03	1/1/03	1	Romania - Gorj	2/1/03	…						S Q Su Tr Cr	
Europe - Non EU	sui	2/1/03	1/1/03	4	Romania - Salaj	2/1/03	…						S Q Su Tr Cr	
Europe - Non EU	sui	2/1/03	1/1/03	7	Romania - Satu Mare	2/1/03	…						S Q Su Tr Cr	
Europe - Non EU	sui	2/1/03	1/1/03	2	Romania - Timis	2/1/03	…	1133	282	815	36	?	S Q Su Tr Cr	1133 susceptible pigs
Europe - Non EU	sui	3/1/03	2/1/03	28	Romania - Alba	3/1/03	…						S Q Su Tr Cr	
					Romania - Arad	3/1/03	…						S Q Su Tr Cr	
					Romania - Arges	3/1/03	…						S Q Su Tr Cr	
					Romania - Bihor	3/1/03	…						S Q Su Tr Cr	

					Romania - Caras-Sevein	3/1/03	…						S Q Su Tr Cr	
					Romania - Cluj	3/1/03	…						S Q Su Tr Cr	
					Romania - Dolj	3/1/03	…						S Q Su Tr Cr	
					Romania - Gorj	3/1/03	…						S Q Su Tr Cr	
					Romania - Harghita	3/1/03	…						S Q Su Tr Cr	
					Romania - Salaj	3/1/03	…						S Q Su Tr Cr	
					Romania - Satu Mare	3/1/03	…						S Q Su Tr Cr	
					Romania - Vaslui	3/1/03	…	457	124	213	120	?	S Q Su Tr Cr	457 susceptible pigs
Europe - Non EU	sui	4/1/03	3/1/03	16	Romania - Alba	4/1/03	…						S Q Su Tr Cr	
					Romania - Arad	4/1/03	…						S Q Su Tr Cr	
					Romania - Bihor	4/1/03	…						S Q Su Tr Cr	
					Romania - Salaj	4/1/03	…						S Q Su Tr Cr	
					Romania - Satu Mare	4/1/03	…						S Q Su Tr Cr	
					Romania - Suceava	4/1/03	…	240	42	196	2	?	S Q Su Tr Cr	240 susceptible pigs
South America	sui	10/28/02	2/1/00	1	Venezuela - Tiara parish, Santos Michelena municipality, State of Aragua	10/14/02	10/7/02	4	1	0	0	vehicle carrying feed?	S Q Su Tr V	66 susceptible pigs in smallholding. Unvaccinated animals

S=Stamping Out, Q=Quarantine, Su= Surveillance, Tr= Tracing, V= Vaccination, Cr= control of wildlife vectors, Sui= domestic swine, Fau=wild swine

Figure 2.12
Summary of CSF activity reported yearly (1998-2002) by geographic region (www.oie.int).

Location	# cntrys	# outbreaks	# cases	# deaths	# destr	# slau	# vaccin	case fatality rate	#cases/ outbreak	# destr/ outbreak
Europe (EU)	10	1295	16981	6744	277675	9130	0	39.71	13.11	214.42
Europe Non (EU)	13	883	22010	9698	74493	17776	185592260	44.06	24.93	84.36
Asia	19	1720	699156	296437	32940	81881	47007726	42.40	406.49	19.15
Central-America/ Caribbean	7	920	14255	7988	397	8849	40642980	56.04	15.49	0.43
South America	8	122	3218	1377	94	8	6660427	42.79	26.38	0.77
Total	**57**	**4940**	**755620**	**322244**	**385599**	**117644**	**279903393**	**42.65**	**152.96**	**78.06**

Figure 2.13
Summary of CSF activity according to archived weekly reports (1998-2003) by geographic region (www.oie.int).

Location	# Outbreaks	# susc	# cases	# deaths	# destr	# slau	case fatality rate (%)	Morb. Rate (%)	Mort. Rate (%)	% destr/ outbreak	#cases/ outbreak	#susc/ outbreak	# destr/ outbreak
European Union	101	197736	10528	3991	180441	0	37.91	5.32	2.02	91.25	39.51	1957.78	1786.54
Europe Non-EU	62	4800	448	189	3221	209	42.19	9.33	3.94	67.10	3.05	77.42	51.95
Asia	18	15796	772	270	7895	0	34.97	4.89	1.71	49.98	15.00	877.56	438.61
Central-America/ Caribbean	26	2254	1336	718	1277	33	53.74	59.27	31.85	56.65	27.62	86.69	49.12
South America	13	3775	236	95	57	1	40.25	6.25	2.52	1.51	7.31	290.38	4.38
Total	**439**	**448709**	**26357**	**10520**	**385775**	**486**	**39.91**	**5.87**	**2.34**	**85.97**	**23.96**	**1022.12**	**878.76**

Figure 2.14
Classical Swine Fever outbreaks by year and geographic region from 1998-2003. The numbers for 2002 and 2003 were incomplete and therefore may not be representative of the yearly situations (Provided by OIE via yearly reporting).

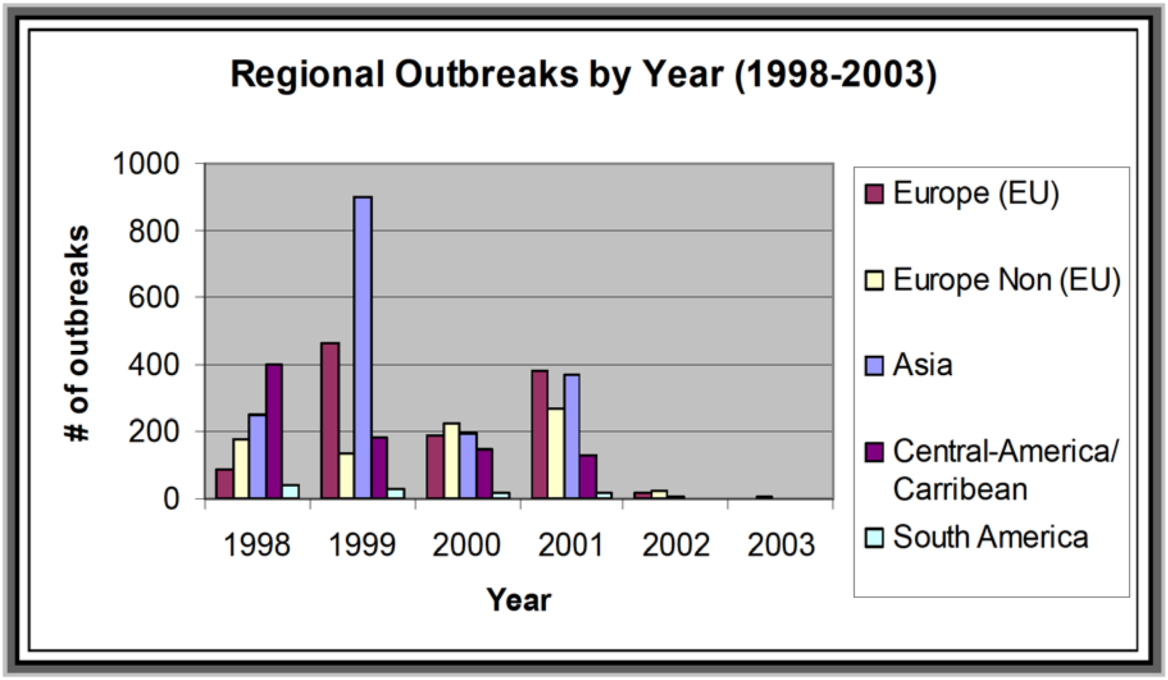


Figure 2.15
Reported CSF outbreaks by year and the average number of reported outbreaks by region (1998-2001) (Provided by OIE via yearly reporting).

	1998	1999	2000	2001	Average (1998-2001)	2002	2003
Europe (EU)	91	467	193	378	282.25	16	2
Europe Non (EU)	179	135	225	268	201.75	22	3
Asia	248	899	194	371	428	6	1
Central-America/ Carribean	400	184	146	133	215.75	0	0
South America	42	32	19	15	27	0	1

Figure 2.16
Classical Swine Fever outbreaks by month and geographic region from 1998-2003 (Provided by OIE via weekly reporting).

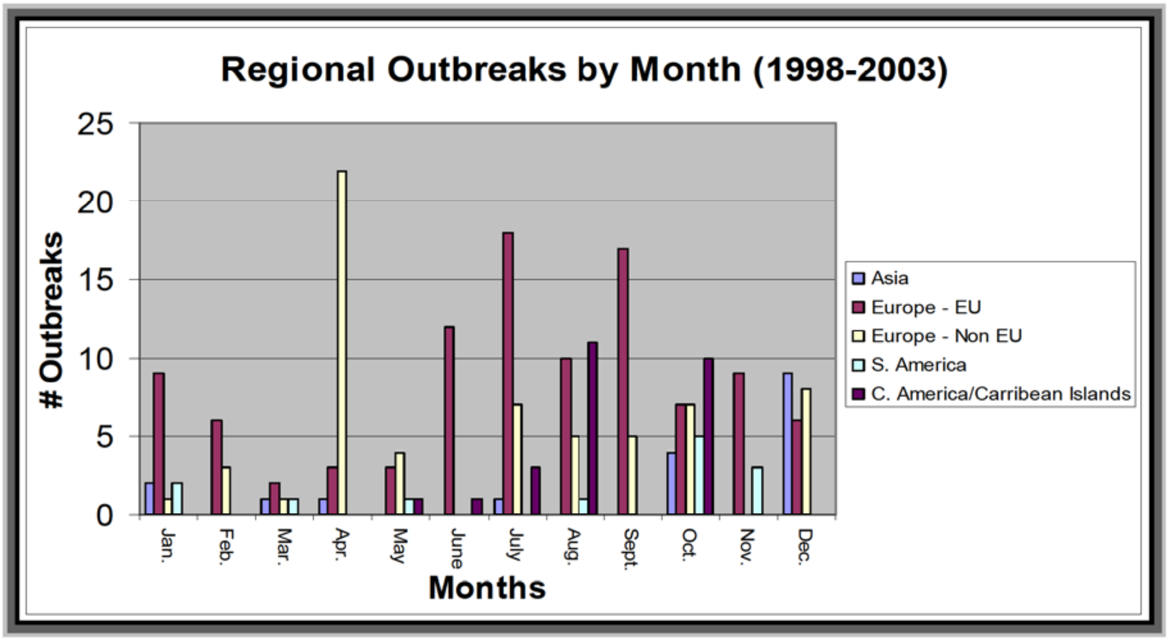


Figure 2.17
CSF outbreaks by month from 1998-2003 (Provided by OIE via weekly reporting).

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Occurrences	11	10	6	20	8	13	22	21	19	20	10	11

Key Definitions for Figures 2.10 & 2.11

The following lists the terminology used to describe the summarization of CSF activity world-wide during the period 1998-2003.

Outbreak of disease

means an occurrence of one of the diseases in OIE *List A* or *List B* in an agricultural establishment, breeding establishment or premises, including all buildings and all adjoining premises, where *animals* arepresent.

Where it cannot be defined in this way, the *outbreak* shall be considered as occurring in the part of the territory in which, taking local conditions into account, it cannot be guaranteed that both susceptible and non–susceptible animals have had no direct contact with affected or suspected *cases* inthatarea.

For example, in the case of certain parts of Africa, an *outbreak* means the occurrence of the disease within a sixteenth square degree (using longitudinal and latitudinal coordinates); the occurrence is still referred to as an *outbreak* even though the disease may occur in several places within the same sixteenth square degree.

Case

means an individual *animal* infected by a pathogenic agent listed by the OIE.

Susceptible

means any individual animal that could possibly be infected by a pathogenic agent

Deaths

animals that died as a direct result of infection by a pathogenic agent

Destroyed

animals that were destroyed as a result of an eradication campaign meant to minimize spread of disease

Slaughtered

animals that were slaughtered in the face of an outbreak and were then processed for further use

Vaccinated

animals that were vaccinated either preventatively or on an ad hoc basis in attempts to stop disease spread

Case Fatality Rate

represents the rate of cases of disease that result in death, specifically the number of deaths divided by the number of cases

Morbidity Rate

represents the rate of morbidity that occurs as a result of disease within a number of susceptible animals, specifically the number of cases divided by the number of susceptible animals

Mortality Rate

represents the rate of mortality that occurs as a result of disease within a number of susceptible animals, specifically the number of deaths divided by the number of susceptible animals

% Destroyed per Outbreak

represents the percentage of animals destroyed per outbreak or specifically the number or animals destroyed divided by the number of susceptible animals

 # Cases per Outbreak

represents the average total number of cases per outbreak, this is accomplished by taking the total number of cases and dividing by the total number of outbreaks

 # Destroyed per Outbreak

represents the average total number of animals destroyed per outbreak, this is accomplished by taking the total number of animals destroyed and dividing by the total number of outbreaks

 # Susceptible per Outbreak

represents the average total number of animals susceptible per outbreak, this is accomplished by taking the total number of animals susceptible and dividing by the total number of outbreaks (representative of on farm hog-density).

Chapter 3 Figures

Figure 3.1

US Imports of Live Hogs for Breeding (1994-2003) (data provided by USDA-APHIS).

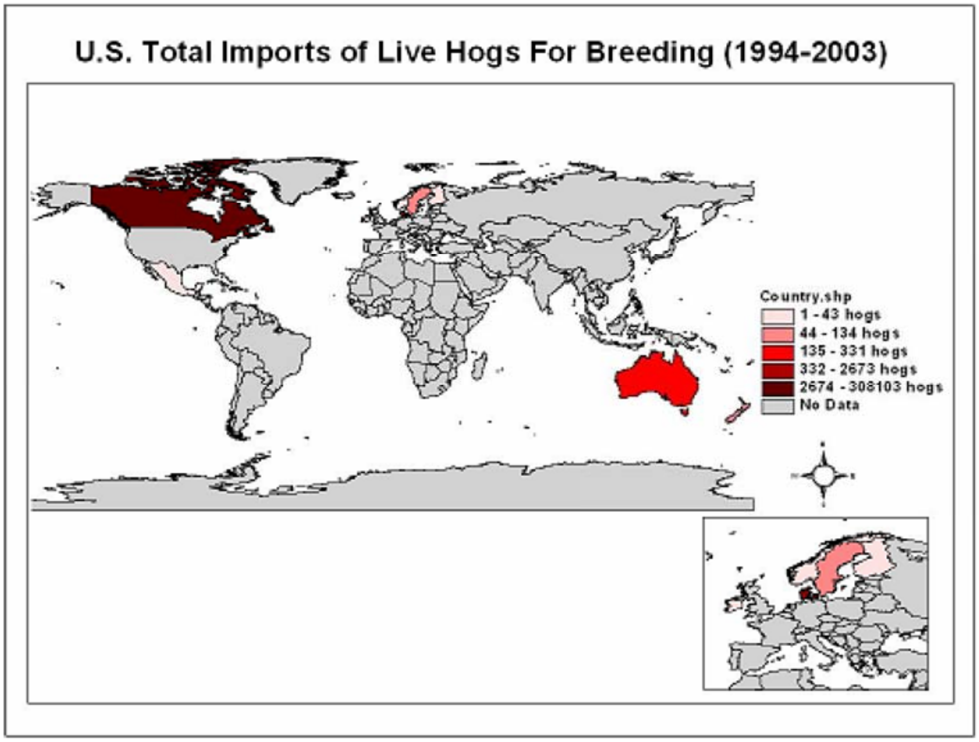


Figure 3.2
US Imports of Feeder Hogs (1994-2003) (data provided by USDA-APHIS).

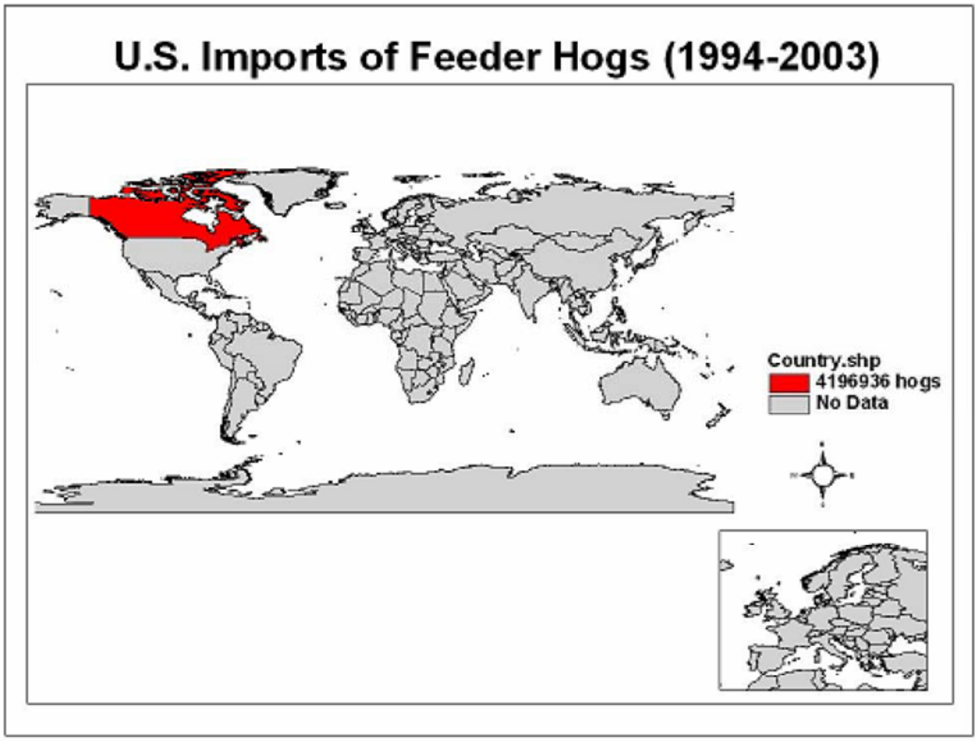


Figure 3.3
US Imports of Swine Semen (1994-2003) (data provided by USDA-APHIS).

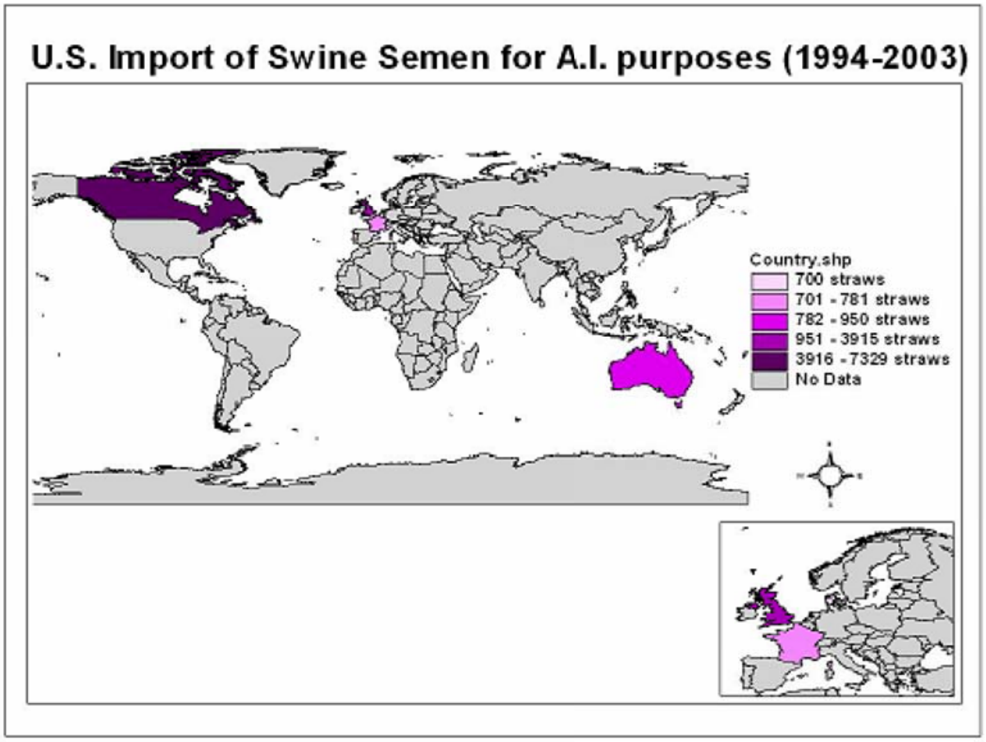


Figure 3.4
US Imports of hogs for slaughter (1994-2003) (data provided by USDA-APHIS).

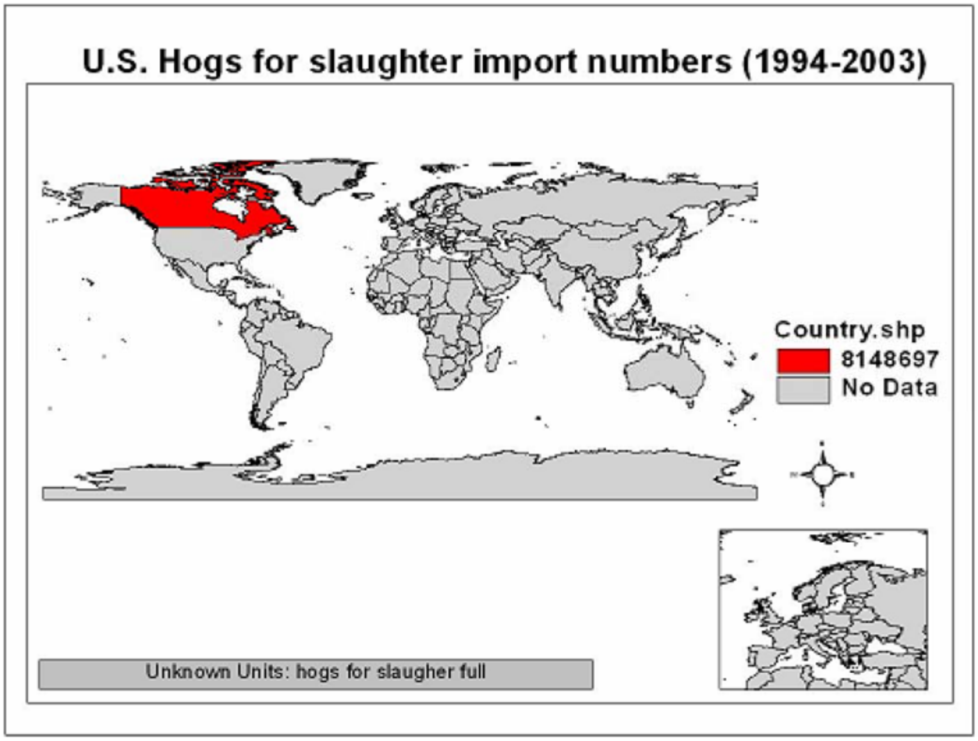
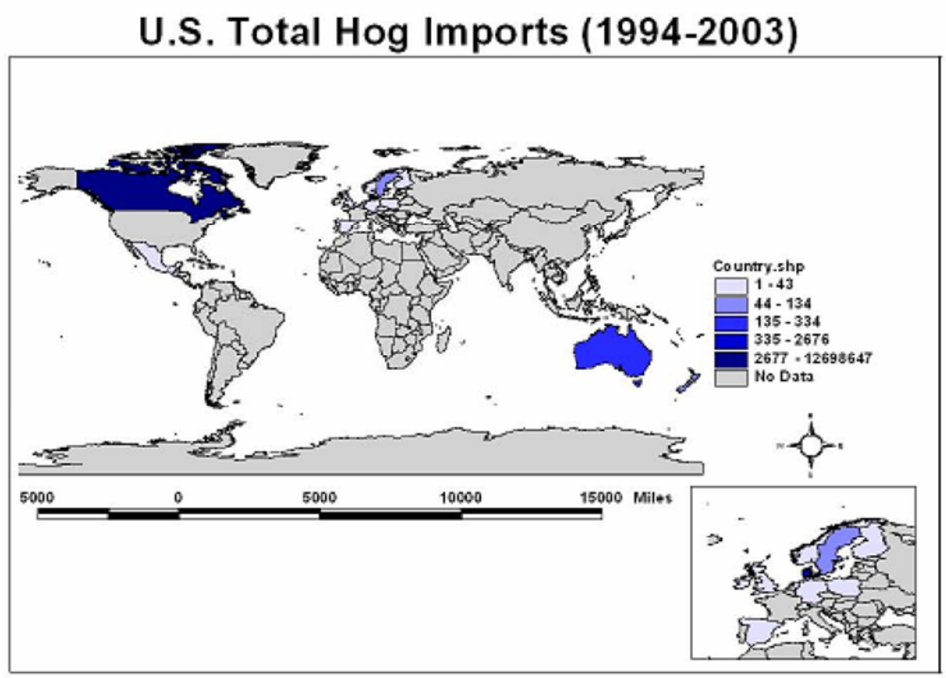


Figure 3.5
US Total Hog Imports (1994-2003) (data provided by USDA-APHIS).



Figures 3.6

United States import of swine and swine semen and ova in the year 2000 (information provided by USDA-APHIS dataset). NRRELEASED = number of animals entering the US from origin country

US SWINE IMPORTS (2000)				
COUNTRY	PURPOSE	UNIT	NRRELEASED	HARMONYCOD
AS	BRE	STRAW	1939	103110000
CA	BRE	STRAW	20054	103110000
UK	BRE	STRAW	122	103110000
CA	BRE	LIVE	96356	103100000
CA	SLA	LIVE	1954457	103120000
CA	PET	LIVE	1	103130000
CA	OTH	LIVE	5127	103140000
CA	COM	LIVE	784	103150000
CA	FDR	LIVE	2279650	103160000
CA	INB	LIVE	9100	103170000
CA	TRN	LIVE	1019	103180000
Total	BRE	STRAW	22115	
Total	ALL	LIVE	4346494	

Figures 3.7

United States import of swine and swine semen and ova from (1994-2002) excluding products of Canadian origin (information provided by USDA-APHIS dataset). NRRELEASED = number of animals entering the US from origin country

US SWINE IMPORTS (1994-2002) EXCLUDING IMPORTS OF CANADIAN ORIGIN			
COUNTRY	PURPOSE	NRRELEASED	HARMONYCOD
AUSTRALIA	BRE	5259	0103110000
AUSTRALIA	RES	3	0000000031
BARBADOS	RES	3	0000000031
DENMARK	DIA	3	0000000098
DENMARK	BRE	1480	0103110000
IRELAND	BRE	120	0103110000
FIJI	DIA	6	0000000098
FRANCE	BRE	781	0103110000
GERMANY	DIA	3	0000000098
GERMANY	BRE	1736	0103110000
NETHERLANDS	DIA	6	0000000098
POLAND	DIA	30	0000000098
SPAIN	DIA	3	0000000098
UNITED KINGDOM	BRE	4190	0103110000

BRE = Breeding	PET = Pet	COM = Commercial	INB = In Bound
SLA = Slaughter	RES = Research	FDR = Feeder	TRN = Training

Figure 3.8

List of approved airports, Canadian and Mexican border ports for importation of live swine

1. Airports: Los Angeles, California, Miami, Florida, and Newburgh, New York international airports.

2. Canadian Border Ports: Eastport, Idaho; Houlton and Jackman, Maine; Detroit, Port Huron, and Sault Ste. Marie, Michigan; Baudette, Minnesota, Opheim, Raymond, and Sweetgrass, Montana; Alexandria Bay, Buffalo, and Champlain, New York; Dunseith, Pembina, and Portal, North Dakota; Derby Line and Highgate Springs, Vermont; and Blaine, Lynden, Oroville, and Sumas, Washington

3. Mexican Border Ports: Brownsville, Hidalgo, Laredo, Eagle Pass, Del Rio, Presidio, and El Paso, Texas; Douglas, Naco, Nogales, Sasabe, and San Louis, Arizona; Calexico and San Ysidro, California; and Antelope Wells, and Columbus, New Mexico.

Figure 3.9
Survival times of CSF in selected products as reported by APHIS in the 1985 Hog Cholera Eradication Guide. (Individual references were unable to be located for the HCEG).

Location or Material	Conditions of Storage	Duration of viability in Days
Blood	natural conditions, 37.5°C, pH 5.2	8
Blood	(-20°C)	270
Blood	dried, in ice box	≥180
Blood	4°C to 8°C	≥720
Blood	In putrified blood and organs in soil	7 to 14
Blood	Room Temp	90
Carcasses	refrigerator	≤95
Carcasses	buried and unburied, summer	<7
Carcasses	buried, winter	several months
Carcasses	deep-freezer	≤226
Meat	chilled	≥33
Meat	(-10°C)	≥1,598 (4yrs & 4.5 months)
Meat:Dried, Salted or Pickled	not described	≥73
Pork	(-10°C)	≥1,460 (4 yrs)
Pork	(-10°C) -(-3°C)	
Muscle	cured w/ salt and brine	<95
Ham	brining, curing	≥84
Ham	not described	180
Ham, shoulders	52 days in brine, 3 days in hickory smoke	≥55
Bone Marrow of ham	not described	≤73
Bone Marrow	3.3°C	≥73
Sausage	not described	180
Bacon	not described	≥27, <57
Casings	stripped at room temp	≤86
Lymph Node	frozen	≥3,285 (9 years)
Skin	4°C	33
Serum Albumin	Spray, dried with incoming air 140°C to 160°C and outgoing air 70°C to 80°C	≥1,095 (3 years)
Eye and Nasal Secretions	10°C to 18°C	≥2
Swine Urine	Room Temp	<21
Swine Urine	in ice box	23
Blood w/ 0.5% phenol	refrigerator	≥100
Contaminated Pens	hot weather	<1
Contaminated Stable	not described	≤7
Contaminated Pens	thoroughly cleaned	>14

Excreta and bedding	not described	≥28
Pork	composted w/ garbage, except in winter	>7
Organs	putrefied	>4
Blood mixed with pig manure	18°C	≥1.75, <3.75
Blood mixed with garden soil	not described	≥7, <13

Figure 3.10

A list of swine products, swine related products and their respective harmony codes and groupings (data provided by USDA-FAS).

Use	Product	Harmony Code	Description
FHC	**SWINE,LV,PBB ANM**	103100000	SWINE, LIVE, PUREBRED BREEDING ANIMALS
FHC	**SWN,LV,NES,>50KG**	103920000	SWINE, LIVE, NESOI, WEIGHING 50 KG OR MORE EACH
FHC	**SWN,>50KG,IMD,SL**	103920010	SWINE,LIVE,NESOI,WEIGHING 50KG OR MORE EACH, NOT FOR IMMEDIATE SLAUGHTER
FHC	**SWN,>50KG,OTHER**	103920090	SWINE,LIVE,NESOI,WEIGHING 50KG OR MORE EACH, NOT FOR IMMEDIATE SLAUGHTER
FHC	**HAMS,CUTS,PROC**	203121010	HAMS AND CUTS THEREOF, BONE IN PROCESSED FRESH/CHILLED
FHC	**HAMS,SHLDRS,PROC**	203121020	SHOULDERS & CUTS, SWINE, BONE IN PROCESSED FRESH/CHILLED
FHC	**HMS,CUT F/CH,NTP**	203129010	HAMS AND CUTS THEREOF, BONE IN NOT PROCESSED FRESH/CHILLED
FHC	**HMS,SHL F/CH,NTP**	203129020	SHOULDERS AND CUTS, SWINE, BONE IN NOT PROCESSED FRESH/CHILLED
FHC	**SP RBS, PRC,F/CH**	203192010	SPARE RIBS, SWINE, PROCESSED, FRESH OR CHILLED
FHC	**OTH CARC PRC,F/C**	203192090	MEAT OF SWINE, NESOI, PROCESSED, FRESH OR CHILLED
FHC	**BELS F/CH,NT PRC**	203194010	BELLIES OF SWINE, NESOI, NOT PROCESSED, FRESH/CHILLED
FHC	**OTH CR NTPR,F/CH**	203194090	MEAT OF SWINE, NESOI, NOT PROCESSED, FRESH/CHILLED
FHC	**C/HC,SWINE,FROZ**	203210000	MEAT OF SWINE, FROZEN, CARCASSES AND HALF CARCASSES
FHC	**HAM,S/C,BN,P/FZ**	203221000	HAMS, SHOULDERS AND CUTS, BONE IN, PROCESSED, FROZEN
FHC	**HAM,S/C,B,XP,FZ**	203229000	HAMS/SHOULDERS AND CUTS, BONE IN NOT PROCESSED, FROZEN
FHC	**MT,SW,NES,PR/FZ**	203292000	MEAT OF SWINE, NESOI, PROCESSED, FROZEN
FHC	**MT,SW,NES,XP,FZ**	203294000	MEAT OF SWINE, NESOI, EXCEPT PROCESSED, FROZEN
FHC	**OFL SWN,ED,F/CH**	206300000	OFFAL OF SWINE, EDIBLE, FRESH/CHILLED
FHC	**LVR,SWN,ED,FRZN**	206410000	LIVER OF SWINE, EDIBLE, FROZEN
FHC	**OFL SW(XL)ED,FZ**	206490000	OFFAL OF SWINE EXCEPT LIVERS, EDIBLE, FROZEN
FHC	**M&EDOF,NESOI**	208909000	MEAT AND EDIBLE MEAT OFFAL, NESOI, FRESH, CHILLED OR FROZEN
FHC	**HM,CUTS,DR/SM**	210110010	HAMS AND CUTS, BONE IN, SALTED/DRIED/SMOKED/BRINE
FHC	**HM,SHLDR DR/SM**	210110020	SHOULDERS & CUTS, BONE IN, SALTD/DRIED/SMOKD/BRINE
FHC	**BACON**	210120020	BACON
FHC	**BL/CD,SW,SIB,DS**	210120040	BELLIES, CUTS, SWINE, SALTD, IN BRINE, DRIED, SMKD
FHC	**CN BACON,D,S,OT**	210190010	CANADIAN STYLE BACON, OF SWINE
FHC	**OT SW MT DR/SMK**	210190090	MEAT OF SWINE NESOI, SALTED, IN BRINE, DRIED, SMKD
FHC	**HG GT/BL/ST 4SSC**	504000020	HOG GUTS, BLADDERS, STOMACHS FOR SAUSAGE CASINGS
FHC	**G/B/S,NES,4 SSC**	504000040	GUT/BLADDER/STOMACH ANMLS NESOI FOR SAUSAGE CASING
NFHC	**PANCREAS GLANDS**	510004010	PANCREAS GLANDS
NFHC	**BILE AND OTHER A**	510004020	BILE AND OTHER ANIMAL SECRETIONS
HIDE	**P/W,RW HS,GSNES**	511992000	PARINGS/WASTE OF RAW HIDES/SKINS, GLUE STOCK NESOI
NFHC	**ANML PRDS, NFHC**	511993060	ANIMAL PRODUCTS, NOT FOR HUMAN CONSUMPTION
NFHC	**OT AN PROD NES**	511994070	OTHER ANIMAL PRODUCTS, NESOI
NFHC	**XTRCT/JCS OF MT**	1603009010	EXTRACTS/JUICES OF MEAT
NFHC	**DOG/CAT/FD,CANS**	2309100010	DOG/CAT FOOD CANNED
NFHC	**DOG/CAT/FD,OTH**	2309100090	DOG/CAT FOOD OTHER
NFHC	**PET FOOD, OTHER**	2309901015	PET FOOD, OTHER
FEED	**SWINE FEED**	2309901035	SWINE FEED
FEED	**OTH LVSTK FEED**	2309901045	OTHER LIVESTOCK FEED
FEED	**MXD FDS, NESOI**	2309901050	MIXED FEEDS, NESOI
NFHC	**LVR,DR/NT DR**	3001100010	LIVER,DRIED,WHETHER OR NOT DRIED
NFHC	**OTH_GLND/ORG,DR**	3001100050	OTHER GLANDS/ORGANS, DRIED

NFHC	**EXTRACTS OF GLAN**	3001200000	EXTRACTS OF GLANDS
HIDE	**SW SKN,XPTN,F/S**	4103301000	SWINE RAW SKINS, (NOT PRETANNED), FRESH, OR SALTED, DRIED, LIMED, PICKLED OR OTHERWISE PRESERVED, BUT NOT TANNED, PARCHMENT DRESSED, FURTHER PREPARED
HIDE	**SWN RAW SKN,PRN**	4103302000	SWINE RAW SKINS, PRETANNED, FRESH OR SALTED, DRIED, LIMED, PICKLED OR OTHERWISE PRESERVED BUT NOT PARCHMENT DRESSED OR FURTHER PREPARED
HIDE	**SWN SKN,TN,WTB**	4106311000	SWINE TANNED SKINS, IN THE WET STATE, WET-BLUE, WITHOUT WOOL ON, WHETHER OR NOT SPLIT, BUT NOT FURTHER PREPARED
HIDE	**SWN SKN,TN**	4106319000	SWINE TANNED SKINS, IN THE WET STATE OTHER THAN WET BLUE, WITHOUT WOOL ON, WHETHER OR NOT SPLIT, BUT NOT FURTHER PREPARED
HIDE	**SWN CRST,DRY**	4106320000	SWINE CRUST SKINS, IN THE DRY STATE, WITHOUT WOOL ON, WHETHER OR NOT SPLIT, BUT NOT FURTHER PRPEPARED
HIDE	**FINE AHR,NC/C/PR**	5102196060	FINE OR COARSE ANIMAL HAIR, NOT CARDED OR COMBED: FINE ANIMAL HAIR: NOT PROCESSED BEYOND THE DEGREASED OR CARBONIZED CONDITION: OTHER FINE ANIMAL HAIR
HIDE	**F/C AH,PRCSSD**	5102199000	FINE OR COARSE ANIMAL HAIR, PROCESSED BEYOND DEGREASING OR CARBONIZATION, NESOI
HIDE	**F/C AH,NC/C,CRS**	5102200000	FINE OR COARSE ANIMAL HAIR NOT CRD/CMB COARSE HAIR
HIDE	**WL,FINE HAIR C/C**	5105390000	WOOL AND FINE OR COARSE ANIMAL HAIR, CARDED OR COMBED (INCLUDING COMBED WOOL IN FRAGMENTS): FINE ANIMAL HAIR, CARDED OR COMBED,NESOI
FARM	**DISC PLOWS**	8432100040	DISC PLOWS
FARM	**PLOWS, NESOI**	8432100060	PLOWS, NESOI
FARM	**DISC HARROWS**	8432210000	DISC HARROWS
FARM	**CULTIVATOR DRAWN**	8432290040	CULTIVATORS, DRAWN
FARM	**ROTARY TILLERS**	8432290060	ROTARY TILLERS
FARM	**CULTIVATORS, NES**	8432290080	CULTIVATORS, NESOI
FARM	**HARROWS, NESOI**	8432290090	HARROWS, NESOI
FARM	**MANURE SPREADERS**	8432400000	MANURE SPREADERS
FARM	**FEED-PREP MACH**	8436100000	MACHINERY FOR PREPARING ANIMAL FEEDS
FARM	**BARNYARD MACH**	8436800040	BARNYARD MACHINES
FARM	**CROP-PREP MACH**	8436800060	MACHINERY FOR PREPARING CROPS
FHC	**AN/GM,MPD 2B FRD**	9817007000	ANIMAL, GAME, IMPORTED TO BE LIBERATED IN THE U.S.

FHC =	FOR HUMAN CONSUMPTION
NFHC =	NOT FOR HUMAN CONSUMPTION
HIDE =	PRODUCTS DERIVED FROM HIDES
FARM =	FARM EQUIPTMENT PRODUCTS
FEED =	PRODUCTS USED FOR FEED

Figure 3.11

Countries from which the United States imported swine and swine related industry products during the year 2000 and the respective CSF status as reported by OIE during the year 2000 (www.oie.int).

COUNTRY	STATUS	COUNTRY	STATUS
ARGENTINA		JAPAN	
AUSTRALIA(*)		MALAYSIA	(+)
AUSTRIA		MEXICO	(+)
BARBADOS		NETHERLANDS	
BELGIUM-LUXEMBOURG(*)	(+)	NETHERLANDS ANTILLES(*)	
BOSNIA-HERCEGOVINA	(+)	NEW ZEALAND(*)	
BRAZIL	(+)	NORWAY(*)	
CANADA		PAKISTAN	
CHILE		PANAMA	
CHINA, PEOPLES REPUB	(+)	PARAGUAY	
COLOMBIA	(+)	PERU	(+)
CROATIA		PHILIPPINES	(+)
CZECH REPUBLIC		POLAND	
DENMARK(*)		PORTUGAL	
ECUADOR	(+)	SEYCHELLES	
EGYPT		SINGAPORE	
FINLAND		SLOVENIA	
FRANCE(*)		SPAIN	
GERMANY(*)	(+)	SWEDEN	
GHANA		SWITZERLAND(*)	
GUATEMALA	(+)	TAIWAN	
HONG KONG	(+)	THAILAND	(+)
HUNGARY		TURKEY	
ICELAND		UGANDA	
INDIA	(+)	UNITED KINGDOM	(+)
IRELAND		URUGUAY	
ISRAEL(*)		VENEZUELA	(+)
ITALY(*)	(+)		

Figure 3.12
United States importation of Farm Equipment (2000) (FAS-ONLINE).

COUNTRY	FARM EQUIPMENT (MT)
MEXICO	30846
FRANCE(*)	28245
CANADA	22370
INDIA	10464
ITALY(*)	8050
SPAIN	3666
UNITED KINGDOM	2712
NETHERLANDS	1919
JAPAN	1080
DENMARK(*)	1053
AUSTRALIA(*)	930
GERMANY(*)	902
ISRAEL(*)	55
SWEDEN	23
NORWAY(*)	14
FINLAND	8
AUSTRIA	3
NEW ZEALAND(*)	2
IRELAND	1
BRAZIL	1

MT - metric tons

Figure 3.13
United States importation of feed (2000) (FAS-ONLINE).

COUNTRY	FEED (MT)
CANADA	116940
UNITED KINGDOM	14663
GERMANY(*)	5662
NORWAY(*)	3452
NEW ZEALAND(*)	1283
NETHERLANDS	1151
AUSTRALIA(*)	1003
MEXICO	905
MALAYSIA	884
TAIWAN	613
FRANCE(*)	355
ITALY(*)	123
JAPAN	105
INDIA	100
TURKEY	57
BELGIUM-LUXEMBOURG(*)	49
PANAMA	22
DENMARK(*)	20
COLOMBIA	18
CHILE	17
SPAIN	11
IRELAND	11
BARBADOS	10

MT - metric tons

Figure 3.14
United States imports of Hog Products for Human Consumption (HPFHC) (2000, FAS-ONLINE)

COUNTRY	HPFHC (MT)
CANADA	294805
DENMARK(*)	44643
UNITED KINGDOM	2478
IRELAND	2153
ITALY(*)	2008
MEXICO	1647
FINLAND	822
NEW ZEALAND(*)	816
NETHERLANDS	647
BRAZIL	549
GERMANY(*)	493
AUSTRALIA(*)	480
FRANCE(*)	417
URUGUAY	346
SWEDEN	304
SPAIN	257
BELGIUM-LUXEMBOURG(*)	238
ARGENTINA	173
TAIWAN	30
JAPAN	25
POLAND	19
PORTUGAL	19
BOSNIA-HERCEGOVINA	18

MT - metric tons

Figure 3.15
United States Importation of Hides (2000, FAS-ONLINE).

COUNTRY	HIDES (M^2)
THAILAND	8401
MEXICO	6382
GERMANY(*)	6353
COLOMBIA	2805
BRAZIL	2798
PARAGUAY	1609
ARGENTINA	787
ECUADOR	773
CANADA	655
BELGIUM-LUXEMBOURG(*)	127
FRANCE(*)	99
DENMARK(*)	92
TAIWAN	71
SPAIN	69
NETHERLANDS	41
VENEZUELA	22
URUGUAY	11
SWITZERLAND(*)	11
SINGAPORE	5
PANAMA	2
PHILIPPINES	1

M^2 – Square meters

Figure 3.16
United States importation of Hog Products not for Human Consumption (HPNFHC) (2000, FAS-ONLINE).

COUNTRY	HPNFHC (MT)
CANADA	178223
NEW ZEALAND(*)	36780
AUSTRALIA(*)	17527
THAILAND	16413
BRAZIL	7805
GERMANY(*)	2513
MEXICO	1799
ECUADOR	1156
DENMARK(*)	979
NETHERLANDS	959
JAPAN	873
FRANCE(*)	834
ITALY(*)	791
GHANA	657
CHILE	451
ARGENTINA	428
TAIWAN	348
SPAIN	348
UNITED KINGDOM	314
PHILIPPINES	163
IRELAND	114
HUNGARY	106
COLOMBIA	99

Rows that are shaded in gray are countries considered CSF (+) in the year 2000.

Figure 3.17

United States Live Swine trading grid sample (full copy will be available on e-version). Numbers indicate the amount of animals traded and percentage of import market for the importing country (information from UN-FAO WATF)

Imp↓ Exp→	United States	Canada	Denmk	United Kingdom	France	Ireland	Germany	Argentina	Spain
United States		4358626 (99.9%)	724 (0.08%)	5 (0.02%)	0	0	0	0	0
Canada	4537 (58.5%)		2436 (31.4%)	100 (1.2%)	675 (8.7%)	0	0	0	0
Denmark	0	0		0	0	0	0	0	0
United Kingdom	0	0	0		506 (0.1%)	267005 (99.8%)	1 (0.1%)	0	0
France	0	0	114 (0)	2460 (0.4%)		500 (0)	124987 (22.8%)	176 (0%)	138217 (25.3%)
Ireland	127 (29.4%)	11 (2.5%)	0	293 (67.9%)	0		0	0	0
Germany	0	0	936132 (29.3)	26528 (0.8%)	616 (0)	0		0	3117 (0)
Argentina	0	0	0	0	0	0	0		0
Spain	0	0	343 (0)	741 (0)	64919 (5.1%)	101 (0)	161388 (12.7%)	0	
Italy	0	0	0	5802 (0.5%)	68442 (6.4%)	4110 (0.3%)	89040 (8.3%)	0	143277 (13.4%)

1º Countries from which the U.S. imported live swine from in 2000
2º Countries from which U.S. primary trade partners imported live swine in 2000
3º Countries from which U.S. secondary trade partners imported pig meat in 2000
Countries which were positive for CSF in 2000

Figure 3.18

United States Swine Products trading grid sample (full copy will be available on e-version). Numbers indicate the amount of swine products traded in metric tons (MT) and percentage of import market for the importing country (information provided by UN-FAO WATF).

Imp↓ Exp →	US	Canada	Australia	Ireland	UK	Nthrlnds	Germany	Italy
US		273001, [85%]	12, [0%]	1986, [.6%]	2477, [0.7%]	148, [0%]	138, [0%]	18, [0%]
Canada	9386, [98.7%]		0	0	0	0	0	0
Australia	0	15500, [45.5%]		0	0	0	0	0
Ireland	5, [0%]	0	0		1856, [20.3%]	2866, [31.4%]	734, [8%]	395, [2.8]
UK	130, [.1%]	0	0	23053, [26.9%]		16918, [19.7]	9603, [11.2%]	918, [1%]
Netherlands	602, [1.6%]	0	91, [.2%]	1070, [2.8%]	4181, [11.1%]		13012, [34.8]	146, [.3%]
Germany	0	0	168, [0%]	11021, [3.3%]	39931, [12%]	37411, [11.2%]		3546, [1%]
Italy	1326, [0.6%]	0	43, [0%]	2843, [1.3%]	5990, [2.9%]	33303, [16.2%]	34875, [17%]	

1° ~ Countries from which the U.S. imports pig meat directly

2° ~ Countries from which U.S. primary trade partners import pig meat

3° ~ Countries from which U.S. secondary trade partners import pig meat

4° ~ Countries with outbreaks of Classical Swine Fever in the year 2000

Figure 3.19
US International Trade of Live Swine (2000) (data provided by WATF-FAO).

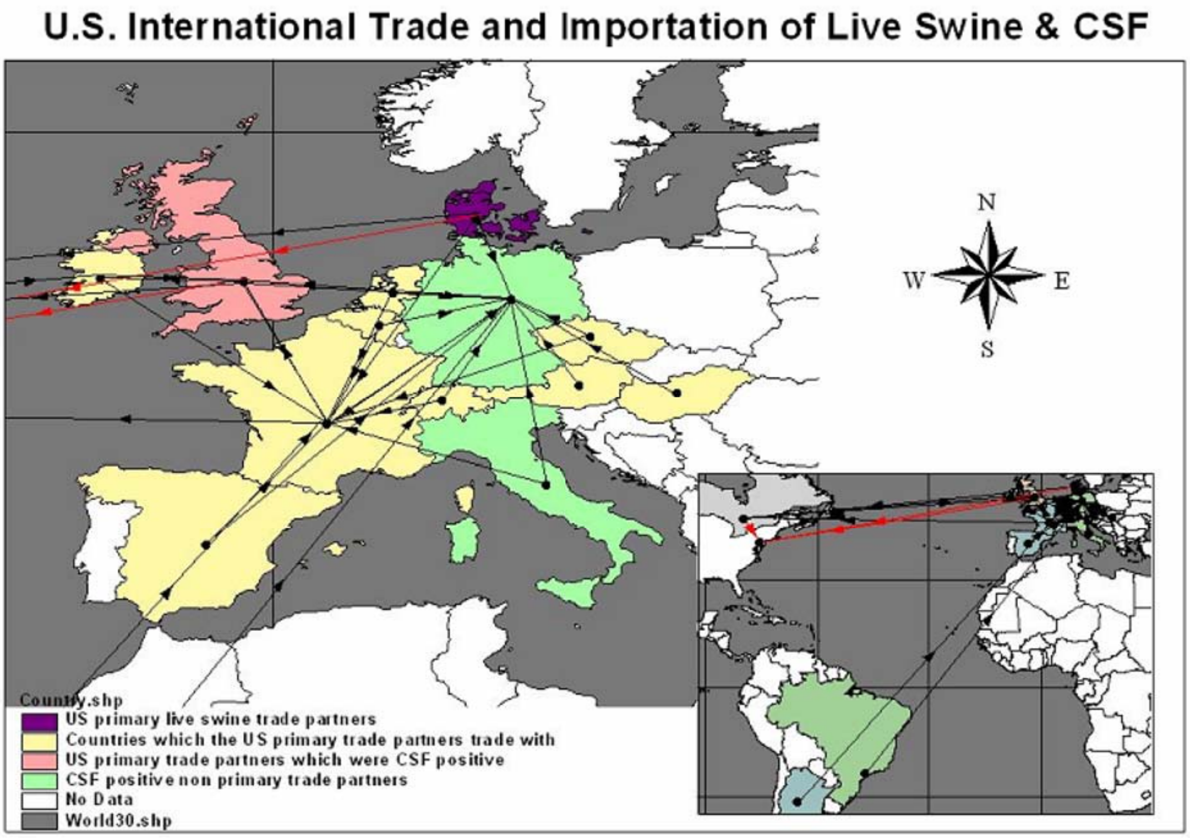


Figure 3.20
US International Trade of Pork Products (2000) (data provided by WATF-FAO).

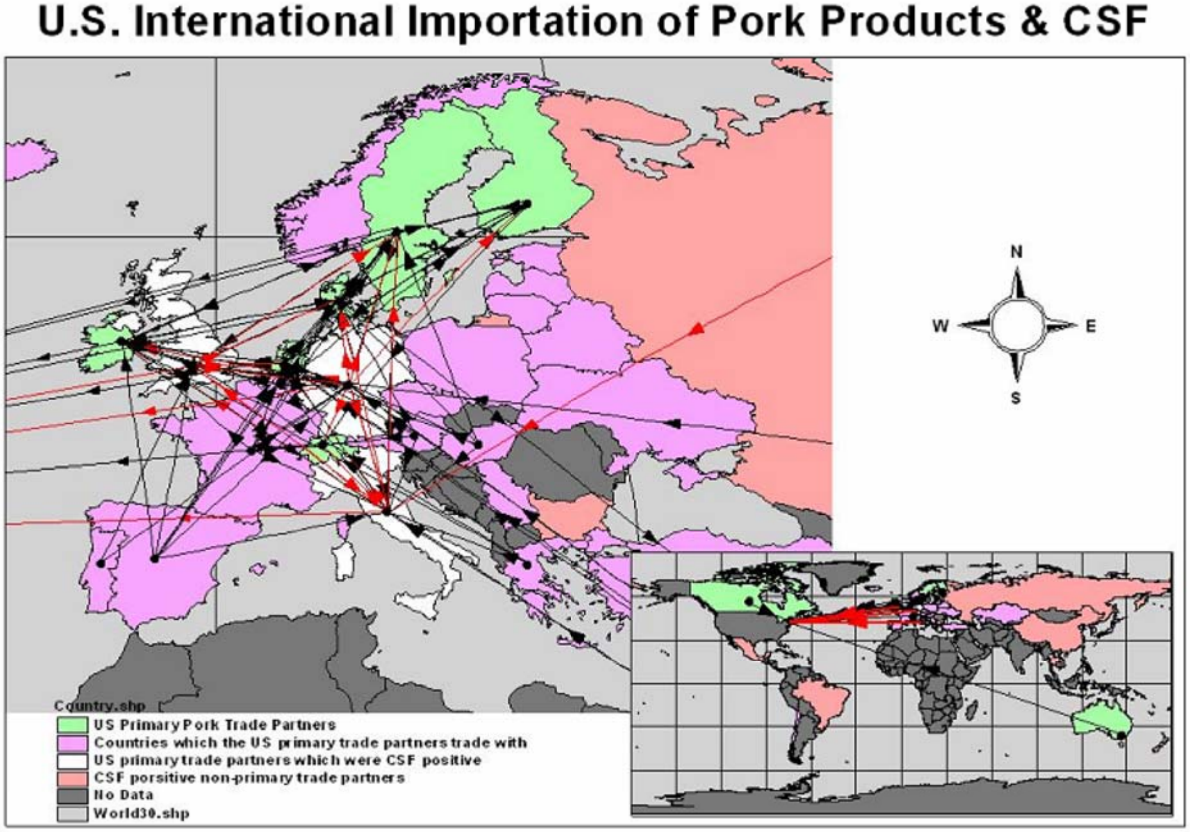


Figure 3.21
USDA Approved Airports for Handling and Disposing of Garbage and

Galley Refuse from International Flights in 2002
(www.aphis.usda.gov/ppq/manuals/pdf_files/AMOM%20in%20PDF/AppN-USDAAppAirports.pdf).

Airport Location
Akron–Canton Airport Akron, OH
Albuquerque International Airport Albuquerque, NM
Anchorage International Airport Anchorage, AK
Atlanta International Airport Atlanta, GA
Austin Bergstrom International Airport Austin, TX
Baltimore/Washington International Airport Baltimore, MD
Bangor International Airport Bangor, ME
Birmingham Municipal Airport Birmingham, AL
Boeing Field Seattle, WA
Boeing Field, Wichita Division Wichita, KS
Bradley Int'l Airport Hartford, CT
Byrd International Airport Richmond, VA
Carran International Airport Las Vegas, NV
Charleston International Airport Charleston, SC
Cincinnati/Northern Kentucky International Airport Cincinnati, OH (Erlanger, KY)
Cleveland Hopkins International Airport Cleveland, OH
Dallas/Ft. Worth International Airport Dallas, TX
Daytona Beach International Airport Daytona, FL
Detroit Metropolitan Airport Detroit, MI
Douglas International Airport Charlotte, NC
Dulles International Airport Chantilly, VA
Duluth International Airport Duluth, MN
Ellington Field Airport Houston, TX
Eppley Airfield Omaha, NE
Fort Lauderdale/Hollywood International Airport Port Everglades, FL
Fort Wayne International Airport Fort Wayne, IN
General Mitchell Field Milwaukee, WI
Great Falls International Airport Great Falls, MT
Greater Pittsburgh International Airport Pittsburgh, PA
Guam International Airport Agana, GU
Harrisburg International Airport Harrisburg, PA
Honolulu International Airport1 Honolulu, HI
Houston Intercontinental Airport1 Houston, TX
Hulman Regional Airport Terre Haute, IN
Huntsville International Airport Huntsville, AL
Indianapolis International Airport Indianapolis, IN
Jacksonville International Airport Jacksonville, FL
James M. Cox Dayton International Airport Dayton, OH
JF Kennedy International Airport1 Jamaica, NY
Kansas City International Airport Kansas City, MO
Key West International Airport Key West, FL
Lambert–St. Louis International Airport St. Louis, MO
Laredo International Airport Laredo, TX
Lindbergh Field International Airport1 San Diego, CA
Logan Int'l Airport Boston, MA
Los Angeles International Airport1 Los Angeles, CA
Luis Munoz Marin International Airport 1 San Juan, PR
Lunken Airport Cincinnati, OH

KEY:
U - Data are unavailable
NA - Data are not applicable or may be unavailable
R - Data are revised
SOURCE: U.S. DOT, BTS based on data from U.S. Customs Service, Mission Support Services, Office of Field Operations, Operations Management Database

Figure 3.22
The number of people entering the US from Mexico through various ports and modes within the year 2000 (Bureau of Transportation Statistics, 2000).

Port Name	Passenger Crossings on Trains	Passenger Crossings in Personal Vehicles	Passenger Crossings on Buses	Pedestrian Crossings
Arizona, Total	**4,752**	**26,856,458**	**167,035**	**8,390,803**
Douglas, AZ	NA	6,193,596	13,762	682,872
Lukeville, AZ	NA	1,125,638	15,763	109,800
Naco, AZ	NA	881,911	NA	92,617
Nogales, AZ	4,752	11,501,672	136,471	4,677,819
Sasabe, AZ	NA	85,530	NA	3,133
San Luis, AZ	NA	7,068,111	1,039	2,824,562
California, Total	**5,522**	**74,569,309**	**1,670,733**	**18,596,679**
Andrade, CA	NA	1,808,452	3,381	1,762,700
Calexico, CA*	9	20,094,460	19,367	8,352,324
Calexico East, CA	1,687	7,600,859	6,885	2,293
Otay Mesa/San Ysidro, CA	408	41,684,841	1629537	8,191,206
Tecate, CA	3,418	3,380,697	11,563	288,156
New Mexico, Total	**NA**	**1,582,972**	**1,400**	**191,351**
Columbus, NM	NA	1,414,791	405	187,709
Santa Teresa, NM	NA	168,181	995	3,642
Texas, Total	**7,980**	**136,785,813**	**1,626,748**	**19,910,809**
Brownsville, TX	NA	19,693,130	78,032	3,017,533
Del Rio, TX	NA	5,866,666	7,053	265,252
Eagle Pass, TX	5,792	8,594,198	8,568	920,114
El Paso, TX	2,188	48,420,274	155,493	5,825,155
Fabens, TX	NA	2,116,881	NA	23,813
Hidalgo, TX	NA	21,947,731	648,751	2,575,622
Laredo, TX	NA	17,877,845	608,184	5,492,769
Presidio, TX	NA	1,900,683	3,700	16,019
Progreso, TX	NA	3,321,066	17,683	1,193,590
Rio Grande City, TX	NA	2,383,033	NA	86,225
Roma, TX	NA	4,664,306	99,284	494,717
U.S. - Mexico Border Total	**18,254**	**239,794,552**	**3,465,916**	**47,089,642**

Figure 3.23

The number of people entering the US from Canada through various ports and modes within the year 2000 (Bureau of Transportation Statistics, 2000).

Port Name	Passenger Crossings on Trains	Passenger Crossings in Personal Vehicles	Passenger Crossings on Buses	Pedestrian Crossings
Alaska, Total	**35,253**	**264,428**	**149,128**	**216**
Alcan, AK	NA	127,350	16,201	5
Dalton Cache, AK	NA	43,238	2,076	211
Skagway, AK	35,253	93,840	130,851	0
Idaho, Total	**2,097**	**510,001**	**18,177**	**2,864**
Eastport, ID	2,097	261,970	8,595	2,355
Porthill, ID	NA	248,031	9,582	509
Maine, Total	**3,177**	**7,968,478**	**64,023**	**121,807**
Bridgewater, ME	NA	171,410	362	1
Calais, ME	480	3,111,520	20,437	51,033
Fort Fairfield, ME	NA	432,891	1,408	15
Fort Kent, ME	NA	638,815	1,792	14,711
Houlton, ME	NA	814,273	9,781	713
Jackman, ME	1,230	524,788	16,261	3,451
Limestone, ME	NA	105,372	214	12
Madawaska, ME	NA	1,406,006	4,896	14,631
Portland, ME (ferry crossing)	NA	41,916	7,672	29,495
Van Buren, ME	835	576,083	766	7,058
Vanceboro, ME	632	145,404	434	687
Michigan, Total	**53,721**	**32,470,866**	**1,157,136**	**NA**
Algonac, MI	NA	NA	NA	NA
Detroit, MI	11,792	21,723,936	857,607	NA
PortHuron, MI	40,633	6,865,507	155,153	NA
Sault Ste. Marie, MI	1,296	3,881,423	144,376	NA
Minnesota, Total	**20,261**	**3,040,019**	**98,449**	**27,888**
Baudette, MN	4,835	493,446	7,991	1,146
Grand Portage, MN	NA	650,295	31,970	NA
International Falls, MN	6,912	1,289,832	11,331	26,456
Noyes, MN	3,993	115,434	10,908	205
Pinecreek, MN	NA	15,511	111	6
Roseau, MN	NA	95,329	1,093	U
Warroad, MN	4,521	380,172	35,045	75
Montana, Total	**1,447**	**1,453,161**	**39,930**	**14,418**
Del Bonita, MT	NA	56,900	492	283
Morgan, MT	NA	13,982	NA	NA
Opheim, MT	NA	11,873	80	NA
Piegan, MT	NA	299,736	7,619	309
Raymond, MT	NA	69,504	2,332	NA
Roosville, MT	NA	254,248	7,333	766
Scobey, MT	NA	14,280	7	NA
Sweetgrass, MT	1,447	705,028	21,288	13,060
Turner, MT	NA	13,708	779	NA
Whitetail, MT	NA	11,385	NA	NA
Whitlash, MT	NA	2,517	NA	NA
New York, Total	**93,395**	**25,302,257**	**2,475,160**	**286,693**
Alexandria Bay/Cape Vincent, NY	NA	1,757,270	77,516	1,754
Buffalo-Niagara, NY	53,603	16,523,141	1,973,016	280,941
Champlain-Rouse Pt., NY	38,459	2,747,141	317,205	3,281

Massena, NY	NA	3,044,019	91,810	111
Ogdensburg, NY	NA	682,800	12,947	27
Trout River/Fort Covington/Chateaugay, NY	1,333	547,886	2,666	579
North Dakota, Total	**5,181**	**1,675,262**	**111,875**	**7,303**
Ambrose, ND	NA	12,421	NA	NA
Antler, ND	NA	28,809	NA	NA
Carbury, ND	NA	32,288	146	NA
Dunseith, ND	NA	168,482	5,933	NA
Fortuna, ND	NA	21,475	4,453	NA
Hannah, ND	NA	15,134	16	NA
Hansboro, ND	NA	28,503	1,535	NA
Maida, ND	NA	39,015	861	NA
Neche, ND	NA	92,987	139	272
Noonan, ND	NA	60,987	206	NA
Northgate, ND	33	38,716	923	NA
Pembina, ND	NA	699,319	85,140	79
Portal, ND	5,148	245,302	11,823	6,952
Sarles, ND	NA	14,013	78	NA
Sherwood, ND	NA	25,938	229	NA
St. John, ND	NA	72,733	83	NA
Walhalla, ND	NA	53,747	197	NA
Westhope, ND	NA	25,393	113	NA
Vermont, Total	**2,601**	**3,123,217**	**192,395**	**21,835**
Beecher Falls, VT	NA	188,885	1,592	307
Derby Line, VT	NA	1,512,476	71,583	16,474
Highgate Springs, VT	706	957,869	115,341	314
Norton, VT	1,111	192,126	1,524	392
Richford, VT	784	271,861	2,355	4,348
Washington, Total	**52,369**	**14,239,259**	**566,670**	**102,167**
Blaine, WA	46,343	8,234,557	441,320	17,392
Boundary, WA	NA	76,860	479	69
Danville, WA	667	131,827	402	586
Ferry, WA	NA	26,731	411	217
Frontier, WA	722	82,786	5,909	65
Laurier, WA	625	103,243	8,915	169
Lynden, WA	NA	1,289,163	8,778	612
Metaline Falls, WA	NA	74,342	2,031	60
Nighthawk, WA	NA	16,183	NA	138
Oroville, WA	NA	510,251	30,139	1,439
Point Roberts, WA	NA	1,655,367	18,988	24,198
Sumas, WA	4,012	2,037,949	49,298	57,222
U.S. - Canada Border Total	**269,502**	**90,046,948**	**4,872,943**	**585,191**

U - Data are unavailable
NA - Data are not applicable or may be unavailable
R - Data are revised
SOURCE: U.S. DOT, BTS based on data from U.S. Customs Service, Mission Support Services, Office of Field Operations, Operations Management Database

Figures 3.24-31: Top ten ports for various modes of entrance into the United States from Canada (Bureau of Transportation Statistics, 2000).

Figure 3.24
Passenger crossing

Port Name	Passenger Crossings in Personal Vehicles
Detroit, MI	21,723,936
Buffalo-Niagara, NY	16,523,141
Blaine, WA	8,234,557
PortHuron, MI	6,865,507
Sault Ste. Marie, MI	3,881,423
Calais, ME	3,111,520
Massena, NY	3,044,019
Champlain-Rouse Pt., NY	2,747,141
Sumas, WA	2,037,949
Alexandria Bay/Cape Vincent, NY	1,757,270

Figure 3.25
Passenger crossings on buses

Port Name	Passenger Crossings on Buses
Buffalo-Niagara, NY	1,973,016
Detroit, MI	857,607
Blaine, WA	441,320
Champlain-Rouse Pt., NY	317,205
PortHuron, MI	155,153
Sault Ste. Marie, MI	144,376
Skagway, AK	130,851
Highgate Springs, VT	115,341
Massena, NY	91,810
Pembina, ND	85,140

Figure 3.26
Pedesrtian crossing

Port Name	Pedestrian Crossings
Buffalo-Niagara, NY	280,941
Sumas, WA	57,222
Calais, ME	51,033
Portland, ME	29,495
International Falls, MN	26,456
Point Roberts, WA	24,198
Blaine, WA	17,392
Derby Line, VT	16,474
Fort Kent, ME	14,711
Madawaska, ME	14,631

Figure 3.27
Passenger Crossings on Trains

Port Name	Passenger Crossings on Trains
Buffalo-Niagara, NY	53,603
Blaine, WA	46,343
PortHuron, MI	40,633
Champlain-Rouse Pt., NY	38,459
Skagway, AK	35,253
Detroit, MI	11,792
International Falls, MN	6,912
Portal, ND	5,148
Baudette, MN	4,835
Warroad, MN	4,521

Top ten ports regarding traffic for various modes of entrance by land into the United States from Mexico (Bureau of Transportation Statistics, 2000).

Figure 3.28
Passengers Crossing on Trains

Port Name	Passenger Crossings on Trains
Eagle Pass, TX	5,792
Nogales, AZ	4,752
Tecate, CA	3,418
El Paso, TX	2,188
Calexico East, CA	1,687
Otay Mesa/San Ysidro, CA	408
Calexico, CA*	9

Figure 3.29
Passengers Crossing in Personal Vehicles

Port Name	Passenger Crossings in Personal Vehicles
El Paso, TX	48,420,274
Otay Mesa/San Ysidro, CA	41,684,841
Hidalgo, TX	21,947,731
Calexico, CA*	20,094,460
Brownsville, TX	19,693,130
Laredo, TX	17,877,845
Nogales, AZ	11,501,672
Eagle Pass, TX	8,594,198
Calexico East, CA	7,600,859
San Luis, AZ	7,068,111

Figure 3.30
Passengers Crossing on Buses

Port Name	Passenger Crossings on Buses
Otay Mesa/San Ysidro, CA	1629537
Hidalgo, TX	648,751
Laredo, TX	608,184
El Paso, TX	155,493
Nogales, AZ	136,471
Roma, TX	99,284
Brownsville, TX	78,032
Calexico, CA*	19,367
Progreso, TX	17,683
Lukeville, AZ	15,763

Figures 3.31
Pedestrians Crossing

Port Name	Pedestrian Crossings
Calexico, CA*	8,352,324
Otay Mesa/San Ysidro, CA	8,191,206
El Paso, TX	5,825,155
Laredo, TX	5,492,769
Nogales, AZ	4,677,819
Brownsville, TX	3,017,533
San Luis, AZ	2,824,562
Hidalgo, TX	2,575,622
Andrade, CA	1,762,700
Progreso, TX	1,193,590

Figure 3.32
Apprehensions of persons entering the U.S. illegally at southwest borders by month (http://uscis.gov/graphics/shared/aboutus/statistics/msrsep01/SWBORD.HTM)

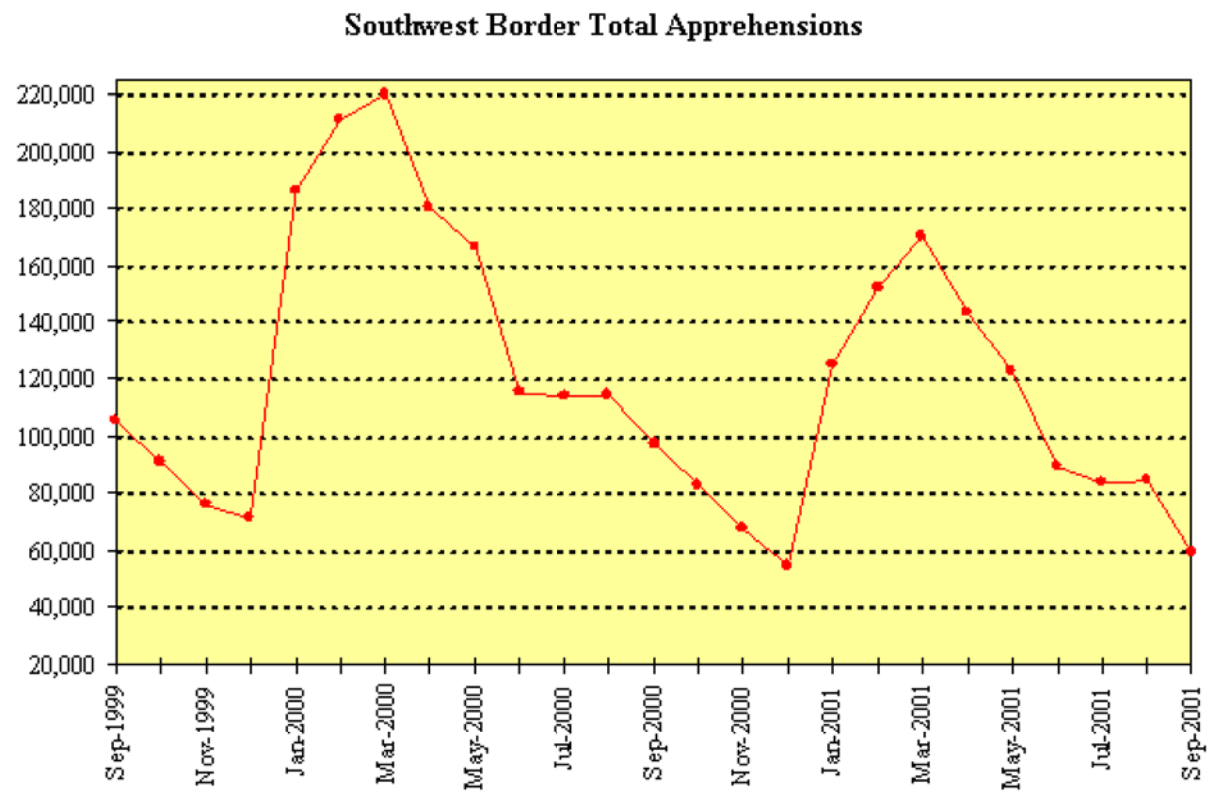


Figure 3.33

The number of air passengers from countries reported as positive for CSF entering the United States at various ports in the year 2000 (Bureau of Transportation Statistics, 2000).

Country	# of passengers from CSF (+) countries in yr. 2000
United Kingdom	7963230
Mexico	6961812
Germany	3294037
Italy	1035894
Dominican Republic	998444
China	958829
Colombia	586434
El Salvador	565383
Venezuela	565202
Hong Kong-China	514066
Peru	417749
Philippines	395242
Guatemala	390514
Haiti	329096
Ecuador	313183
Honduras	245641
Russia	170626
India	161265
Nicaragua	155095
Malaysia	76688
Luxembourg	90

Figure 3.34
Passengers arriving in the U.S. by city from countries that were reported as CSF positive in 2000 (www.customs.gov)

DEST_CITY_	TOTAL
Miami, FL	3643962
New York, NY	3282421
Los Angeles, CA	2949066
Chicago, IL	2059300
Houston, TX	1804938
San Francisco, CA	1541378
Washington, DC	1529723
Newark, NJ	1499099
Atlanta, GA	1444872
Dallas/Ft.Worth, TX	1332497
West Palm Beach/Palm Beach	886800
Boston, MA	772186
Philadelphia, PA	627428
Detroit, MI	572530
Orlando, FL	508137
Phoenix, AZ	405052
Sanford, FL	345913
Denver, CO	303392
Las Vegas, NV	210825
Seattle, WA	201934
Minneapolis/St. Paul, MN	199122
Charlotte, NC	196035
St. Louis, MO	150468
Pittsburgh, PA	142513
Cleveland, OH	130018
Newburgh, NY	124647
San Diego, CA	120215
Oakland, CA	99210
San Antonio, TX	81375
Tampa, FL	72236
Cincinnati, OH	71930
Baltimore, MD	65624
San Jose, CA	64038
Raleigh/Durham, NC	52139
Milwaukee, WI	36473
Salt Lake City, UT	35649
New Orleans, LA	32321
Indianapolis, IN	28688
Honolulu, HI	27824
Portland, OR	24461
Memphis, TN	20478
Ft. Myers, FL	20088
Ontario/San Bernardino, CA	18377
Kansas City, MO	12200
Covington, KY	11952
Austin, TX	11538
Sacramento, CA	10689
Tucson, AZ	10061
Minneapolis/St. Paul Int,	9876
Anchorage, AK	8673
Saginaw/Bay City/Midland, MI	7469
Fort Lauderdale, FL	6325

El Paso, TX	5397
Laredo, TX	5091
Nashville, TN	4711
Columbus, OH	2918
Buffalo/Niagara Falls, NY	2330
Bismarck/Mandan, ND	1396
Hartford, CT	1123
Fairbanks, AK	926
Brownsville, TX	797
Santa Ana, CA	783
Fargo, ND	727
Sioux Falls, SD	601
Bangor, ME	509
Albuquerque, NM	473
Reno, NV	431
Camp Springs, MD	425
Richmond, VA	376
Des Moines, IA	341
Omaha, NE	277
Tulsa, OK	231
Knoxville, TN	199
Jacksonville, FL	181
Alexandria, LA	171
Green Bay/Clintonville, WI	170
Rochester, MN	169
Albany, NY	168
Lincoln, NE	167
Oklahoma City, OK	166
Duluth, MN	159

Figure 3.35
AQI Monitoring Data: Foreign Arrival Passenger Data: Comparison of Years Related to Farm Visits, both Foreign and Domestic (AQIM, 2002).

FY	Total Samples	Total Passengers	# Samples Been On Farm (Foreign)	# Samples Going ToFarm (US)	Been On & Going To Farm
2001	106296	154460	N/A	666	N/A
2002	106796	151053	1313	753	228
2003	109004	152981	962	729	197

Figure 3.36
2002 OIE Data.

PAX ORIGIN	CSF status - 2002	Number Sampled by Country of PAX 2002	CSF-potential from # Sampled 2002	PAX Going to a Farm 2002	CSF-potential Going to Farm 2002	Going to Farm by State (Where known) 2002
AFGHANISTAN	NO	1	0	0	0	
AFRICA COUNTRY UNKNOWN	NO	3	0	2	0	TX, KS
ALBANIA	YES	1	1	0	0	
ANTIGUA & BARBUDA	NO	2	0	0	0	
ANTIGUA ISLAND	NO	1	0	1	0	ID
ARGENTINA	YES	26	26	4	0	PA, NJ, NY
ARMENIA	YES	0	0	0	0	
AUSTRALIA	NO	7	0	4	0	ID
AUSTRIA	YES	7	7	5	0	MA, CA
AZERBAIJAN	NO	1	0	1	0	LA
AZORES	NO	0	0	1	0	
BAHAMAS	NO	0	0	0	0	
BAHRAIN	NO	0	0	0	0	
BANGLADESH	NO	0	0	0	0	
BARBADOS	NO	2	0	0	0	
BELARUS	YES	1	1	0	0	
BELGIUM	YES	5	5	9	0	VA, AK
BELIZE	NO	3	0	0	0	
BOLIVIA	YES	3	3	0	0	
BOSNIA & HERZEGOVINA	YES	1	1	0	0	
BRAZIL	YES	31	31	10	0	TX, CA, NY, NM
BULGARIA	YES	2	2	2	0	
CAMBODIA	YES	1	1	0	0	
CAMEROON	NO	2	0	1	0	
CANADA	NO	3	0	0	0	
CANARY ISLANDS	YES	0	0	0	0	
CAYMAN ISLANDS	NO	1	0	5	0	FL
CHILE	NO	7	0	5	0	OR, FL
CHINA	YES	13	13	7	0	
COLOMBIA	YES	9	9	4	0	CA, FL
CONGO	NO	0	0	0	0	
COSTA RICA	YES	16	16	7	0	GA, FL
COTE D'IVOIRE	NO	1	0	1	0	VA
CROATIA	YES	0	0	0	0	
CUBA	YES	9	9	1	0	FL
CZECH REPULIC	YES	1	1	2	0	
DENMARK	NO	4	0	6	0	MX, CA

DOMINICA	NO	0	0	0	0	
DOMINICAN REPUBLIC	YES	53	53	17	0	NJ, PR, CO,CA
ECUADOR	YES	4	4	2	0	
EGYPT	NO	1	0	1	0	
EL SALVADOR	YES	24	24	4	0	TX, WA
ERITREA	NO	0	0	0	0	
ETHIOPIA	NO	1	0	0	0	
FIJI	NO	2	0	0	0	
FINLAND	NO	2	0	2	0	NY
FRANCE	YES	61	61	39	0	NY, IA, CA, OR, OH, TX
GABON	NO	0	0	0	0	
GAMBIA	NO	1	0	0	0	
GEORGIA	NO	0	0	0	0	
GERMANY	YES	52	52	51	0	MA, NH, FL, VA, NJ, TX, OH, AR, MN, GA, NM
GHANA	NO	6	0	0	0	
GREECE	NO	3	0	1	0	
GRENADA	NO	0	0	1	0	
GUADELOUPE	NO	1	0	0	0	
GUAM	NO	1	0	0	0	
GUATEMALA	YES	9	9	3	0	OK, DC
GUINEA	NO	1	0	1	0	TN
GUYANA	YES	3	3	1	0	
HAITI	YES	10	10	4	0	FL, NY
HONDURAS	YES	11	11	1	0	
HONG KONG	YES	3	3	3	0	
HUNGARY	YES	1	1	3	0	
ICELAND	NO	19	0	8	0	NY, WA, WI, IA
INDIA	YES	19	19	6	0	MA, ME
INDONESIA	YES	0	0	2	0	
IRELAND	NO	70	0	13	0	MS, VA, MA, WV, MT, CO
IRELAND, NORTHERN	NO	1	0	0	0	
ISRAEL	NO	8	0	1	0	
ITALY	YES	22	22	20	0	NC, WA, MO, FL, NY, CA
JAMAICA	NO	41	0	26	0	IL, FL, IT
JAPAN	NO	31	0	18	0	MI, TX, CO, WA, HI
JORDAN	NO	2	0	1	0	CA
KAZAKSTAN	NO	1	0	0	0	
KENYA	NO	9	0	3	0	TX
KOREA, SOUTH	YES	10	10	15	0	VA, CA, TX
KUWAIT	NO	0	0	0	0	

LAO PEOPLE'S DEM. REP.	YES	3	3	1	0	
LATVIA	YES	0	0	1	0	
LIBERIA	NO	1	0	0	0	
LITHUANIA	YES	1	1	0	0	
LUXEMBOURG	YES	0	0	0	0	
MACEDONIA	YES	3	3	1	0	NJ
MALAWI	NO	0	0	0	0	
MALAYSIA	YES	2	2	1	0	
MALI	NO	0	0	0	0	
MALTA	YES	0	0	0	0	
MEXICO	YES	154	154	137	0	AL, IL, WI, NY, TX, CA, OH, CO, FL, MO
MICRONESIA (FED. ST. OF)	NO	0	0	0	0	
MOLDOVA, REPUBLIC OF	YES	2	2	1	0	OR
MONGOLIA	YES	1	1	0	0	
MOROCCO	NO	1	0	2	0	VT
NAMIBIA	NO	0	0	0	0	
NEPAL	YES	1	1	0	0	
NETHERLANDS	YES	24	24	25	0	CA, IA, AL, XX, OR
NEVIS	NO	0	0	1	0	
NEW ZEALAND	NO	10	0	2	0	IL
NICARAGUA	YES	4	4	2	0	FL
NIGERIA	NO	4	0	4	0	FL, CA
NORWAY	NO	13	0	9	0	MN, AK
OMAN	NO	0	0	1	0	
PAKISTAN	NO	3	0	5	0	GA, CA
PANAMA	NO	2	0	1	0	
PARAGUAY	YES	2	2	0	0	
PERU	YES	13	13	2	0	
PHILIPPINES	YES	15	15	8	0	FL, IA, CA
POLAND	YES	4	4	7	0	CA
PORTUGAL	NO	6	0	0	0	
QATAR	NO	0	0	1	0	
ROMANIA	YES	3	3	0	0	
RUSSIAN FEDERATION	YES	2	2	2	0	
RWANDA	NO	0	0	0	0	
SAINT EUSTATIUS	NO	0	0	0	0	
SAINT KITTS & NEVIS	NO	3	0	0	0	
SAINT LUCIA	NO	5	0	2	0	
SAINT MARTIN	NO	4	0	4	0	NJ
SAUDI ARABIA	NO	0	0	0	0	
SENEGAL	NO	2	0	0	0	
SEYCHELLES	NO	0	0	0	0	
SIERRA LEONE	NO	1	0	0	0	

SINGAPORE	YES	0	0	0	0	
SLOVAKIA	YES	0	0	0	0	
SLOVENIA	NO	0	0	0	0	
SOUTH AFRICA	NO	22	0	15	0	IA, ND, MN, TX, KS, FL
SPAIN	YES	18	18	7	0	PR, CA
SRI LANKA	YES	1	1	1	0	PA
SUDAN	NO	0	0	1	0	
SWEDEN	NO	9	0	6	0	VA, WA
SWITZERLAND	YES	18	18	10	0	MA, FL, TX, MO
TAHITI	NO	1	0	0	0	
TAIWAN, PROVIDENCE OF CHINA	YES	8	8	5	0	WA
TANZANIA, UNITED REP. OF	NO	9	0	1	0	
THAILAND	YES	18	18	11	0	TX, VT, NY, VA, WA
TOGO	NO	0	0	0	0	
TONGA	NO	1	0	0	0	
TORTOLA	NO	1	0	0	0	
TRINIDAD AND TOBAGO	NO	3	0	0	0	
TUNISIA	NO	1	0	0	0	
TURKEY	NO	6	0	4	0	
TURKS AND CAICOS ISLANDS	NO	1	0	0	0	
UGANDA	NO	3	0	1	0	MA
UKRAINE	YES	2	2	2	0	
UNITED ARAB EMIRATES	NO	1	0	2	0	
UNITED KINGDOM	YES	233	233	132	0	ME, MA, VT, NC, VA, DC, OH, CA, FL, WI, XX, MN, MD, WA, NY, MT, UT, TX, NM, NV, AZ, AL, MO
URUGUAY	NO	1	0	0	0	
VENEZUELA	YES	9	9	2	0	AZ
VIETNAM	YES	6	6	1	0	
VIRGIN ISLANDS, (BRITISH)	NO	1	0	1	0	MA
YUGOSLAVIA	YES	2	2	0	0	
ZAMBIA	NO	0	0	0	0	
ZIMBABWE	NO	2	0	2	0	
Total	**#NAME?**	**1313**	**957**	**749**	**0**	

Figure 3.37
2003 OIE Data.

PAX ORIGIN	CSFstatus-2003	Number sampled by Country of PAX 2003	CSF-potential from # Sampled 2003	PAX Going to a Farm 2003	CSF-potential Going to Farm 2003	Going to Farm by State (Where known) 2003
AFGHANISTAN	NO	0	0	0	0	
AFRICA COUNTRY UNKNOWN	NO	0	0	0	0	
ALBANIA	YES	0	0	1	0	
ANTIGUA & BARBUDA	NO	0	0	0	0	
ANTIGUA ISLAND	NO	0	0	0	0	
ARGENTINA	YES	14	14	9	0	FL, ND, MA, CO, MD
ARMENIA	YES	1	1	0	0	
AUSTRALIA	NO	12	0	13	0	CA, SC, FL
AUSTRIA	YES	7	7	7	0	MA, TX, SD, ID
AZERBAIJAN	NO	0	0	0	0	
AZORES	NO	0	0	0	0	
BAHAMAS	NO	0	0	0	0	
BAHRAIN	NO	0	0	1	0	
BANGLADESH	NO	0	0	0	0	
BARBADOS	NO	0	0	1	0	
BELARUS	YES	0	0	0	0	
BELGIUM	YES	2	2	1	0	
BELIZE	NO	3	0	4	0	
BOLIVIA	YES	3	3	3	0	CA, FL
BOSNIA & HERZEGOVINA	YES	0	0	0	0	
BRAZIL	YES	16	16	10	0	IT, CO, CA
BULGARIA	YES	1	1	0	0	
CAMBODIA	YES	0	0	0	0	
CAMEROON	NO	1	0	0	0	
CANADA	NO	3	0	0	0	
CANARY ISLANDS	YES	0	0	0	0	
CAYMAN ISLANDS	NO	4	0	3	0	TX
CHILE	NO	8	0	0	0	
CHINA	YES	9	9	14	0	OR, CA
COLOMBIA	YES	5	5	2	0	
CONGO	NO	0	0	0	0	
COSTA RICA	YES	16	16	5	0	DC
COTE D'IVOIRE	NO	0	0	1	0	
CROATIA	YES	0	0	0	0	
CUBA	YES	3	3	2	0	FL
CZECH REPULIC	YES	2	2	2	0	MA

DENMARK	NO	5	0	5	0	IT, MN
DOMINICA	NO	1	0	0	0	
DOMINICAN REPUBLIC	YES	40	40	17	0	OH, MA, NJ, PR, NY
ECUADOR	YES	6	6	3	0	IL
EGYPT	NO	2	0	0	0	
EL SALVADOR	YES	16	16	5	0	CA
ERITREA	NO	1	0	0	0	
ETHIOPIA	NO	1	0	0	0	
FIJI	NO	1	0	0	0	
FINLAND	NO	0	0	1	0	
FRANCE	YES	28	28	25	0	TX, CO, CA, NY
GABON	NO	1	0	0	0	
GAMBIA	NO	1	0	0	0	
GEORGIA	NO	1	0	0	0	
GERMANY	YES	49	49	63	0	WA, VA, AL, CA, NC
GHANA	NO	7	0	1	0	PA
GREECE	NO	1	0	1	0	
GRENADA	NO	0	0	0	0	
GUADELOUPE	NO	0	0	0	0	
GUAM	NO	1	0	0	0	
GUATEMALA	YES	5	5	4	0	
GUINEA	NO	0	0	0	0	
GUYANA	YES	2	2	1	0	TN
HAITI	YES	7	7	5	0	FL
HONDURAS	YES	6	6	3	0	
HONG KONG	YES	7	7	9	0	CA, MN
HUNGARY	YES	4	4	2	0	MT
ICELAND	NO	18	0	3	0	CA,NY
INDIA	YES	15	15	8	0	SC
INDONESIA	YES	1	1	0	0	
IRELAND	NO	51	0	10	0	MD, PA, GA, NJ
IRELAND, NORTHERN	NO	0	0	0	0	
ISRAEL	NO	5	0	5	0	CA
ITALY	YES	25	25	16	0	MA, UT, WA, PA, MD, VA
JAMAICA	NO	28	0	13	0	FL, IA, IL, MD
JAPAN	NO	11	0	22	0	MN, NY, CA
JORDAN	NO	2	0		0	
KAZAKSTAN	NO	0	0	0	0	
KENYA	NO	12	0	2	0	IA
KOREA, SOUTH	YES	8	8	10	0	NJ
KUWAIT	NO	0	0	1	0	
LAO PEOPLE'S DEM. REP.	YES	0	0	0	0	

LATVIA	YES	0	0	0	0	
LIBERIA	NO	0	0	0	0	
LITHUANIA	YES	0	0	0	0	
LUXEMBOURG	YES	0	0	1	0	
MACEDONIA	YES	0	0	0	0	
MALAWI	NO	1	0	0	0	
MALAYSIA	YES	1	1	4	0	CA
MALI	NO	1	0	0	0	
MALTA	YES	0	0	0	0	
MEXICO	YES	143	143	150	0	IT, TX, MS, CA, FL, MN, IA, OK, MO, OR, WA, NY
MICRONESIA (FED. ST. OF)	NO	0	0	0	0	
MOLDOVA, REPUBLIC OF	YES	1	1	0	0	
MONGOLIA	YES	2	2	0	0	
MOROCCO	NO		0	1	0	
NAMIBIA	NO	1	0	1	0	CA
NEPAL	YES	3	3	0	0	
NETHERLANDS	YES	11	11	16	0	MN, MD, NY
NEVIS	NO	0	0	0	0	
NEW ZEALAND	NO	6	0	2	0	IT, CO
NICARAGUA	YES	2	2	2	0	
NIGERIA	NO	9	0	5	0	PA
NORWAY	NO	10	0	5	0	ND, WI, MT, MN
OMAN	NO	0	0	0	0	
PAKISTAN	NO	1	0	3	0	OH
PANAMA	NO	1	0	2	0	
PARAGUAY	YES	4	4	0	0	
PERU	YES	25	25	9	0	NV, PR, NJ
PHILIPPINES	YES	14	14	9	0	CA
POLAND	YES	3	3	1	0	
PORTUGAL	NO	1	0	0	0	
QATAR	NO	1	0	1	0	SC
ROMANIA	YES	1	1	0	0	
RUSSIAN FEDERATION	YES	4	4	5	0	NH, MD, DC
RWANDA	NO	0	0	1	0	
SAINT EUSTATIUS	NO	1	0	1	0	NY
SAINT KITTS & NEVIS	NO	4	0	0	0	
SAINT LUCIA	NO	3	0	0	0	
SAINT MARTIN	NO	2	0	2	0	
SAUDI ARABIA	NO	0	0	0	0	
SENEGAL	NO	0	0	0	0	
SEYCHELLES	NO	1	0	0	0	
SIERRA LEONE	NO	0	0	0	0	
SINGAPORE	YES	1	1	0	0	

SLOVAKIA	YES	0	0	0	0	
SLOVENIA	NO	2	0	0	0	
SOUTH AFRICA	NO	18	0	9	0	WY
SPAIN	YES	8	8	13	0	NY, PA, MA
SRI LANKA	YES	0	0	0	0	
SUDAN	NO	0	0	0	0	
SWEDEN	NO	2	0	5	0	WA
SWITZERLAND	YES	8	8	11	0	WI, OR, OH
TAHITI	NO	1	0	0	0	
TAIWAN, PROVIDENCE OF CHINA	YES	9	9	6	0	CA, OR
TANZANIA, UNITED REP. OF	NO	2	0		0	
THAILAND	YES	6	6	9	0	MA
TOGO	NO	1	0	1	0	NJ
TONGA	NO	0	0	0	0	
TORTOLA	NO	0	0	0	0	
TRINIDAD AND TOBAGO	NO	0	0	2	0	
TUNISIA	NO	1	0	2	0	DC
TURKEY	NO	4	0	2	0	
TURKS AND CAICOS ISLANDS	NO	0	0	2	0	
UGANDA	NO	1	0	1	0	
UKRAINE	YES	0	0	2	0	
UNITED ARAB EMIRATES	NO	2	0	0	0	
UNITED KINGDOM	YES	145	145	112	0	ME, NH, WA, WV, OK, TX, CA, VA, IA, KY, MT, IT, SC, MO, DC, MD, CT, NY, AK
URUGUAY	NO	2	0	2	0	TX
VENEZUELA	YES	2	2	1	0	
VIETNAM	YES	4	4	4	0	CA
VIRGIN ISLANDS, (BRITISH)	NO	3	0	4	0	CA
YUGOSLAVIA	YES	0	0	0	0	
ZAMBIA	NO	2	0	0	0	
ZIMBABWE	NO	2	0	0	0	
Total	**#NAME?**	**962**	**695**	**723**	**0**	

Figure 3.38
California Interception of contraband products, October 2002.

	MEAT Interceptions AT AIRPORT						
MC	WORKUNIT	ACODE	SUM(QUANTITY)				
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1	LOS.ANGELES.CA	1039A	1190		LOS.ANGELES.CA	1039A	1190
1	PHOENIX.AZ	1039A	163		LOS.ANGELES.CA	1039B	39
1	LOS.ANGELES.CA	1039B	39		LOS.ANGELES.CA	1039C	5
1	LOS.ANGELES.CA	1039C	5		PHOENIX.AZ	1039A	163
TOTAL:			1397				
	INEDIBLE Interceptions AT AIRPORT						

1	LOS.ANGELES.CA	1041A	132				
1	LOS.ANGELES.CA	1041C	1				
TOTAL :			1530				
	MEAT Interceptions AT LAND BORDER						

1	SAN.DIEGO.CA	1072A	379		CALEXICO.CA	1072A	174
1	SAN.DIEGO.CA	1072B	195		CALEXICO.CA	1072B	35
1	CALEXICO.CA	1072A	174		SAN.DIEGO.CA	1072A	379
1	TECATE.CA	1072A	61		SAN.DIEGO.CA	1072B	195
1	SANLUIS.AZ	1072A	57		SAN.DIEGO.CA	1072D	43
1	SAN.DIEGO.CA	1072D	43		SANLUIS.AZ	1072A	57
1	CALEXICO.CA	1072B	35		SANLUIS.AZ	1072B	11
1	SANLUIS.AZ	1072B	11		TECATE.CA	1072A	61
1	TECATE.CA	1072D	1		TECATE.CA	1072D	1
TOTAL:			956				
CALEXICO:			209				
SAN DIEGO:			617				
SAN LUIS:			68				
TECATE:			62				
TOTAL MEAT:			956				
	INEDIBLE Interceptions AT LAND BORDER						
MC	WORKUNIT	ACODE	SUM(QUANTITY)				
--	-------------------	-----	----------- -				
1	CALEXICO.CA	1074A	318		CALEXICO.CA	1074A	318
1	SANLUIS.AZ	1074A	11		CALEXICO.CA	1074B	3
1	SAN.DIEGO.CA	1074A	9		SAN.DIEGO.CA	1074A	9
1	TECATE.CA	1074A	8		SAN.DIEGO.CA	1074B	4
1	SAN.DIEGO.CA	1074B	4		SAN.DIEGO.CA	1074D	1
1	CALEXICO.CA	1074B	3		SANLUIS.AZ	1074A	11
1	SAN.DIEGO.CA	1074D	1		SANLUIS.AZ	1074B	0

1	SANLUIS.AZ	1074B	0		SANLUIS.AZ	1074C	0
1	SANLUIS.AZ	1074C	0		TECATE.CA	1074A	8
TOTAL:			354				
CALEXICO:			321				
SAN DIEGO:			14				
SAN LUIS:			11				
TECATE:			8				

Figure 3.39
California Interception of contraband products, November 2002.

	MEAT Interceptions AT AIRPORT					
MC	WORKUNIT	ACODE	SUM(QUANTITY)			
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2	LOS.ANGELES.CA	1039A	1096			
2	LOS.ANGELES.CA	1039B	57			
2	LOS.ANGELES.CA	1039C	1			
TOTAL:			1154			
	INEDIBLE Interceptions AT AIRPORT					

2	LOS.ANGELES.CA	1041A	122			
2	LOS.ANGELES.CA	1041C	0			
TOTAL LOS ANGELES:			1276			
	MEAT Interceptions AT LAND BORDER					

2	NOGALES.AZ	1072A	603		CALEXICO.CA	1072A
2	SAN.DIEGO.CA	1072A	395		CALEXICO.CA	1072B
2	CALEXICO.CA	1072A	218		NOGALES.AZ	1072A
2	SAN.DIEGO.CA	1072B	217		NOGALES.AZ	1072D
2	NOGALES.AZ	1072D	86		NOGALES.AZ	1072B
2	SANLUIS.AZ	1072A	47		NOGALES.AZ	1072C
2	NOGALES.AZ	1072B	43		SAN.DIEGO.CA	1072A
2	TECATE.CA	1072A	35		SAN.DIEGO.CA	1072B
2	CALEXICO.CA	1072B	23		SAN.DIEGO.CA	1072D
2	SANLUIS.AZ	1072B	16		SANLUIS.AZ	1072A
2	SAN.DIEGO.CA	1072D	4		SANLUIS.AZ	1072B
2	NOGALES.AZ	1072C	3		TECATE.CA	1072A
2	TECATE.CA	1072D	0		TECATE.CA	1072D
TOTAL:			1690			
CALEXICO:			241			
NOGALES:			735			
SAN DIEGO:			616			
SAN LUIS:			63			

TECATE:			35			
TOTAL MEAT:			1690			
	INEDIBLE Interceptions AT LAND BORDER					
MC	WORKUNIT	ACODE	SUM(QUANTITY)			
--	--------------------	-----	--------- ----			
2	CALEXICO.CA	1074A	318		CALEXICO.CA	1074A
2	NOGALES.AZ	1074A	136		CALEXICO.CA	1074B
2	SANLUIS.AZ	1074A	17		NOGALES.AZ	1074A
2	NOGALES.AZ	1074D	16		NOGALES.AZ	1074D
2	SAN.DIEGO.CA	1074A	13		NOGALES.AZ	1074C
2	TECATE.CA	1074A	8		SAN.DIEGO.CA	1074A
2	SAN.DIEGO.CA	1074B	7		SAN.DIEGO.CA	1074B
2	NOGALES.AZ	1074C	3		SAN.DIEGO.CA	1074D
2	CALEXICO.CA	1074B	1		SANLUIS.AZ	1074A
2	SAN.DIEGO.CA	1074D	1		SANLUIS.AZ	1074B
2	SANLUIS.AZ	1074B	0		SANLUIS.AZ	1074C
2	SANLUIS.AZ	1074C	0		TECATE.CA	1074A
TOTAL:			520			
CALEXICO:			319			
NOGALES:			155			
SAN DIEGO:			21			
SAN LUIS:			17			
TECATE:			8			
	COOP MEAT AND MEAT BY PRODUCTS Interceptions					
MC	WORKUNIT	ACODE	SUM(QUANTITY)			
--	--------------------	-----	--------- ----			
2	NOGALEZ.AZ	1077	36		CALEXICO.CA	1077
2	TECATE.CA	1077	2		NOGALEZ.AZ	1077
2	CALEXICO.CA	1077	2		TECATE.CA	1077
TOTAL			40			
	A CODE KEY					
	Interceptions-Meat/Poultry (Baggage)	1039A				
	Interceptions-Meat/Poultry (Aircraft)	1039B				
	Interceptions-Meat/Poultry (Cargo)	1039C				
	Interceptions-Inedible Animal Prod (Baggage)	1041A				
	Inedible Animal Product (Cargo)	1041C				
	Interceptions-Meat/Poultry Prod (Vehicle)	1072A				
	Interceptions-Meat/Poultry Prod (Pedestrian)	1072B				
	Interceptions-Meat/Poultry Prod (Cargo)	1072C				
	Interceptions-Meat/Poultry Prod (Bus)	1072D				

	Interceptions-Inedible Animal Prod (Vehicle)	1074A				
	Interceptions-Inedible Animal Prod (Pedestrian)	1074B				
	Interceptions-Inedible Animal Prod (Cargo)	1074C				
	Interceptions-Inedible Animal Prod (Bus)	1074D				
	Interceptions-Meat/Poultry Prod (COOP)	1077				

Figure 3.40
California Interception of contraband products, December 2002

	MEAT Interceptions AT AIRPORT						
MC	WORKUNIT	ACODE	SUM(QUANTITY)				
--	-------------------	-----	-------------				
3	LOS.ANGELES.CA	1039A	1324				
3	LOS.ANGELES.CA	1039B	60				
3	LOS.ANGELES.CA	1039C	0				
TOTAL:			1384				
	INEDIBLE Interceptions AT AIRPORT						

3	LOS.ANGELES.CA	1041A	147				
3	LOS.ANGELES.CA	1041C	1				
TOTAL LOS ANGELES:			1532				
	MEAT Interceptions AT LAND BORDER						

3	NOGALES.AZ	1072A	418		CALEXICO.CA	1072A	177
3	SAN.DIEGO.CA	1072A	366		CALEXICO.CA	1072B	31
3	SAN.DIEGO.CA	1072B	243		NOGALES.AZ	1072A	418
3	CALEXICO.CA	1072A	177		NOGALES.AZ	1072D	58
3	TECATE.CA	1072A	61		NOGALES.AZ	1072B	25
3	NOGALES.AZ	1072D	58		NOGALES.AZ	1072C	6
3	SANLUIS.AZ	1072A	48		SAN.DIEGO.CA	1072A	366
3	SAN.DIEGO.CA	1072D	43		SAN.DIEGO.CA	1072B	243
3	CALEXICO.CA	1072B	31		SAN.DIEGO.CA	1072D	43
3	NOGALES.AZ	1072B	25		SANLUIS.AZ	1072A	48
3	SANLUIS.AZ	1072B	23		SANLUIS.AZ	1072B	23
3	NOGALES.AZ	1072C	6		TECATE.CA	1072A	61
3	TECATE.CA	1072B	1		TECATE.CA	1072B	1
3	TECATE.CA	1072D	1		TECATE.CA	1072D	1
TOTAL:			1501				1501
CALEXICO:			208				
NOGALES.AZ			507				
SAN DIEGO:			652				

SAN LUIS:			71				
TECATE:			63				
TOTAL MEAT:			1501				
	INEDIBLE Interceptions AT LAND BORDER						
MC	WORKUNIT	ACODE	SUM(QUANTITY)				
--	--------------------	-----	-------------				
3	NOGALES.AZ	1074A	80		CALEXICO.CA	1074A	8
3	SANLUIS.AZ	1074A	13		CALEXICO.CA	1074B	3
3	SAN.DIEGO.CA	1074A	13		NOGALES.AZ	1074A	80
3	CALEXICO.CA	1074A	8		NOGALES.AZ	1074D	2
3	TECATE.CA	1074A	4		NOGALES.AZ	1074B	1
3	SAN.DIEGO.CA	1074B	4		NOGALES.AZ	1074C	0
3	CALEXICO.CA	1074B	3		SAN.DIEGO.CA	1074A	13
3	NOGALES.AZ	1074D	2		SAN.DIEGO.CA	1074B	4
3	SAN.DIEGO.CA	1074D	1		SAN.DIEGO.CA	1074D	1
3	NOGALES.AZ	1074B	1		SANLUIS.AZ	1074A	13
3	SANLUIS.AZ	1074B	0		SANLUIS.AZ	1074B	0
3	NOGALES.AZ	1074C	0		SANLUIS.AZ	1074C	0
3	SANLUIS.AZ	1074C	0		TECATE.CA	1074A	4
TOTAL:			129				
CALEXICO:			11				
NOGALES:			83				
SAN DIEGO:			18				
SAN LUIS:			13				
TECATE:			4				
	COOP MEAT AND MEAT BY PRODUCTS Interceptions						
MC	WORKUNIT	ACODE	SUM(QUANTITY)				
--	--------------------	-----	-------------				
3	NOGALES.AZ	1077	19		NOGALES.AZ	1077	19
3	TECATE.CA	1077	6		TECATE.CA	1077	6
3	CALEXICO.CA	1077	4		CALEXICO.CA	1077	4
			29				29
	A CODE KEY						
	Interceptions-Meat/Poultry (Baggage)	1039A					
	Interceptions-Meat/Poultry (Aircraft)	1039B					
	Interceptions-Meat/Poultry (Cargo)	1039C					
	Interceptions-Inedible Animal Prod (Baggage)	1041A					
	Inedible Animal Product (Cargo)	1041C					
	Interceptions-Meat/Poultry Prod (Vehicle)	1072A					
	Interceptions-Meat/Poultry Prod (Pedestrian)	1072B					
	Interceptions-Meat/Poultry Prod (Cargo)	1072C					
	Interceptions-Meat/Poultry Prod (Bus)	1072D					

	Interceptions-Inedible Animal Prod (Vehicle)	1074A					
	Interceptions-Inedible Animal Prod (Pedestrian)	1074B					
	Interceptions-Inedible Animal Prod (Cargo)	1074C					
	Interceptions-Inedible Animal Prod (Bus)	1074D					
	Interceptions-Meat/Poultry Prod (COOP)	1077					

Figure 3.41
Texas Interception of contraband products, October 2002 – January 2003.

Airport – Dallas-Ft. Worth					
Activity	**2-Oct**	**2-Nov**	**2-Dec**	**3-Jan**	**TOTAL**
Meat/Poultry (Baggage)(1039A)	418	0	478	0	894
Meat/Poultry (Aircraft)(1039B)	20	0	34	0	54
Meat/Poultry (Cargo)(1039C)	4	0	2	0	6
Inedible Animal Product (Baggage) (1041A)	2	0	2	0	4
TOTAL	44	0	914	0	958
Airport – San Antonio					
Activity	**2-Oct**	**2-Nov**	**2-Dec**	**3-Jan**	**TOTAL**
Meat/Poultry (Baggage)(1039A)	12	0	0	0	12
Meat/Poultry (Aircraft)(1039B)	6	0	0	0	6
Meat/Poultry (Cargo)(1039C)	0	0	0	0	0
TOTAL	12	0	0	0	12
AIRPORT GRAND TOTAL					**976**
Maritime(Houston, Galveston, Austin (Corpus Christie reports to Austin)					
Activity	**2-Oct**	**2-Nov**	**2-Dec**	**3-Jan**	**TOTAL**
Baggage (1039A)	0	0	0	0	0
Aircraft (1039B)	0	0	0	0	0
TOTAL	0	0	0	0	0

Land Border - El Paso					
Activity	**2-Oct**	**2-Nov**	**2-Dec**	**3-Jan**	**TOTAL**
Meat/Poultry Product (Vehicle) (1072A)	555	502	573	0	1630
Meat/Poultry Product (Pedestrian) (1072B)	72	61	84	0	217
Meat/Poultry Product (Cargo) (1072C)	6	0	0	0	6
Meat/Poultry Product (Commercial Bus) (1072D)	43	47	55	0	145
Meat/Poultry Product (Coop) (1077)	10	6	2	0	18
Vehicle (1074A)	102	75	85	0	262
TOTAL	788	691	799	0	2278
Land Border - Laredo					
Activity	**2-Oct**	**2-Nov**	**2-Dec**	**3-Jan**	**TOTAL**

Meat/Poultry Product (Vehicle) (1072A)	1007	506	0	0	1513
Meat/Poultry Product (Pedestrian) (1072B)	184	84	0	0	268
Meat/Poultry Product (Cargo) (1072C)	0	0	0	0	0
Meat/Poultry Product (Commercial Bus) (1072D)	108	39	0	0	147
Meat/Poultry Product (Coop) (1077)	0	0	0	0	0
Vehicle (1074A)	0	4	0	0	4
TOTAL	1299	633	0	0	1932
Land Border - Eagle Pass					
Activity	**2-Oct**	**2-Nov**	**2-Dec**	**3-Jan**	**TOTAL**
Meat/Poultry Product (Vehicle) (1072A)	121	514	181	0	816
Meat/Poultry Product (Pedestrian) (1072B)	0	0	0	0	0
Meat/Poultry Product (Cargo) (1072C)	0	0	0	0	0
Meat/Poultry Product (Commercial Bus) (1072D)	6	7	0	0	13
Meat/Poultry Product (Coop) (1077)	0	0	3	0	3
Inedible Animal Product Vehicle (1074A)	22	43	14	0	79
TOTAL	149	564	195	0	911
LAND BORDER GRAND TOTAL					**5121**

Survey Figures

Figure 3.42

14-question domestic swine producer's survey.

Domestic Swine Producers' Survey

1. What do you feel could be the most damaging threat to your herd (circle one)?

    a)Foot and Mouth Disease

    b)Pseudorabies

    c)Classical Swine Fever/Hog Cholera

    d)Other

    If other, please list main concern? ________________________

2. Have you traveled internationally in the past year?

    Yes____ No____

    If no, skip to question 5

    If yes, which countries have you visited?

    ____

    If yes, did you visit a farm?

    Yes____ No____

    If yes, did you have contact with livestock on the premise?

    Yes____ No____

    If yes, were foot-baths (mats) present at the US airport or border crossing where you entered and exited the country?

    Yes____ No____Don't know _________

3. At your point of entry into the U.S. were you subjected to an inspection of your person and/or luggage for agricultural products (i.e. meat, plants, exotic insects, etc.)?

Yes___ No___

4. At your point of entry into the U.S. were you provided information on precautions to take if you planned to visit a farm once you had re-entered the United States from a foreign country?

Yes___ No___

5. Have any of your employees traveled internationally in the past year?

Yes____ No____Don't Know____

If yes, did they visit a farm?

Yes____ No____Don't know___

If yes, in what countries were the farms located? ______________

____

6. Have you bought any agricultural, meat, or biological products from a foreign country in the past year?

Yes____ No____Don't know____

If yes, did any of the products come in contact with swine?

Yes____ No____Don't know____

7. What precautions are used to prevent introduction of disease into your herd by workers or visitors? (Circle all that apply)

a)Shower in/shower out b)Foot bath

c)Barn clothing provided d)Restricted Visitors

e)Sign in logs f)Other________________________

8. Have you seen wild hogs on your property in the past year?

Yes____ No____

9. Do any of your employees raise swine?

Yes____ No____Don't Know____

10. Are you a licensed swill (waste food) feeder?

Yes____ No____

11. What type of operation do you run?

a)Farrow to finish b)Farrow to Wean

c)Weaner or Feeder/finisher d)Breeding

e)Other (Please specify)________________________________

12. What is the size of your operation? (Current number of swine on premises)

a) 0-500 b) 501-1000

c) 1001-5000 d) 5001-10000

e)Other (Please specify)________________________________

13. How many employees do you have?

a)0-5 b)6-10 c)11-20 d)21 or more

14. What state(s) is/are your operation located in? ________________________
____

Figure 3.43 States where survey participants lived or ran swine operations and the number of participants from each out of the 970 total participants.

State	Number	State	Number	State	Number
AK	1	KY	23	NY	11
AL	7	LA	2	OH	76
AR	9	MA	1	OK	23
AZ	1	MD	6	OR	1
CA	7	ME	3	PA	20
CO	13	MI	26	RI	1
CT	1	MN	118	SC	8
DE	1	MO	88	SD	54
FL	3	MS	2	TN	11
GA	6	MT	10	TX	16
HI	2	NC	22	UT	3
IA	162	ND	13	VA	6
ID	11	NE	70	WA	3
IL	62	NH	1	WI	40
IN	50	NJ	1	WV	2
KS	18	NV	2	WY	2

Figure 3.44
Countries visited by survey participants in the past year and the number of participants who visited each. (Total number of participants who visited a foreign country in the past year = 119).

Country	Number	Country	Number	Country	Number
Argentina	2	France	3	St. Lucia	1
Aruba	1	Germany	3	Sweden	2
Asia	1	Greece	1	Switzerland	1
Australia	3	Holland	1	Taiwan	2
Bahamas	1	Hondouras	1	Thailand	3
Barbados	1	HongKong	2	UK	6
Belgium	2	Hungary	1	Vietnam	1
Belize	1	Ireland	1		
Brazil	10	Italy	2		
Br. VirginIslands	1	Jamaica	5		
Canada	27	Japan	6		
Carribean	2	Korea	1		
Chile	1	Mexico	27		
China	5	NewZealand	1		
Colombia	2	Peru	1		
CostaRica	2	Philippines	1		
Curacao	1	Puerto Rico	1		
Denmark	3	Romania	1		
Ecuador	2	Russia	2		
Egypt	1	SouthAfrica	1		
England	1	SouthAmerica	1		

Figure 3.45
Swine population and number of operations in specific population ranges.

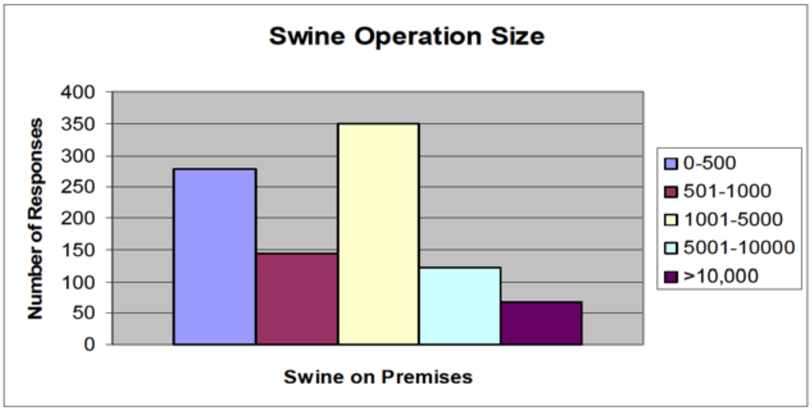


Figure 3.46
Type of swine production operations owned or operated by survey participants.

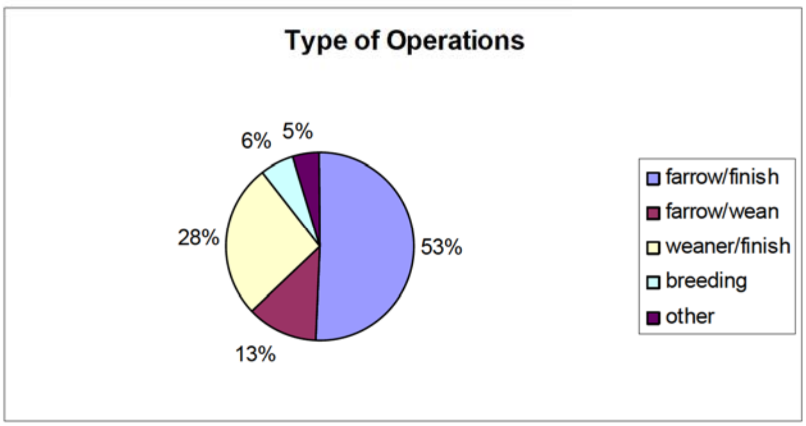


Figure 3.47
Number of employees per swine operation participating in survey.

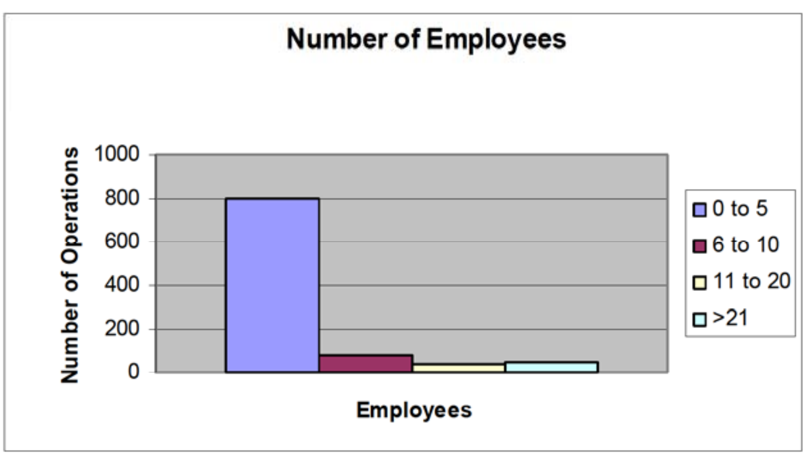


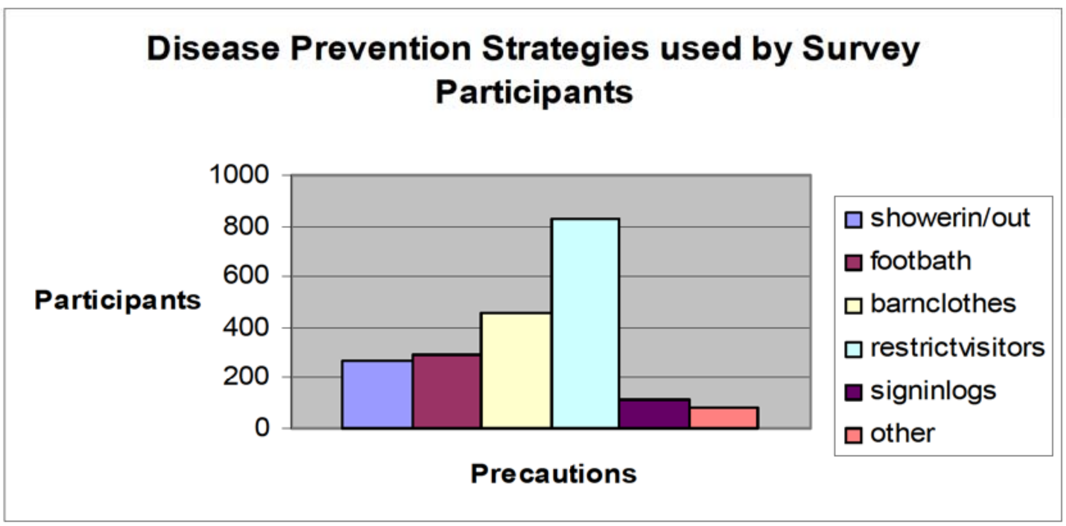
Figure 3.48

Countries visited by employees of survey participants in the past year and the number of employees who visited each. (Number of employees who traveled internationally in the last year = 60).

Country	Number	Country	Number	Country	Number
Austria	1	France	2	Philippines	1
Belgium	1	Germany	3	Poland	2
Brazil	2	Guatemala	1	Romania	1
Canada	3	Hungary	1	South Africa	3
China	2	Ireland	1	Switzerland	1
Cuba	1	Japan	1	Thailand	1
Czech.Republic	2	Mexico	9		
Denmark	2	Netherlands	1		

Figure 3.49

Disease prevention strategies used in survey participants.



Chapter 4 Figures

Figure 4.1
Flow chart of breeding pig movements.

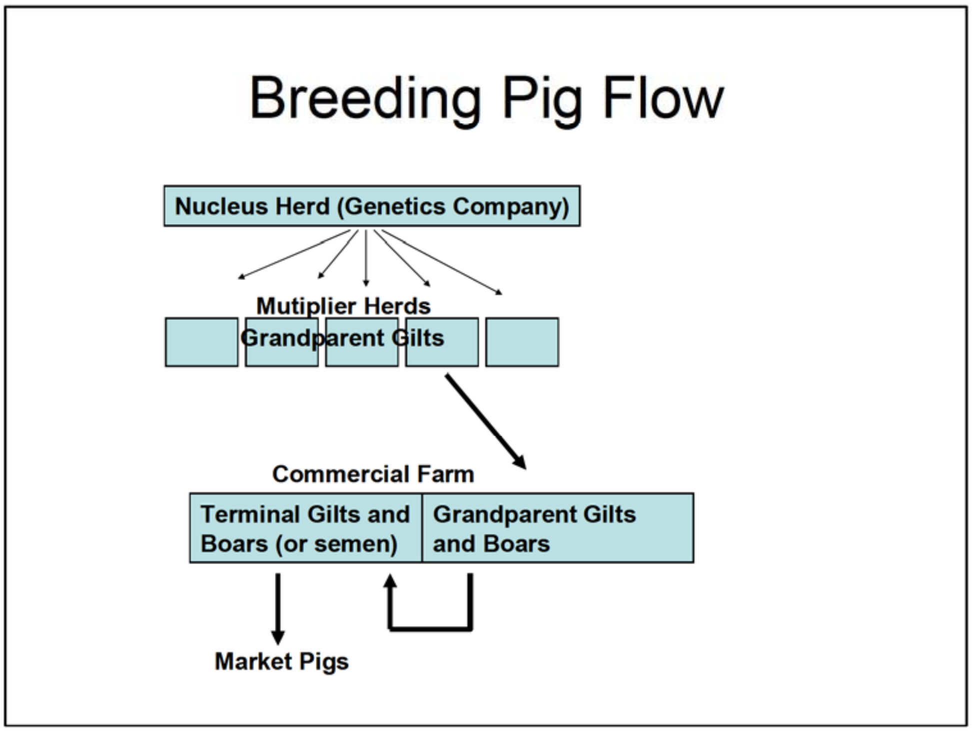


Figure 4.2
Percent of litters sired by artificial insemination.

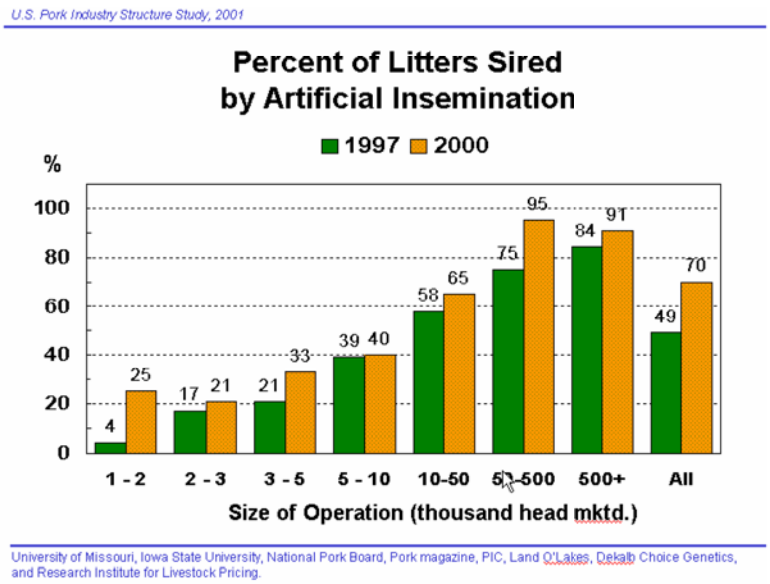
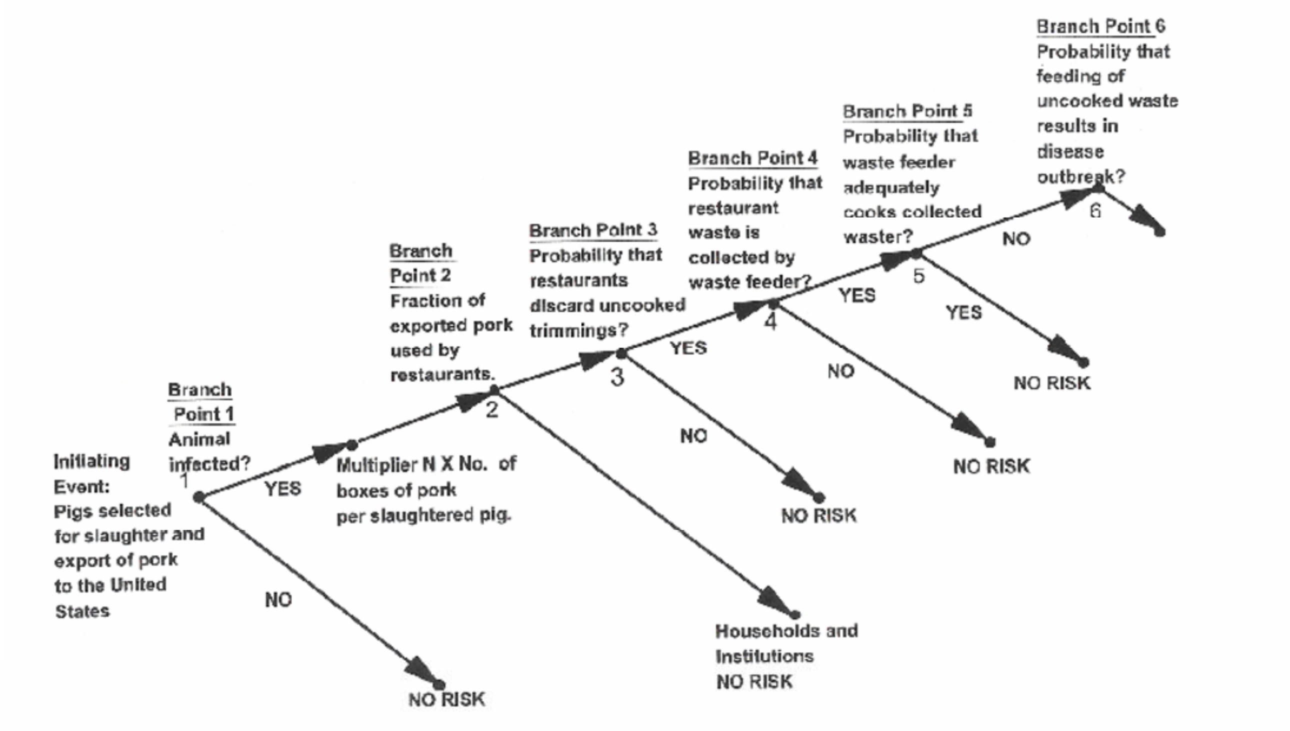


Figure 4.3
Results of Survey of Waste Feeder Premises, 2001

	No. of premises	Ave Herd Size	Median Herd Size	Range of Herd Size
Arkansas	32	33	21	1 - 203
Hawaii	170	53	26	2 - 340
Maine	6	58	34	12 - 123
N. Carolina	62	46	26	1 - 232
N Hampshire	8	105	38	9 - 390
N. Jersey	23	342	150	6 - 3550
Ohio	6	2,882	2,200	200 – 6,500
Oklahoma	51	18	10	5 - 58
Pennsylvania	4	392	415	39 - 700
Puerto Rico	1,393	36	17	1 - 972
Rhode Island	9	76.5	72.5	22 - 150
Texas	596	51	25	1 – 1,846
W. Virginia	11	19.8	20	2 - 43

Figure 4.4

Scenario tree of the pathway for potential importation of CSF into the United States – Pork Model.



Source: USDA/APHIS: Risk analysis for importation of Classical Swine Fever Virus in Swine and Swine Products from the European Union, December 2000 (http://www.aphis.usda.gov/vs/ncie/swine_manual/index.html)

Figure 4.5

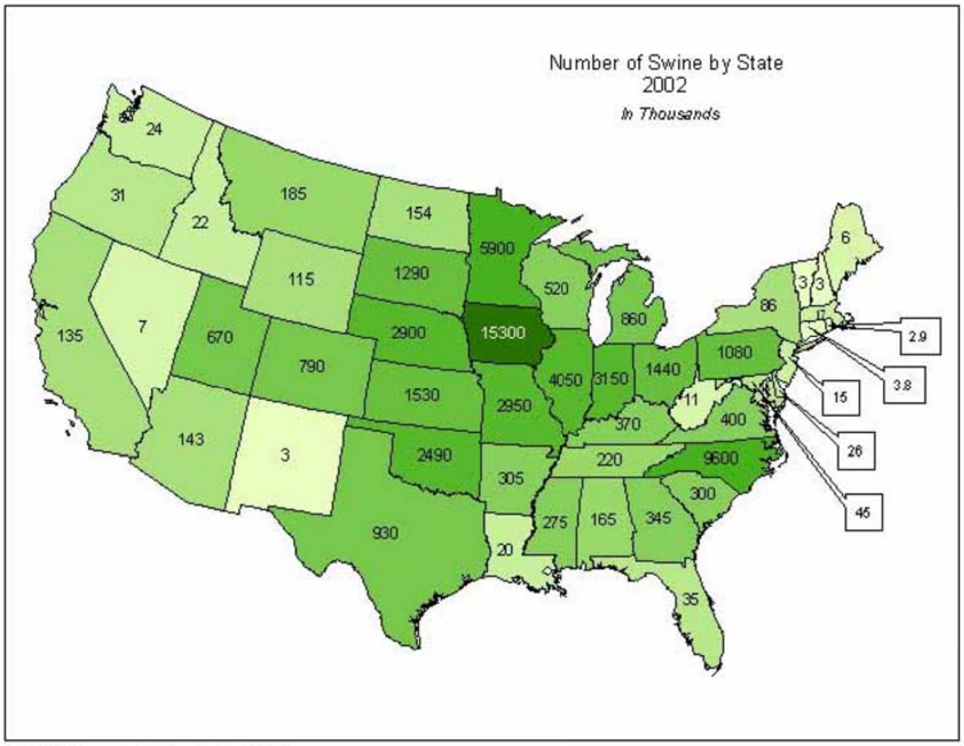
Distribution of swine in the United States by state, 2001-2002.

State	Operations		Number		Value			
	2001	2002 [1]	2001	2002 [1]	Value per head		Total value	
					2001	2002 [1]	2001	2002 [1]
	Number	*Number*	*Thousands*	*Thousands*	*Dollars*	*Dollars*	*1,000 dollars*	*1,000 dollars*
AL	300	300	195	165	76	70	14,820	11,550
AK	50	40	1.0	1.2	160	170	160	204
AZ	200	180	133	143	83	76	11,039	10,868
AR	1,100	1,000	580	305	63	68	36,540	20,740
CA	850	750	110	135	100	92	11,000	12,420
CO	400	390	800	790	92	74	73,600	58,460
CT	200	220	3.5	3.8	100	92	350	350
DE	130	130	26.0	22.0	74	68	1,924	1,496
FL	1,500	1,400	35.0	35.0	80	74	2,800	2,590
GA	900	1,000	315	345	68	63	21,420	21,735
HI	230	230	27.0	24.0	140	140	3,780	3,360
ID	400	400	24.0	22.0	78	72	1,872	1,584
IL	5,300	4,600	4,250	4,050	79	71	335,750	287,550
IN	4,000	3,400	3,200	3,150	78	74	249,600	233,100
IA	10,500	10,000	15,400	15,300	83	75	1,278,200	1,147,500
KS	1,500	1,500	1,570	1,530	73	65	114,610	99,450
KY	1,300	1,200	405	370	63	54	25,515	19,980
LA	600	580	26.0	20.0	83	76	2,158	1,520
ME	400	400	6.5	6.0	83	76	540	456
MD	520	510	52.0	45.0	76	70	3,952	3,150
MA	400	400	18.0	16.5	83	76	1,494	1,254
MI	2,500	2,300	960	860	84	80	80,640	68,800
MN	6,500	6,200	5,800	5,900	90	85	522,000	501,500
MS	1,600	1,500	285	275	82	75	23,370	20,625
MO	3,100	2,800	3,000	2,950	68	61	204,000	179,950
MT	550	500	170	185	80	74	13,600	13,690
NE	3,400	2,900	2,900	2,900	84	75	243,600	217,500
NV	100	100	7.0	6.5	100	92	700	598
NH	250	270	3.5	3.2	91	84	319	269
NJ	400	300	13.0	15.0	91	84	1,183	1,260
NM	400	400	3.0	3.0	83	76	249	228
NY	1,400	1,300	75.0	86.0	76	70	5,700	6,020
NC	3,400	3,200	9,800	9,600	62	58	607,600	556,800
ND	700	600	154	154	80	74	12,320	11,396
OH	4,900	4,500	1,430	1,440	79	76	112,970	109,440
OK	2,700	2,600	2,480	2,490	65	59	161,200	146,910
OR	1,000	1,000	29.0	31.0	83	76	2,407	2,356
PA	2,900	2,900	1,060	1,080	69	67	73,140	72,360
RI	50	50	2.5	2.9	80	74	200	215
SC	700	600	320	300	64	58	20,480	17,400
SD	1,600	1,500	1,290	1,290	83	77	107,070	99,330
TN	1,500	1,300	225	220	66	61	14,850	13,420
TX	4,000	3,800	900	930	71	62	63,900	57,660
UT	500	400	610	670	83	76	50,630	50,920
VT	250	300	2.5	2.5	100	92	250	230
VA	1,100	1,100	415	400	60	59	24,900	23,600
WA	750	750	24.0	24.0	91	84	2,184	2,016
WV	1,000	1,100	11.0	11.0	80	74	880	814
WI	2,700	2,300	540	520	70	68	37,800	35,360
WY	150	150	117	115	91	84	10,647	9,660
US	80,880	75,350	59,804	58,943	77	71	4,589,912	4,159,643

[1] Preliminary. Totals may not add due to rounding
NASS, Livestock Branch, (202) 720–3570.

Source: NASS Livestock Statistics 2003, http://www.usda.gov/nass/pubs/agr03/03_ch7.pdf

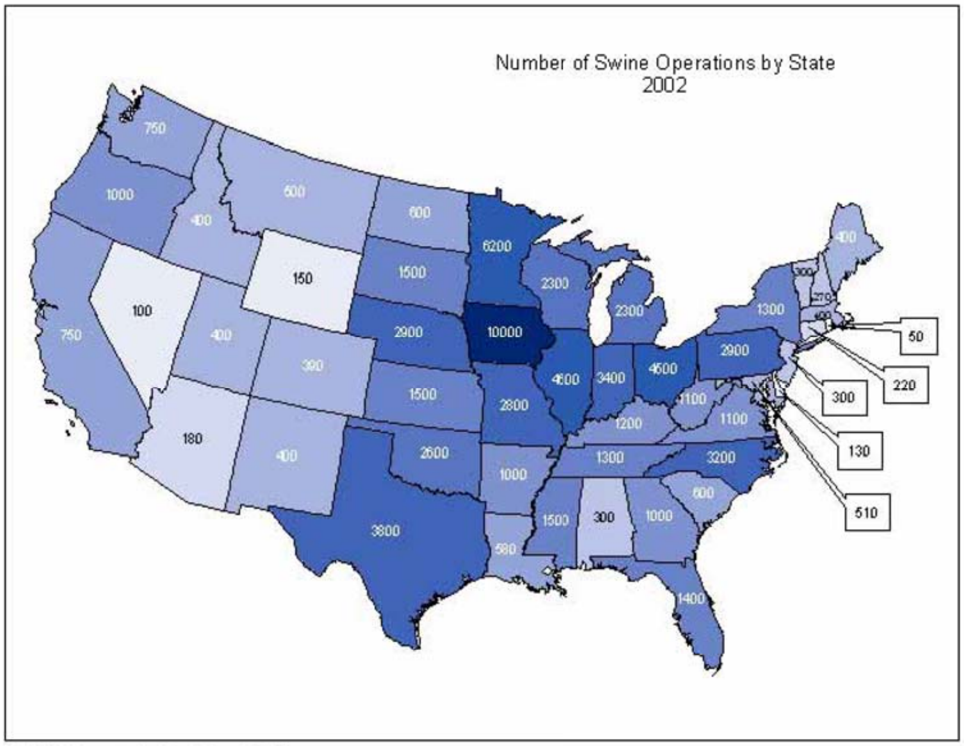
Figure 4.6
Distribution of Swine by State, 2002.



NASS Livestock Statistics 2003

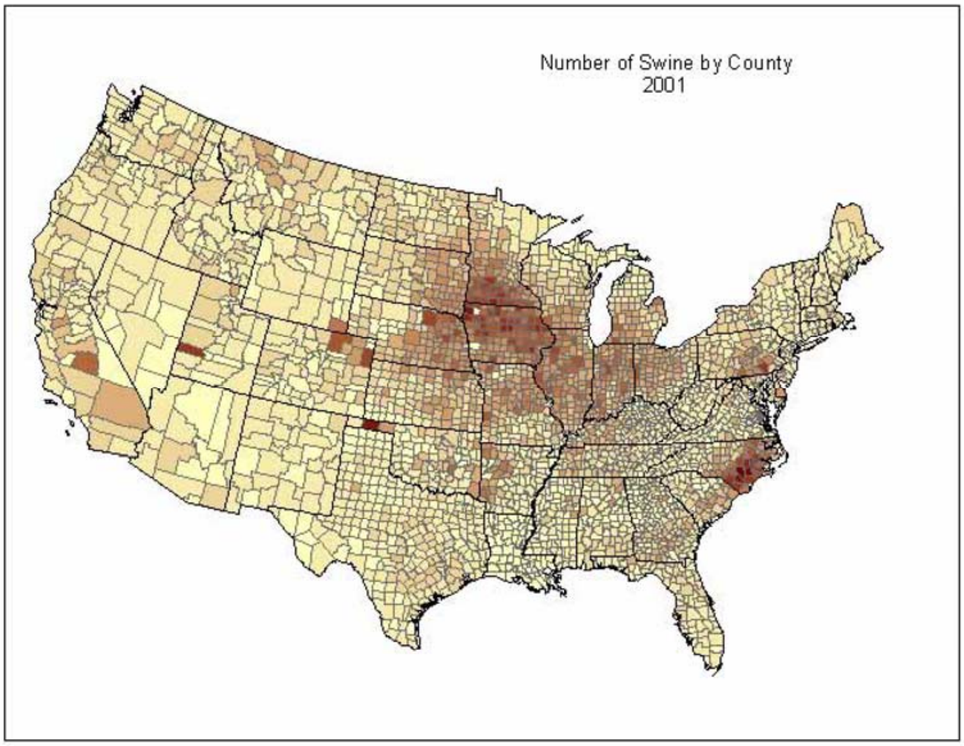
Figure 4.7

Distribution of swine operations by state, 2002.



NASS Livestock Statistics 2003

Figure 4.8
Distribution of swine by county, 2002.



Animal and Plant Health Inspection Service 2001

Figure 4.9
Overview of infection routes for CSF in Netherlands 1997/98

Transport	24%
Neighborhood	39%
Persons	15%
Unknown	11%
Artificial Insemination	8%
Animal	2%
Manure	1%

Quoted by Merks J.W.M. 2001 from Crisis Center Swine Fever Epidemiology Department, Uden

Figure 4.10
Carrol County Swine Premises.

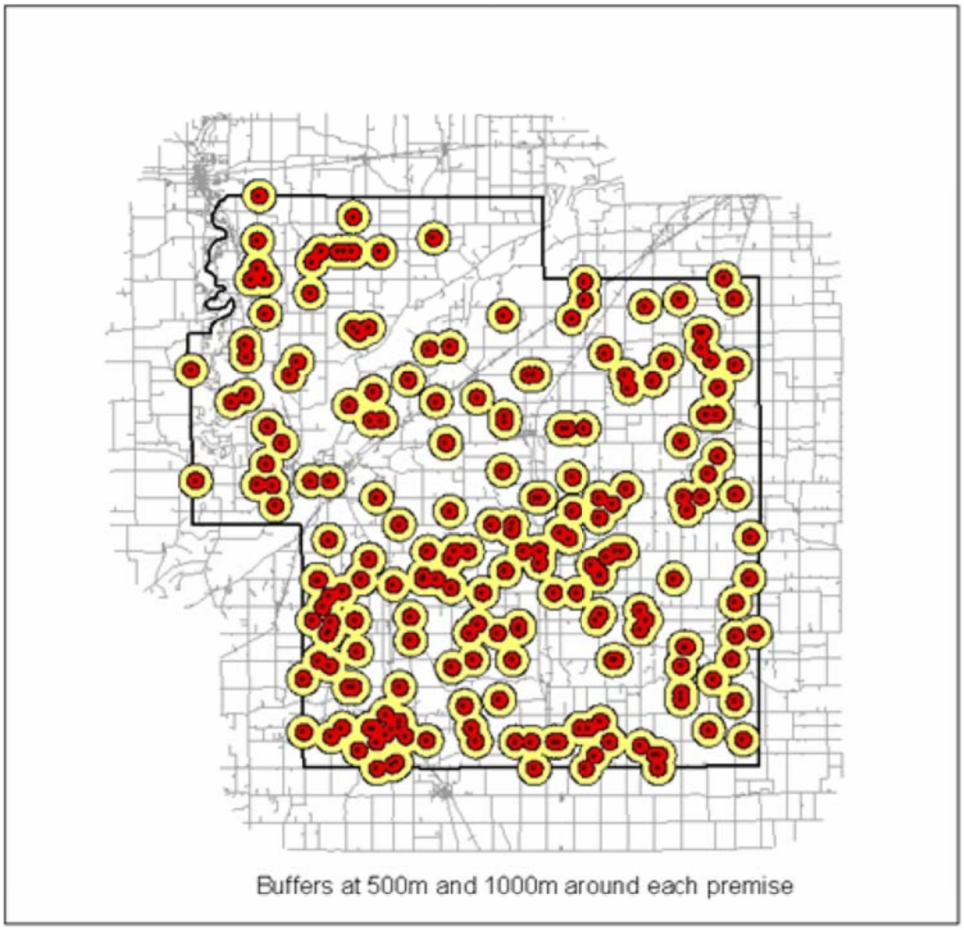


Figure 4.11
Densigy of Swine Premises in Carroll County.

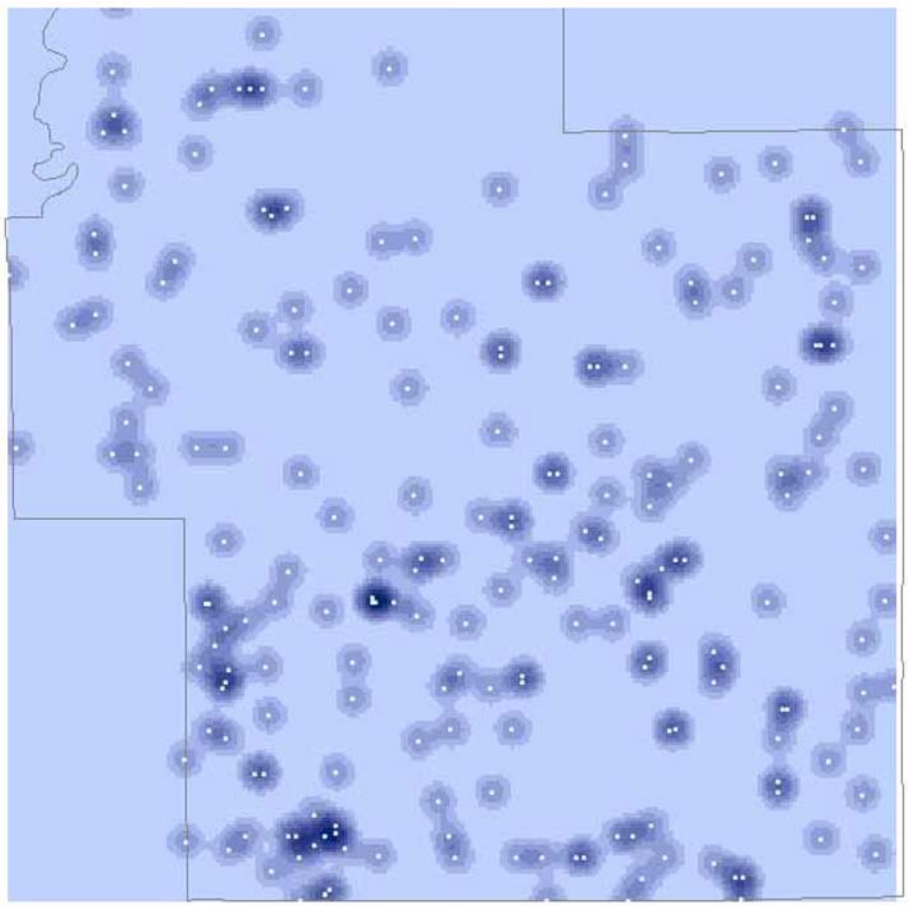


Figure 4.12

Categorization of Swine Premises by Distance to Nearest Neighbor.

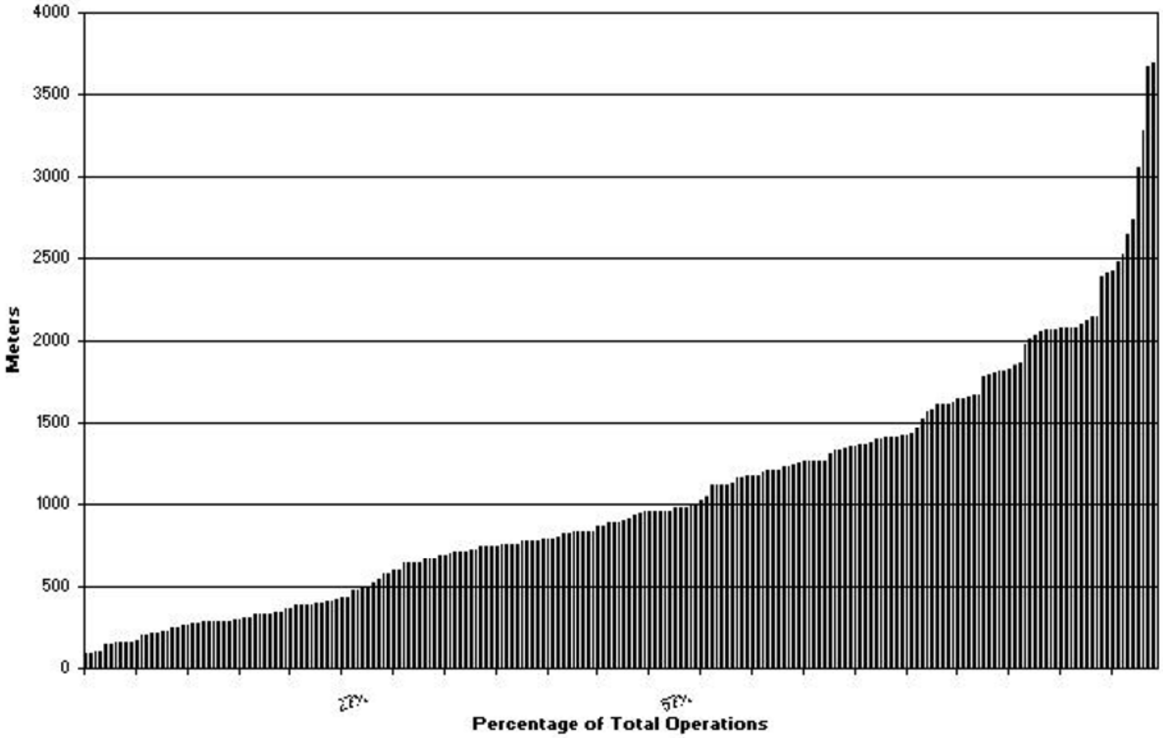


Figure 4.13
Swine Premises in Carroll County Indiana.

Total Premises	209
CFO	112
Non-CFO	97
Density of swine premises per sq km	0.21 5
Total Swine	255, 176
Percentage of total swine premises	
with a nearest neighbor within 0.5 km	27%
with a nearest neighbor within 1 km	57%
Percentage of CFO premises	
with a non-CFO nearest neighbor within 0.5 km	20%
with a non-CFO nearest neighbor within 1 km	41%
Percentage of CFO premises	
With a CFO nearest neighbor within 0.5 km	9%
with a CFO nearest neighbor within 1 km	26%

Figure 4.14
Percent of sites* requiring cleaning and/or disinfection of livestock trucks and trailers.

	Percent Sites			
	Size of Site (Total Inventory)			
Required Practices	Small (Less than 2,000)	Medium (2,000-9,999)	Large (10,000 or More)	All sites
Clean inside of truck	58.2	87.7	96.3	65.4
Disinfect inside of truck	37.2	77.1	90.5	47.0
Clean outside of truck	46.9	77.0	91.4	54.4
Disinfect outside of truck	25.6	59.2	68.9	33.8

*For sites that allowed trucks or trailers transporting livestock onto the pig site.

Source: APHIS Info Sheet: Biosecurity and Health Management on U.S. Swine Operations, Feb 2003

Figure 4.15
Percent sites where all swine buildings were constructed to keep out cats, or rats and mice (by size of site).

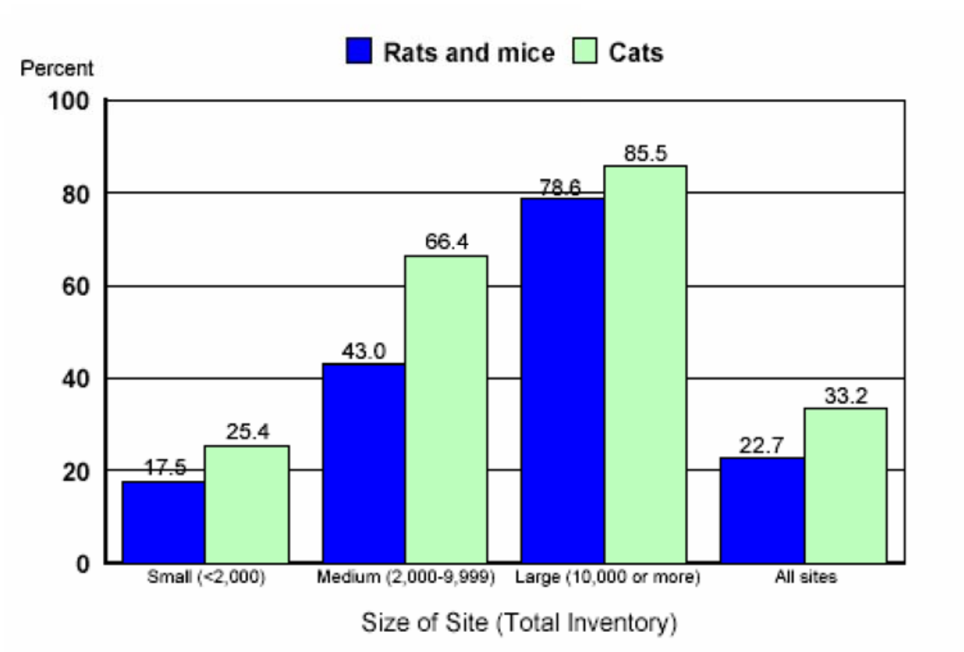


Figure 4.16
Native range of the Eurasian wild boar (Huffman, 2003).

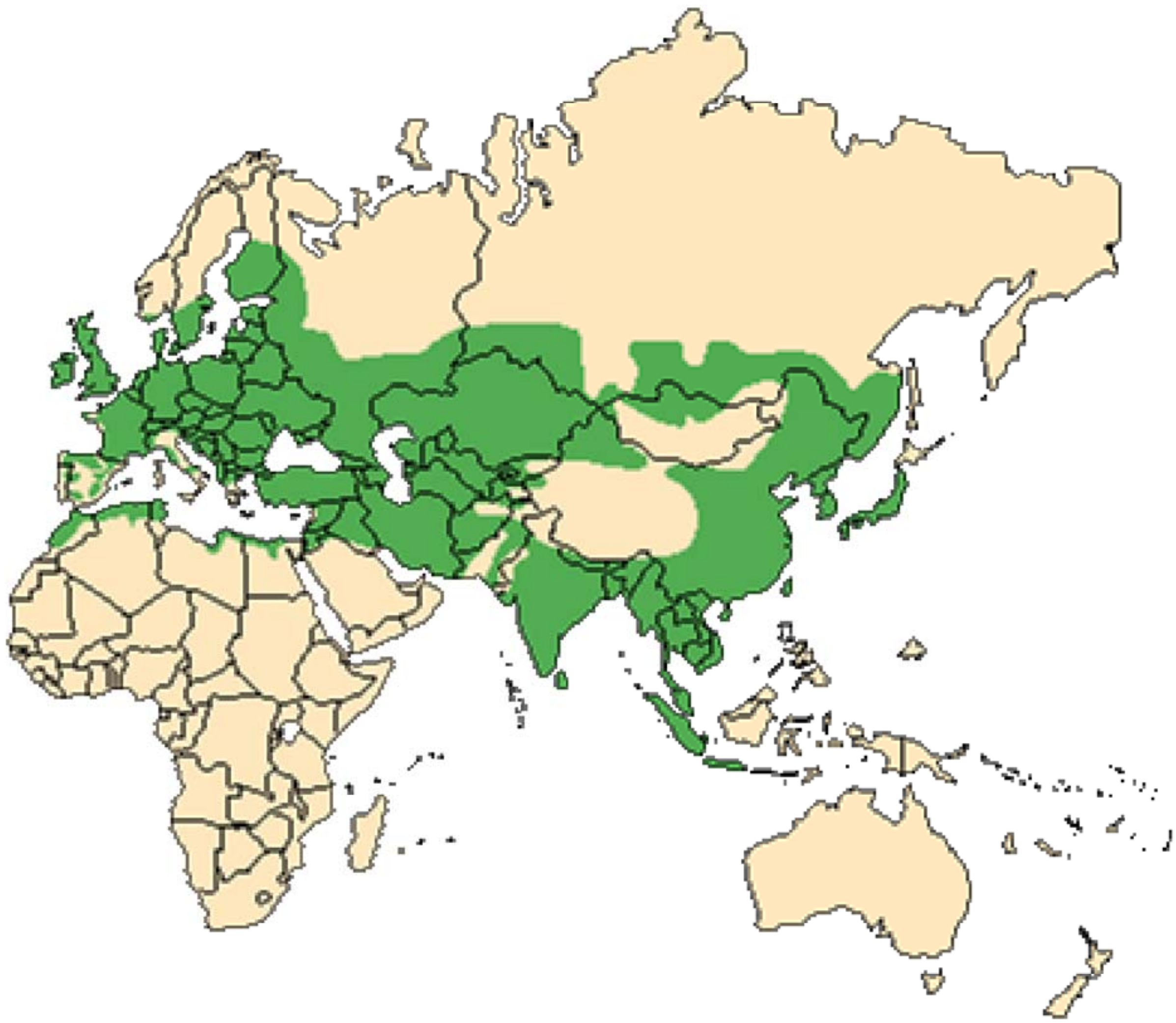


Figure 4.17

Wild swine distribution in the United States. Data used to develop this map was provided by the Southeastern Cooperative Wildlife Disease Study of 1988.

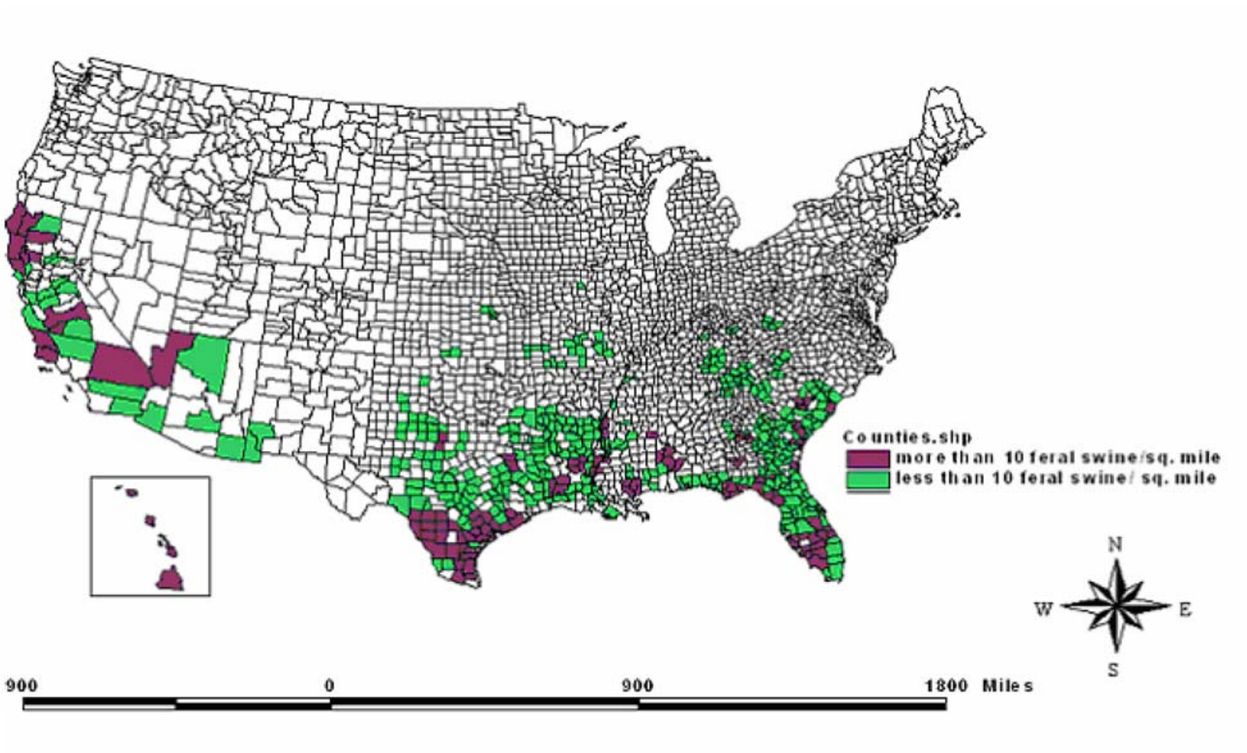


Figure 4.18
Surveys conducted to estimate the wild pig population within the U. S.

Year	Group	Methods	Source	Contact
1982	SCWDS	Survey and telephone interviews of state wildlife and livestock officials	http://www.scwds.org Wildlife Health Building College of Veterinary Medicine University of Georgia Athens, Georgia 30602 (706) 542-1741 fax (706) 542-5865 Personal Communication	Dr. Joe Corn
1988	SCWDS	Survey of telephone interviews state wildlife and livestock officials	http://www.scwds.org Personal Communication	Dr. Joe Corn
1991	MBAH	Paper survey sent to state wildlife and livestock officials in the 50 states	United States Department of Agriculture-Animal and Plant Inspection Service-Veterinary Services http://www.bah.state.mn.us/ 90 West Plato Boulevard, St. Paul, MN 55107. 651-296-2942	T. L. Clouse-USDA-VS
1999	SRNF	Incorporated data from the 1988 SCWDS survey, and also conducted telephone interviews with state wildlife and livestock officials in Oklahoma and Texas	http://www.noble.org/Ag/Wildlife/FeralHogs/03-Current.htm The Noble Foundation 2510 Sam Noble Parkway Ardmore, OK 73401 Personal Communication	R. L. Stevens
2002	TWP	Aircraft counts, slaughter plant numbers, spotlight surveys, telephone interviews of wildlife biologists, and reports. Somewhat based upon Texas white-tail deer population survey numbers.	Texas Wildlife and Parks Wildlife Biology-Uvalde station, P.O. Box 5207,Uvalde, TX 78801 http://www.tpwd.state.tx.us/conserve/wildlife_management/ southtx_plain/counties/uvalde.phtml Personal Communication	R. L. Taylor
2002	CDFG	Population estimation from hunter harvest information	http://www.dfg.ca.gov 1416 Ninth Street Sacramento, California 95814 Phone: (916) 445-0411 Fax: (916) 653-1856 Personal Communication	D. Updike

SCWDS = Southeastern Cooperative Wildlife Disease Study
MBAH = Minnesota Board of Animal Health
SRNF = Samuel Roberts Noble Foundation
TWP = Texas Wildlife and Parks
CDFG = California Division of Fish and Game

Figure 4.19
Wild and domestic swine distribution throughout the United States. The Southeastern Cooperative Wildlife Disease Study of 1988 provided information on wild swine populations while the NASS data on swine industry in the year 1997 was used to portray the US swine industry.

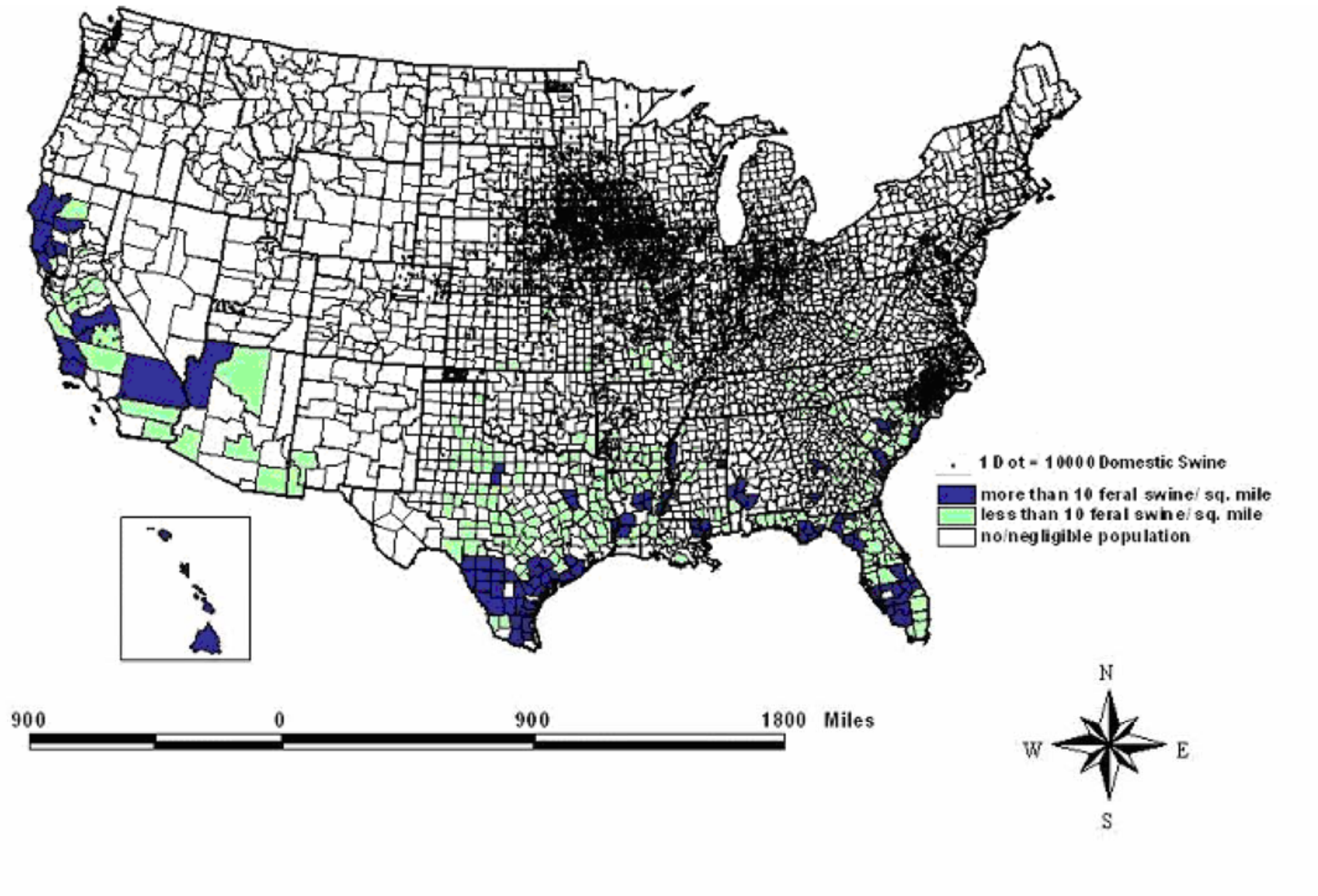


Figure 4.20
Javelina population distribution from Southeastern Cooperative Wildlife Disease Study survey conducted in 1982 (http://www.scwds.org/).

Chapter 5 Figures

Figure 5.1

Laboratory capacity / turnaround time within the United States

Test	Responder	Capacity per day	Turnaround time	Misc. information
FAT	Federal	50/day	24-36 hours	- Used in conjunction with the Monoclonal Antibody (ABC) test
	State	100/day		
Virus Isolation	Federal	50/day	72 hours	
	State	20/ day		
Elisa Antibody Assay	Federal	1,000/day		- 24 hour incubation period to be added into account
	State	1,000/day		Maximum would be 10,000- 15,000 samples per week
Real- time PCR	Federal	1,000/day	5 hours	
	State	300/day w/robot 100/day no robot		

Figure 5.2

Number of individuals we currently have that can accurately diagnose CSF

Responder	Number of individuals who can accurately diagnose CSFV within this laboratory	Number of individuals to run tests
Federal	12	
State	4 but they are working on teaching 2 more individuals	FAT: 2-3 people VI : 1-2 people PCR: 1-2 Real-Time PCR: 0 (?) may have changed since last summer
State		10

Figure 5.3
Responses to Survey.

Laboratory number	Labs ability to run real-time PCR for CSFV	Number of trained Individuals	Expected Date to have bio-level 3 lab built	Best diagnostic tool used to diagnose CSFV
1	None	0	31-Nov-03	Real-time PCR
2	None	0	N/R[1]	Real-time PCR
3	None	0	N/R	Real-time PCR
4	None	0	30-Jul-03	Real-time PCR
5	None	0	30-Jul-03	Real-time PCR
6	Yes	5	23-Jul-08	Real-time PCR
7	None	0	31-Dec-03	N/R
8	None	0	31-Apr-04	Real-time PCR

[1]N/R- No Response

Chapter 6 Figures

Figure 6.1

Characteristics of some common disinfectants (Russell and Hugo, 1987).

Characteristic	Chlorine	Iodine	Quaternary Ammonium	Phenol	Cresol
Irritating	+	+/-	-	+	+
Staining	+	+/-	-	-	+
Residual	-	+/-	+	slight	+
Corrosive	+	+/-	-	slight	+
Active in Organic Matter	-	-	+	+	+
Volatile	+	+/-	+	-	-
Expense	low	mod	mod	mod	high

Figure 6.2
Spectrum of activity, brand name, and use of common disinfectants (Quinn, 1987).

.	Chlorine	Iodine	Quaternary Ammonium	Phenol	Cresol
Spectrum of Activity G+	+	+	+	+	+
Spectrum of Activity G-	+	+	slight	+	+
TB	slight	slight	-	slight	slight
Spores	slight	slight	-	-	-
Fungi	+	+	slight	slight	slight
Viruses	slight	slight	slight	slight	slight
Uses	clean equip.	clean equip.	clean equip.	equip. premise, foot-baths	equip. premise, foot-baths
Brand Names	Clorox	Beta-dine	Zephiran Germex	Environ	Lysol

Figure 6.3
Vaccination technologies currently available to control classical swine fever.

Vaccination Technologies

First Generation Vaccines

Vaccine Type	Examples	Disadvantages	Advantages	Reference
Killed Vaccine	Crystal Violet	Efficacy is not considered sufficient for desirable protection	none	(Sanchez-Vizciano, 2001)
Modified Live Vaccine*	Lapinized Chinese (C) strain	costs more to produce than MLV's**, cannot distinguish serologically from field-strain viruses	most widely used vaccine regimen, efficacy is considered excellent	(European Commission, 2003; Gregg, 2002; OIE,)
Modified Live Vaccine**	Japanese GPE - strain, French Thiverval strain	cannot distinguish serologically from field-strain viruses	cheaper to produce than Chinese-strain, efficacy is considered excellent	(European Commission, 2003; Gregg, 2002; OIE,)

*-denotes animal origin (virus prepared from a series of passages within non-natural host to attenuate) **-denotes cell culture origin

Second Generation Vaccines

Vaccine Type	Examples	Disadvantages	Advantages	Reference
Recombinant Vaccine	rPAV (recombinant porcine adenovirus) & rPRV (recombinant pseudorabies virus) expressing CSFV E2	relatively new technologies, not available commercially and if they were they would be more expensive to produce, possibility of reversion to virulent form	efficacious, allows for serological discrimination from field strain viruses and in some instances provides protection against more than one disease (PRV)	(Hammond et al., 2000; Hooft van Iddekinge, B.J.L. et al., 1996; Peeter, Bienkowska-Szewczyk, Hulst, Gielkens, & Kimman, 1997; Van Zijl et al., 1991)

Chimeric Vaccine	flc9 & flc11 chimeric C-strain CSFVs expressing BVDV E2 and E^{rns} glycoproteins respectively	relatively new technologies, not available commercially and if they were they would be more expensive to produce, possibility of reversion to virulent form	efficacious, allows for serological discrimination from field strain viruses and in some instances provides protection against more than one disease (BVDV)	(De Smit, Van Gennip, Miedema, & Van Rijn, 2000; De Smit, Bouma, Van Gennip, De Kluijver, & Moorman, 2001; van Gennip, van Rijn, Widjojoatmodjo, de Smit, & Moorman, 2001)
DNA Vaccine	naked DNA espression plasmids encoding CSFV E2 glycoprotein	found to be not as efficacious as modified live vaccination in many studies, many are dependent on dosage, method and administration site	when used within a prime boost strategy along with rPAV they are found to provide excellent protection	(Andrew et al., 2000; Hammond et al., 2001; Markowska-Daniel, Collins, & Pejsak, 2001; Xinglong et al., 2001)
Subunit Vaccine	E2 subunit	elicits immunogenic response later than live-attenuated vaccines, controversy over prevention of transmission in many studies	commercially available, safe, efficacious against clinical manifestation, and allows for serological discrimination from field strain viruses	(De Smit, 2000; De Smit, Bouma, De Kluijver, Terpstra, & Moorman, 2001; Dewulf, Laevens, Koenen, Mintiens, & De Kruif, 2002; Dewulf, Laevens, Koenen, Mintiens, & de Kruif, 2002; Terpstra, 2000; van Oirschot, 1999; Van Rijn, Bossers, WEnsvoort, & Moorman, 1996; Van Rijn, Van Gennip, & Moorman, 1999)

Future Generation Vaccines

Vaccine Type	Examples	Disadvantages	Advantages	Reference
Synthetic Peptide Vaccine	E2 epitopes	N/A	N/A	(Sanchez-Vizciano, 2001)
Anti-Idiotype Vaccine	N/A	N/A	N/A	(Sanchez-Vizciano, 2001)

APPENDIX 3.1. SWINE PRODUCERS SURVEY

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As part of the foreign animal disease (Classical Swine Fever) pathway analysis, a survey was developed by the National Agriculture Biosecurity Center Consortium at Kansas State University with cooperation by the National Pork Board to evaluate the role pork producers in the U.S. could possibly play in the introduction and/or prevention of a FAD. In addition, producer concerns pertaining to FAD introduction, travel precautions, and border security issues were also evaluated using the survey.

The 14-question survey (fig. 3.42) was distributed by the National Pork Board to 2479 members in 48 states (fig. 3.43). National Pork Board members include swine unit owners/managers, employees, educational/extension personnel, and government officials. Swine producers were asked to complete the survey and return it to Kansas State University using the business reply envelope included in the survey packet. The survey packet contained a cover letter, copy of the survey, business reply envelope, and an entry form for a prize drawing offered as an incentive for producer participation. The results of each returned survey were entered into a Microsoft Excel database and coded in a 1=yes, 2=no, and 3=don't know format.

Of the 2,479 distributed surveys 970 were returned via business reply to KSU. The overall response rate of the survey was 39% (970/2479). Of the 970 producers responding, 12% (119/970) had traveled internationally to 52 different countries (fig. 3.44) in the past year (December 2002 – December 2003). Of producers who traveled internationally 44% (52/119) visited a farm on their travels and 75% (39/52) of the producers who traveled and visited a farm had contact with livestock. Of the producers who traveled internationally, visited a farm, and had contact with livestock on their farm visit, only 26% (10/39) responded that foot-baths were provided at their point-of-entry to the U.S. Swine producers that traveled internationally were asked if they underwent an inspection of their luggage or person for agricultural products at their point of entry, 49% (58/119) of international travelers replied that their luggage was inspected. However, only 36% (43/119) of travelers were provided with information on the proper precautions to take if they planned to visit a farm upon their return to the U. S.

Of the producers responding, 29% (278) had a herd size of 0-500 pigs, 15% (144) had a herd size of 501-1000, 36%(350) had a herd size of 1001-5000, 13% (122) had a herd size of 5001-10,000, and 7% (68) had a herd size of over 10,000 head (fig 3.45). The majority 53% (513) of the producers who participated in the survey ran farrow to finish operations, 13% (125) had farrow to wean operations, 28% (269) had wean to finish operations, 6% (58) ran breeding operations, and 5% (45) ran other types of operations with 3 no responses to this question (e.g. show, etc.) (fig. 3.46). Of the 970 participants 3% (29) had witnessed wild (feral) swine on their property in the past year. Only 1% (8) of the participating swine producers reported that they were USDA licensed swill feeders.

Of the participating swine producers 82% (797) had 0-5 employees, 8% (77) had 6-10 employees, 4% (41) had 11-20 employees, and 6% (51) had 21 or more employees working within their operation (fig. 3.47). When asked if any of their employees had traveled internationally in the past year (December 2002 – December 2003), 6% (60) said they knew that at least one of their employees had traveled internationally. Twenty-two countries were visited by employees (fig 3.48). Twenty-four (40%) respondents indicated having knowledge of at least one of their employees visiting a farm during their travel. Of the 970 respondents, 7% (63) reported that they had employees that raised swine in their own farming practices.

When asked if they knowingly had bought any agricultural, meat, or biological products from a foreign country, 5% (48/970) of the participants reported that they had bought one or more of these products from a foreign country in the past year. In addition, 23% (11/48) of the respondents who had purchased agricultural, meat, or biological from a foreign country knew that the products had come in direct contact with swine. When asked what threat they felt could be the most damaging to their herd 42% (402/956) with 14 no responses answered Foot and Mouth disease, 22% (224/956) answered Pseudorabies, 10% (98/956) answered Classical Swine Fever, and 26% (255/956) answered other threats of which Porcine Respiratory Reproductive Syndrome composed 70% (178/255). In addition, the bio-security practices of swine production operations were estimated from the survey results. The survey asked swine producers what precautions are used to prevent introduction of disease into their herd by workers or visitors. Of the 970 participants 28% (268/970) used showering in and out as a precaution, 30% (291/970) used footbaths as a precaution, 48% (459/970) mandated the use of clothing provided by the facility, 87% (832/970) restricted visitors, 12% (117/970) used sign-in logs, and 9% (83/970) used other means of precaution to prevent introduction of disease into their herds (fig 3.49). Each participant could use a multi-level approach to disease prevention and indicate all measures taken within their operation.

APPENDIX 4.1

Definitions: Animal and Premise ID numbers, Swine Production System

Abstracted from the Code of Federal Regulations Title 9, Vol. 1, Chapter 1, Part 71.1
http://www.aphis.usda.gov/vs/nahps/animal_id/cfr71/9cfr71-1.txt

Official Eartag

An identification eartag approved by APHIS as being tamper-resistant and providing unique identification for each animal. An official eartag may conform to the alpha-numeric National Uniform

Eartagging System, or it may bear a valid premises identification number that is used in conjunction with the producer's livestock production numbering system to provide a unique identification number.

Official Swine Tattoo

A tattoo, conforming to the six-character alpha-numeric National Tattoo System, that provides a unique identification for each herd or lot of swine.

Premises Identification Number

A unique number assigned by the State animal health official to a livestock production unit that is, in the judgment of the State animal health official or area veterinarian in charge, epidemiologically distinct from other livestock production units. A premises identification number shall consist of the State's two-letter postal abbreviation followed by the premises' assigned number. A premises identification number may be used in conjunction with a producer's own livestock production numbering system to provide a unique identification number for an animal.

Swine Production Health Plan

A written agreement developed for a swine production system designed to maintain the health of the swine and detect signs of communicable disease. The plan must identify all premises that are part of the swine production system and that receive or send swine in interstate commerce and must provide for regular inspections of all identified premises and swine on the premises, at intervals no greater than 30 days, by the swine production system accredited veterinarian(s). The plan must also describe the recordkeeping system of the swine production system. The plan will not be valid unless it is signed by an official of each swine production system identified in the plan, the swine production system accredited veterinarian(s), an APHIS representative, and the State animal health official from each State in which the swine production system has premises. In the plan, the swine production system must acknowledge that it has been informed of and has notified the managers of all its premises listed in the plan that any failure of the participants in the swine production system to abide by the provisions of the plan and the applicable provisions of this part and part 85 of this chapter constitutes a basis for the cancellation of the swine production health plan, as well as other administrative or criminal sanctions, as appropriate.

Swine Production System

A swine production enterprise that consists of multiple sites of production; i.e., sow herds, nursery herds, and growing or finishing herds, but not including slaughter plants or livestock markets, that are connected by ownership or contractual relationships, between which swine move while remaining under the control of a single owner or a group of contractually connected owners.

Interstate Swine Movement Report

A paper or electronic document signed by a producer moving swine giving notice that a group of animals is being moved across State lines in a swine production system. This document must contain the name of the swine production system; the name, location, and premises identification number of the premises from which the swine are to be moved; the name, location, and premises identification number of the premises to which the swine are to be moved; the date of movement; and the number, age, and type of swine to be moved. This document must also contain a description of any individual or group identification associated with the swine, the name of the swine production system accredited veterinarian(s), the health status of the herd from which the swine are to be moved, including any disease of regulatory concern to APHIS or to the States involved, and an accurate statement that swine on the premises from which the swine are to be moved have been inspected by the swine production system accredited veterinarian(s) within 30 days prior to the interstate movement and consistent with the dates specified by the premises' swine production health plan and found free from signs of communicable disease.

APPENDIX 4.2

Theoretical Basis For A Distributed, Decentralized, Animal Tracking System

This appendix describes a a massively distributed, secure, decentralized animal tracking system. The system includes an expert decision making module, tailored for different users, and incorporates backward tracking and forward projection of in contact animals and premises, based on epidemiological and transportation models.

Web-based Software for Veterinarians, Sale Barns, Producers, and Transport Companies

A major component of the proposed CSF tracking system allows veterinarians, sale barns, producers, and transport companies to obtain and enter information on suspect swine syndromes. This component will follow the design principles of Sandia National Laboratories and Kansas State University's Rapid Syndrome Validation Program for Animals (for an overview of that system, see http://philostrate.unm.edu/cgi-bin/rsvpa/rsvp_a.php http://clh.vet.k-state.edu/index.jsp):

- Web-based design supports ease of maintenance;
- Openly accessible and password-accessible sections protect data quality;
- Semi-anonymous data entry allows disease tracking while protecting private or proprietary information;
- Useful and timely information to users provides an incentive to use the system; and
- Web-page design allows users to enter and receive information with minimal effort.

Each of the user groups has different needs, and for this reason the web-based portion of the CSF tracking system will be subdivided.

Producers: Assume that a swine producer has a symptomatic pig. The producer opens his web browser, goes to a web site with secure http, and logs in. Login is essential because it must be possible to authenticate the data to a genuine member of the swine industry. Depending on acceptance by producers, the system may already contain information on what pigs are present at the operation. The producer enters the symptoms and other information, e.g., how long symptoms have been present, how many pigs are symptomatic, whether the pigs are new to the operation, etc.

Swine facilities, particularly larger operations, will commonly have one or more pigs displaying clinical signs of disease and generally manage disease at a pen, rather than individual pig, level. Therefore, the development stage of this system would need to consider the appropriate level of concern (pig versus pen) and the number of sick animals which constitutes a reportable event. This will vary by disease, and therefore by disease symptom. For illustrative purposes, we will refer to a symptomatic pig, understanding that this may represent a "group" event.

At this point the expert system analyzes three kinds of information: data in the database on disease symptomatology, data entered by the user, and recent data collected from other users. The expert system provides immediate feedback to the producer that includes a list of differential diagnoses. If any of the possible diseases are serious, the expert system could take the following steps:

- Ask the producer additional questions designed to distinguish among the possible diseases;
- Recommend the producer consult with a veterinarian and schedule an appointment with a veterinarian who has a calendar on the system, confirming that the time is acceptable to the producer; and
- Recommend what the producer should do in the meantime, e.g., quarantine, and how critical is it to perform these activities.

If the pig has symptoms of a potentially serious disease, such as CSF, the expert system will stress the importance of contacting a veterinarian.

The producer has several incentives for using the system—immediate feedback on the likelihood that his stock has a potentially serious disease, recommendations for on-farm disease management, and convenient appointment scheduling. Producers who use the system become sentinels for the expert disease-tracking system, providing data that can in turn be used to provide useful guidance to private and state veterinarians.

***Veterinarians**:* The veterinarian may be called in to examine a symptomatic pig by the tracking system or by the producer. If the tracking system has set up the appointment, it will also offer a description of the symptoms and a list of differential diagnoses consistent with the symptoms entered by the producer and recent data collected from other producers and veterinarians. The specific veterinarian contacted can be determined either by the producer or by the expert system using protocols set up in advance by individual veterinarians. When the veterinarian examines the symptomatic pig, he must make a tentative diagnosis (or collect samples for laboratory examination), estimate when the pig was exposed and how long the pig has been contagious, and suggest the source of the disease (e.g., wild pigs, on-farm infection, introduced with new pigs).

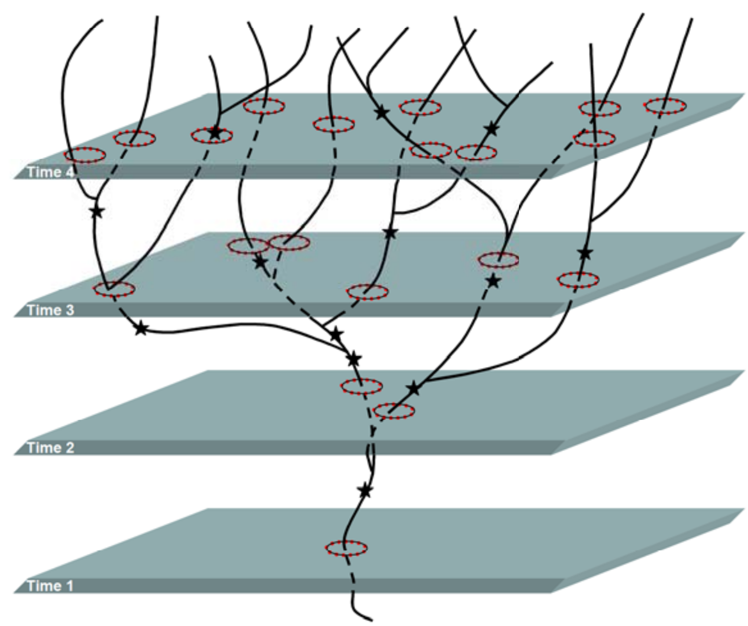

Figure 1 Schematic of hog transportation as a function of time. Red circles are animals contacted at one instance in time.

At that point the veterinarian will enter new information about the pig that supplements information previously entered by the producer. The veterinarian will have password login privileges not available to the producer. The veterinarian will be able to list the tests and examinations performed, the results, and the diagnosis. The veterinarian will be able to do a preliminary epidemiological study with the producer and the tracking system. If the pig has a potentially serious disease like CSF and was not born on this farm, the system will track the pig, let the veterinarian assess the information, and then if he agrees, notify sale barns, transport companies, the state veterinarian, etc. If he does not agree to these notifications, he should be able to justify his objections based on possible time, place, and vectors of disease transmission; enter his own assessment; and get a new analysis from the system.

The expert system should prioritize for the veterinarian the most to least likely diagnosis and the most to least likely region of an outbreak. For serious contagious diseases, this information can be delivered to other veterinarians in the region automatically.

Veterinarians benefit from using the system by knowing what diseases they are most likely to see, the likely area of impact, and what categories of pigs are most likely to be infected. Tests and treatment can be much more efficient. The state veterinarian can monitor disease progression and potentially detect and stop an epidemic in the very early stages. The tracking system can provide information on where the symptomatic pigs have been and what other pigs may have been in contact with them. This allows targeted testing, beginning with the pigs most likely to have been exposed, rather than random testing. Depending on the nature of the disease, it allows treatment or slaughter of pigs in selected areas, with testing in a ring around that. In areas where the expert system offers good confidence that no pigs can be infected because of the tracking history, normal production, sale, and transport can be allowed.

***Sale barn**:* Swine movement would be tracked in part by recording data on lots that pass through sale barns. The sale barn clerk would enter the following data for each lot of swine received:

- Lot number;
- Total number of animals in lot;
- Where it came from (best estimate);
- When it arrived;
- What areas of the sale barn it occupied (e.g., pens, auction blocks);

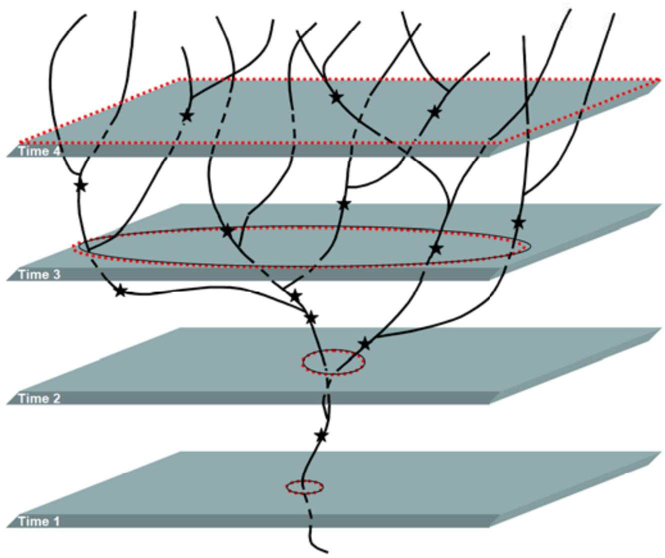

Figure 2 Determination of location and associations at previous times in a hog's life.

Traditional quarantine would require mass treatments. The red circles represent effected animals.

- When it left; and
- Where it went (best estimate).

For lots that are subdivided at sale, the information must be entered for each portion of the lot.

If swine are likely to be sick because of their prior association with sick pigs, the expert system notifies the sale barn immediately. If pigs with a serious contagious disease are tracked to the barn, the expert system offers recommendations about what to do and how critical it is to do this, e.g., shut down for some specified period of time, disinfect pens or auction blocks, call a veterinarian, notify the state veterinarian, etc.

The primary incentive for sale barns to use the system is to enhance continuity of operations. Data from the sale barns will make it possible to track each lot of swine forward and backward through time, as discussed below. This tracking, which is the core function of the expert system, enables the detection of a disease outbreak in the very early stages, while it is still possible to control the disease with minimal quarantine areas, slaughter of diseased and exposed stock, and disruption of commerce.

***Transport companies**:* Currently transport regulations do not allow separate lots of swine to be carried on the same vehicle. We suspect that it probably happens and does not get reported. Using the expert tracking system, it would be possible to safely transport separate lots together by requiring the trucker to record what animals are on the truck when. Any animals exposed to others that subsequently became sick could be tracked rapidly to their current location for observation or testing. The routing clerk would enter the following information into the system for each lot of animals:

- When and where it was loaded;
- Route and truck stops;
- When and where it was off-loaded; and
- When the truck was disinfected.

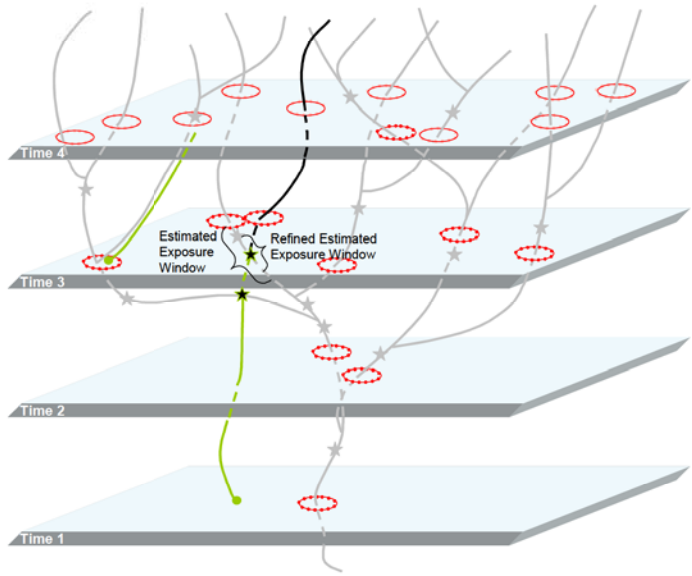

Figure 3 Quarantine area is smaller based on trace back understanding

For drivers and trucks on a regular schedule, the expert system will present the regular route for confirmation or emendation.

Transport companies gain in efficiency by transporting fewer partial loads.

PC-Based Software for Decisionmakers and Veterinarians

The web-based tracking system described above will provide information on where livestock are and have been; what pigs have which symptoms or diseases; and where symptomatic or diseased pigs have been located through time. Using this information, the software predicts what asymptomatic animals have been exposed to a pathogen and makes recommendations that are likely to stop the spread of the pathogen. It does this using two models, an epidemiological modal and a transportation model. When an animal is diagnosed with a disease, the veterinarian estimates what stage of the disease the animal is in, and (either directly or through inference using a model of the disease's progression) when the animal contracted the disease. The system uses this estimate as the starting point for a model-based search.

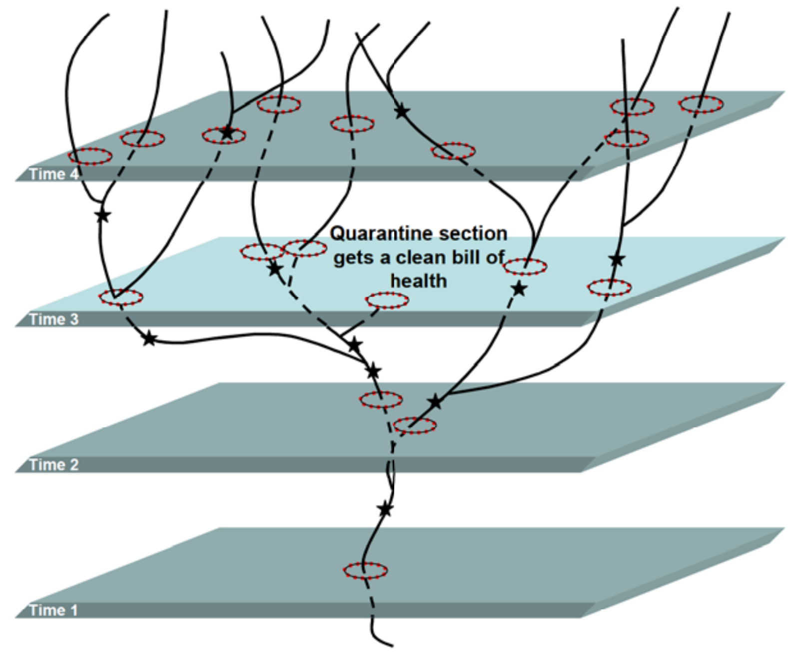

Figure 4 Identification of exposure windows based on new algorithms.

Using the veterinarian's estimates of when the primary animal contracted the disease and inferences on when it may have been contagious, the expert system uses the epidemiological model and the transportation records to track all secondary animals that were exposed to the primary animal during the infectious period. The expert system predicts when the secondary animals would have become contagious and started to exhibiting symptoms, etc. Sick animals can also be traced back to the animals that may have infected them to identify potential sources of a disease. Subsequently an estimate can be made of what other animals may have been infected by all the animals along this pathway, and this estimate can be propagated forward again to the current time. In this way feasible sources and the possible current status of a disease can be rapidly assessed.

The estimate predicts what animals should be symptomatic or asymptomatic at what times, and it assesses what pathways are isolated by choke-point vectors. This allows decisionmakers to contact producers and veterinarians so that they can rapidly confirm or disconfirm paths the disease may have taken. Producers, veterinarians, and laboratories can be prepared to diagnose animals by looking for symptoms or by doing laboratory tests.

If particular diseases always require lab tests or even autopsies for diagnosis, decisionmakers can justify stricter quarantines and suitable delays on transportation of animals into or out of the potentially affected regions. A cost model in the software could estimate the number of veterinarians needed to perform the distributed diagnosis in a timely fashion, the financial impact of a disease if left unchecked vs. the cost of delays in production and transportation, etc., and roll this information up to the decision-maker's view as well, along with estimates of how delays or national aid might affect the final numbers.

All the temporal inferences of where and how a disease is propagated must be modeled with error margins and likelihoods. When a constraint (such as time of transportation, exposure to other animals or potential vectors, or laboratory results) appears that improves confidence and reduces the error of an exposure-time estimate, inferences should be propagated forward and backward from the constraint to control spiraling uncertainty . Search rules can be responsive to features of the disease, and the system should be able to model a variety of diseases, nominally without modifying the search algorithm. For example, for more or less virulent diseases the estimated likelihood that branches of the search tree will actually be affected goes up or down; this may affect what conservative and marginal quarantine zones proposed or lead to more aggressive diagnosis efforts on more remote branches in an attempt to catch up with the disease. For diseases where surviving animals become permanent carriers, exposures propagate forward to the present for all animals; for diseases that are contagious for the duration of the illness, the modeled incubation time is zero, etc.

Decision-makers*:* Decision-makers can get a conservative estimate of where disease may currently be, so they can decide what to quarantine, establish primary and secondary quarantine zones. For example, transport in or out of a state may stop, but within that, nothing may go in or out of County Z, to accommodate uncertainty to protect the rest of the state.

Preliminary Description of the Expert Tracking System

The modeling software that predicts what pigs are currently infected with a disease must to be probabilistic. In the ideal disease model, a description of the current state of a pig and a history of transportation of the population of pigs allows the software to estimate the likelihood that all potentially exposed pigs actually have been exposed to the disease and the likelihood that they have contracted the disease. Having a generative model should also allow us to ask questions like "if disease x, with these features, had been introduced here, where would it be now?", not just the (more typical, in practice, given the need to isolate diseases) question of "if xyz disease is at certain points now, where did it come from and where else could it be?" This information could potentially be used by policy makers to predict the effects of changes in transportation and market rules, if we could generate hypothetical transportation data following different rules. However, there are challenges related to the use of models for predictive purposes in an outbreak (reviewed by Taylor, 2003).

Assume that a model of a disease is available, in at least the following terms:

- From the time of infection, the probability density function (pdf) of a sick pig being contagious over time (the instantaneous probability of an exposed pig catching the disease from this host, taking into account an exposed pig's exposure time and when in that period it may have caught the disease).
- From the time of infection, the pdf of a sick pig being symptomatic (per symptom, including death as a symptom) over time.
- The conditional probability of the pig being contagious given symptoms, or given the pig is asymptomatic (presumably higher and lower than the default curve, respectively).

The software will estimate the time the disease was contracted (or a range of time). All pigs that have come in contact with the symptomatic pig since that time can then be

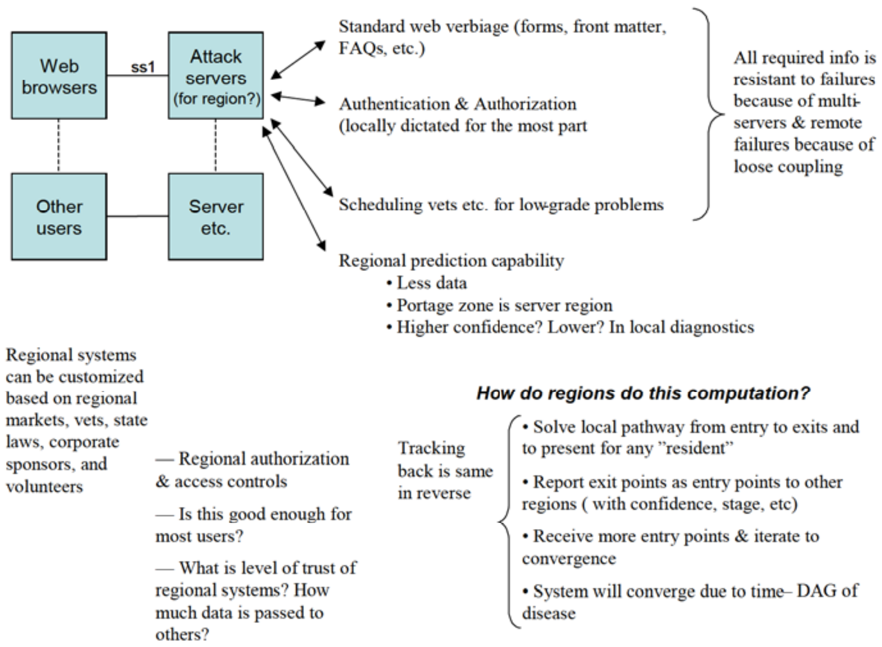

Figure 5 Animal tracking system.

Users interact with the system through web browsers. The bulk of the system is regional servers that have client service functions (web matter, authentication and authorization, and personal schedules) and disease modeling functions (for local prediction and tracking, which can be coordinated between many regions to perform wide-area prediction and tracking). Regional systems are sufficient, but wide-area systems with authority to request more information are useful to establish broader situation awareness. Regional systems may be several computers, and may back up their local data to many neighboring regional systems. Recovery would mean installing a replacement, giving it the original system's cryptographic identity, and letting it automatically recover its information.

assigned a pdf describing their odds of passing on the disease at any particular time, taking into account the period of contact and the uncertainty in the estimate. Then every pig that has come in contact with those next-generation pigs can be assigned a pdf in a similar manner, and so on until all points of contact have been established to the current time and all pigs can be assigned a probability of being sick, infectious, etc.

Based on an estimate of when the original pig got sick, the pigs associated with it at that time can be tracked both forwards and backwards as follows. Some of the pigs that the original pig was in contact with at that time were carrying the disease and have a pdf that describes the likelihood that they became sick at various times. If we cannot determine which pig was the source, we have to treat all lines as suspect. On the other hand, other pigs that were in contact with the original pig when it got sick were in contact with the source at the same time, and they must be traced forwards again to identify other lines forward that may have been infected from the same source. Tracing pigs backwards generates a tree just like tracing pigs forwards.

Trees must be pruned at every opportunity to prevent the data set from exploding. Any time a pig or a lot of pigs is given a clean bill of health, that information should be entered into the databases. Such a sample point, when it occurs on a branch tracing forward or backward will at the very least cut the tree at that point, preventing the branch from growing (unless the testing procedure is unreliable, but even then it should attenuate the pdfs of the pigs sampled). Zeroed-out pdfs or attenuated pdfs allow the pigs in contact with the sampled pigs *prior* to the test to have their pdfs recalculated or eliminated – if the pigs are not sick, in many cases they could never have been sick or it would be detectable, and so could not have given it to pigs prior to the test. Given that a group of pigs is not sick, the pdf of the hypothetical source of the disease along the clean branch can be recomputed as a conditional probability given that the supposed source did not actually pass the disease on. For particularly virulent diseases, this should allow the likelihood of related branches to be attenuated a great deal based on clean samples, because one sick pig in fact should lead to second- and third-generation cases with very high probability. The lack of those cases would indicate that the pig was not sick (and in particular, given the tracking backwards and forwards, this is exactly what should allow the elimination of potential sources of the disease – certain sources of virulent diseases will have highly probable future impact zones, that can be distinguished from one another).

Another means of pruning the tree is through analysis of exposure opportunities. If we see pigs that could have (based on more and more spread-out pdfs) been infected at any of a wide range of times, but have only come in contact with potential sources at certain times, their pdfs can be recomputed based on the actual opportunities of infection and those changes rolled forwards.

There are a few ways that the probabilities involved in the epidemiological model could be managed. The likelihood that a pig in various stages of health might come down with a disease when exposed for a certain length of time to a positive pig could be represented as a closed-form probability density function, probability tables, or clouds of points making up an implicit distribution. In addition to combining and adjusting distributions over time, it would be productive to not only provide a model to the system, but to use the model and the evidence to come up with better assessments of the parameters of the observed system. This is essentially a machine-learning problem: the system refines its understanding of the significance of contributing factors to disease spread (is physical proximity necessary? Is a clean stall mostly safe? What's the mean and variance?). In particular it uses the evidence of diagnoses and outbreaks to inform the epidemiologists of the specifics of the diseases it observes. Whether epidemiologists would use this system to improve their estimates is an issue. Possibly the system should be capable of observing when a disease's rates of transmission (based on feedback from advised sample pigs) is more than one standard deviation away from the mean and of hypothesizing a new virulent strain of the disease, predicting where that would mean it had gotten to, and working with the

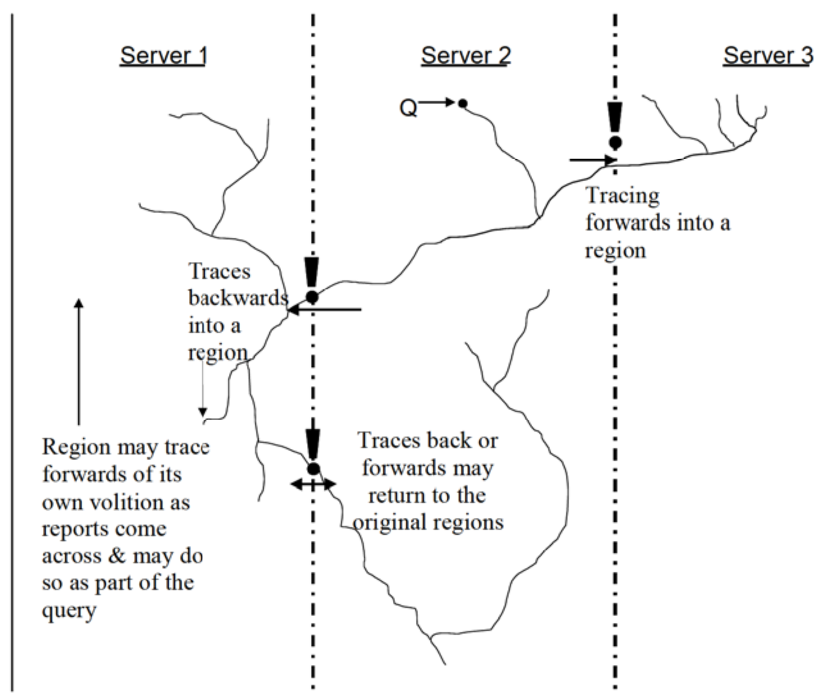

Figure 6 Scenario of query and its effect on the tracking of animals.

When a query (Q) is submitted to Server 2 asking about the most likely source and current state of a disease, the disease is traced back and forth through associations until the regional boundaries (in an information sense) are reached. Information about boundary elements is passed to the servers for those regions in the form of a query and can be a source, status, or dual query. It is possible that the regional point of contact is a place where pigs from one region are exposed to pigs from another region and are then transported elsewhere within either region. Secondary and tertiary regional servers tracing backwards or forwards may reach their own information limits at some point and pass their own queries to others or even to the original system.

scientists to narrow down the source of the more virulent strain separately from other more average, controllable strains.

The system design could be a simple web client at the user end. A regional server provides https service and does authentication and permissions checking. This server is responsible for providing web forms, front matter, FAQs, medical data sheets, links to medical journals, etc., and for referring more important matters to the actual disease tracking computers. These computers are assigned locales within the region if need be, or a single computer might manage an entire region, depending on the quantity of data. The tracking computers are informed of and record all entry, exit, and movement within their area in a timely fashion. They track diagnoses and the current state of diseases as far as is known. Regional systems are sufficient, but wide-area systems with authority to request more information than is typically shared are useful to establish broader situation awareness. Regional systems may be composed of several computers and may back up their local data across many neighboring regional systems. Recovery would require only installing a replacement, giving it the original system's cryptographic identity, and letting it automatically recover its information.

When a request to track down the source or the current spread of a disease is made, the initial data point for such a query may be at an entry or exit point or a point within a region . Regional knowledge is used to trace the disease into the past, to the present, into the future (making predictions given known schedules, with lower confidence), back to any possible points of entry, or forward to exit points. When the boundaries of the region are reached, the boundary point information and possibly a query is sent to the bordering regions, stimulating those regions to perform similar computations. Queries may potentially contain information about the original poser of a question so that the answers may be directed to the right people.

At the next level up (the state level, perhaps, or regions with many locale trackers) the information of interest may be more along the lines of current status. Each county potentially may have a server, or in counties with sparse pig populations perhaps several counties would be run by the same server. Regions and locales afflicted with a disease in the population could be requested to provide current status information, and the severity or presence or even details could be reported and displayed as a summary with little difficulty. As regions report in or update their status, the rolled-up information could be updated. For example, at the state level a disease-control official interested in what the current status of all counties could be presented with a colored county map. Counties with no traceable pig population are white, healthy counties are green, and sick counties fade to red as the problem becomes more severe in terms of the percentage of pigs sick optionally weighted by the size of the population.

Several display options could be available for conceptualizing the same information. County colors could become less saturated over time if they had not reported new information, to simultaneously give some idea of the timeliness of the available data. Changes over time could also be reported either as a different view or on the same view to give an idea of where outbreaks were being brought under control. A graph of exchanges between counties (paralleling inter-server communication) could also be presented, to give a picture of the spread of the disease. This could be presented as a single directed graph, or as a time-series of images of traffic. All county information could be consolidated for the state-level computers. A similar consolidation could be done at the federal level, if regional servers knew that certain regional borders were also state borders. The transmission of diseases across those boundaries could be consolidated at the state level as well, and the state-level computers would have comparable information to feed up to the federal level. At the federal level, states of particular interest could be probed by asking the state servers for more detailed information, and states could do the same for particular regions

Data entry and data quality issues

This system, as described, is dependent on complete and timely input of disease symptom information by swine producers. In order to ensure compliance and data quality, the system would need to be value-added to the producer. This has been a constraint with many previous livestock disease-recording systems. Typically, disease information within multi-farm management systems is considered confidential. This is an area which needs to be addressed to ensure buy-in by the integrated swine producers.

Due to the non-specific nature of the symptoms of CSF, another concern would be the considerable potential for false-positive alarms. The system must balance the need for timely identification of an actual CSF case with the potential for disease symptoms to be mimicked by endemic diseases. Regular false-positive alarms would be a serious disincentive to producer compliance.

Software Development Issues

As envisioned, the expert system described above would be a powerful tool for the U.S. pork industry and the veterinary community. However, it will contain substantial amounts of proprietary data. System security is absolutely critical to success. Furthermore, the ability of the system to recover in the event of accidental failures or malicious attacks must be built in.

It is important to consider the feasibility of implementing the system as a massively distributed, decentralized, and, most important, secure information system. While such a system could be built, existing systems of this sort are rife with security vulnerabilities, must be periodically taken offline, or require large maintenance efforts. Many examples of such systems are owned, maintained, and arbitrated by individual corporations. The system we are proposing must be secure, would be owned and managed by many organizations, should rarely require individual systems to be taken offline, and should never require the entire distributed system to be taken offline. In addition, maintenance of the system should be trivial; the bulk of the installation should be automated, and upgrades to the system should not require local administrative efforts, except possibly to sanction installations.

Security: Given the scale and visibility of the system being proposed, network attacks are inevitable. The regional systems should be set up as small clusters of redundant dedicated servers running only the application of interest. The cluster should sit on a private local area network behind a state-of-the-art firewall. The system can use this same medium to pass inter-system queries and data for other system functions. Insider threats cannot be ignored. Malicious or misbehaving insiders may be system administrators, users, or compromised or malfunctioning computers, and may cause failures opportunistically in a crisis. Disabled or disconnected regional systems must have their data recovered and managed by other systems, and users of the original system must be able to automatically fall back to the replacement. Systems that stop reporting or misreport source and status information must be identified and superseded, and users that begin introducing false information into the system must be reported and their information excised or independently verified.

Making the entire system exhibit these security features requires a mix of redundancy and pre-emptive analysis. Success requires an in-depth analysis of the possible threats and acceptable and unacceptable failure modes, and a design that provides for the various contingencies. Given the need for security, extensive logging, oversight, and policy support must be included in the design. Access to this information by the appropriate individuals needs to be independent but only slightly separated from the process of acting on this information.

Utility: Installing and maintaining the expert system described here could be expensive. To prevent this effort from being wasted, the system must be designed and developed with the active participation of potential users and administrators from all parts of the pork industry, the veterinary community, and regulators.

Maintainability and Reliability: An entire server, OS and all, should be installable onto a new computer from a CD or available as an uninitialized-server hard drive image to simplify installation and recovery. New servers should be easily added to a regional system by an administrator. Adding the installation to the network, registering it with a Certifying Authority, and using a web interface to inform the regional system of the addition should be simple. Multiparty threshold cryptography provides some security advantages against compromised or malfunctioning servers. When a server is added to a regional system it should automatically be initialized with the region database and configuration. Loss of servers in a regional system should be reported to the administrators. Replacements should be given a new cryptographic identity, added to the regional system, and sanctioned by an administrator to take over the responsibilities of the previous machine. The system should be able to recover the data from the distributed representation in case of failure.

Creation of a new regional system should amount to the installation of a set of servers, plus steps to form a regional system out of the set of servers, configure the system, and register it with other regions. Upgrades should be published on the web electronically by the distributors with the appropriate cryptographic signatures after extensive testing, or distributed on CDs for administrators to install manually.

The resulting system will have many attributes ascribed to “agent” software systems (autonomy, persistence, reasoning, collaboration, etc.). During requirements analysis and design, it should be considered whether an agent metaphor is appropriate and whether existing agent frameworks can provide the necessary infrastructure.

Recommendations

Based on the description of the disease spread above, the models used and an analysis of the outbreak in the UK, a number of recommendations for further work can be made.

First and foremost is the need for a national system. Since the pork industry is by and large an interstate process, there is a need to communicate between the states' veterinarians, the farms and the slaughterhouses. A national network of communication channels between these would enable immediate exposure information to be shared with all those affected.

Second is a need for individual animal identification. The next improvement over a national database of communication nodes is a method to now identify the life and travel history of every pig in the country. Just as the airline industry has chosen to ID people's risks as they board airplanes, so to can the national system ID the dangers to animals based on their itinerary or place of origin.

The third recommendation is a completed epidemiological model that includes all of aspects of this process that would enable scenarios to be played out with a significant degree of accuracy. This would enable tests of the national database and ID program as well as planning for disease outbreak occurrence.

Finally, any software tools built to carry out these programs must be designed and built with an emphasis on security and reliability.

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Appendix 4.3

Carroll County Swine Premise Spatial Analysis

The density of swine premises in Carroll County, Indiana's most hog dense county, was evaluated using data collected by Indiana Department of Environmental Management (IDEM), Indiana Board of Animal Health (BOAH) and the county extension educator. Confined Feeding Operations (CFO) are identified by IDEM as those containing at least 600 swine (IDEM, 2004). Global Positioning Systems data was collected for CFO's by IDEM and for all known swine premises by the BOAH and the extension educator. The number of swine present in Carroll County was provided by Animal and Plant Health Inspection Service. Arcview 8.3 was used to evaluate the data. CFO data was filtered so that only hog operations containing more than 0 hogs at the time of record were included. Overlap between the two data sets was eliminated by looking at aerial photography of Carroll County and merging multiple points representing a single premise. Once the total number of premises was determined, the nearest neighbor to each swine premise was identified and the distance to that nearest neighbor calculated. Nearest neighbor distances were also calculated for CFO to CFO points as well as CFO to non-CFO points. The percentage of these nearest neighbor distances within 0.5 km and 1 km were determined for comparison.

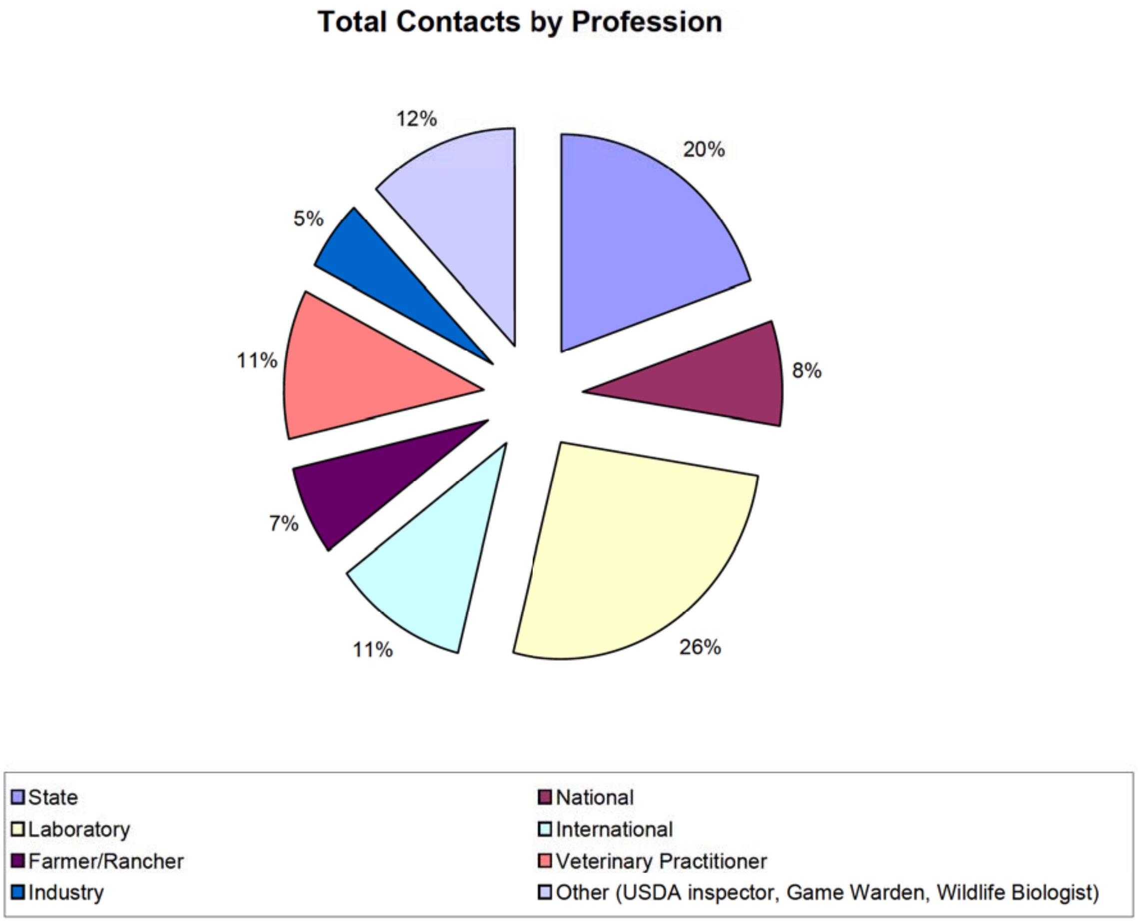
Carroll County Indiana

Total Premises	209
CFO	112
Non-CFO	97
Density of swine premises per sq km	0.215
Total Swine	255,176
Percentage of total swine premises	
with a nearest neighbor within 0.5 km	27%
with a nearest neighbor within 1 km	57%
Percentage of CFO premises	
with a non-CFO nearest neighbor within 0.5 km	20%
with a non-CFO nearest neighbor within 1 km	41%
Percentage of CFO premises	
with a CFO nearest neighbor within 0.5 km	9%
With a CFO nearest neighbor within 1 km	26%

The density of swine premises in Carroll County is 0.215 per km^2. In the Netherlands during 2000, the European Union defined the southwest area as low density, having .21 premises per km^2, and the south area as high density, having 1.09 premises per km^2 (de Vos et al, 2003). Comparing these densities is useful for evaluating the models constructed after the 1997-8 outbreak of CSF in the Netherlands. Neighborhood spread to farms within 0.5 km was determined by Stegeman et al (2002) to be the risk factor for CSF development second only to direct contact with infected, live pigs. As 27% of the farms in Carroll County were found to have a nearest neighbor within 0.5 km, the potential for this mode of spread to occur within Carroll County becomes evident. Confined feeding operations tend to be farther from each other and farther from the smaller operations than indicated by the overall density. The CFO premises, however, are connected epidemiologically by series of smaller operations, which provides the potential for disease dissemination through neighborhood spread.

The limits of this analysis involve the limits of that data available. There are 7 premises which lie within .5 km of the county border and do not have a nearest neighbor within .5 km. Premises outside of the county border were not included in this analysis, hence it is not possible to determine if these border premises may have a nearest neighbor within .5 km outlying the county border. This may serve to artificially decrease the number of nearest neighbors within .5 km. Another restraint is the method of data collection by the sources. Carroll County collected its swine premise data by driving the roads and recording a GPS value at the mailbox of every known swine premise. The method for CFO data collection from IDEM is not known. When all points were overlaid upon the aerial photograph, it was apparent that neither data set gave the GPS location of the actual animal holding area (barn). The spatial analysis that was conducted to obtain nearest neighbor distances was based upon the given data sets, so the actual values from animal location to animal location may be slightly different. Further, the collection date for the BOAH data occurred in 2003, while the IDEM data collection spans the dates of CFO permit approvals.

Appendix 5.1: Description of survey respondents



Total Responded Contacts	
Personal	47
Telephone	10
Email	23
Responded Lab Surveys	7
Presented at Texas A&M	4
Total Responded Contacts:	**91**

Total Contacts Separated by Profession	
State	18
National	7
Laboratory	24
International	10
Farmer/Rancher	6
Veterinary Practitioner	10
Industry	5
Other (USDA inspectors, Game Warden, Wildlife Biologist)	11
Total	**91**

Appendix 5.2: Methods used for detection of CSFV in Europe

Country/Territory	Date	Susceptible	Cases	Deaths	Destroyed	Slaughtered	Laboratory	Virus Isolation	Immunofluorescence Test		Rt-PCR	ELISA	5'NTR Nucleotide Sequencing
									Direct	Indirect			
Spain	Jan-98	17,558	381	98	17,460	0	N/A						
Germany	Jan-98	62,850	3,402	1,545	61,305	0	Veterinary Research Services, Rostock and Oldenburg	X					
Germany	Feb-98	11	11	….	11	0	Veterinary Research Services, Rostock		X				
Moldavia	Apr-98	4,827	….	….	….	703	All-Russia Research Institute for Animal Health Vladimir, Russia		X*	X*	X		
SPAIN	Apr-98	4,113	1,694	414	3,699	0	N/A						
Moldavia	May-98	14	5 piglets	0	0	7 piglets	Republic Veterinary Diagnostic Centre		X*	X*			
Switzerland	May-98	6 wild boar	6	4	….	…..	Institutes of Virology and Immunoprophylaxis, Mittelhausen			X	X	X	X
Spain	Jul-98	4,117	413	138	3,979	0	N/A						
Italy	Aug-98	1,375	….	53	1,322	0	N/A						
Moldavia	Aug-98	31	….	5	37	7	Veterinary Diagnostic Centre		X*	X*			
Germany	Oct-98	208	48	3	205	0	State Department for Animal Health research, Munster	X					
Germany	Oct-98	2,683	5	1	2,682	0	State Department for Animal Health research, Lower Saxony Land	x					

Germany	May-99	47	1	0	47	0	Staatliches Veterinaurunterschungsamt, Krefeld	X				
Germany	Jun-99	633	20	5	628	0	Staatliches Veterinaurunterschungsamt, Krefeld	x				
Croatia	Jul-99	9	5	1	4	0	N/A				X	
Germany	Aug-99	1,669	41	37	1,632	0	Staatliches Veterinaurunterschungsamt, Krefeld	X				
Germany	Aug-99	569	30	0	569	0	State Department of Veterinary Research, Koblenz	X				
Bulgaria	Mar-00	104	….	15	33	56	Central research Institute, Sofia		X* X*			
United Kingdom	Aug-00	9,435	….	…..	…..	…..	Veterinary Laboratories agency, Weybridge	X	X	X	X	X
Germany	Jul-00	1,045	….	….	1,045	0	State Department of Veterinary Research, Koblenz	X			X	
United Kingdom	Aug-00	1,037	….	….	….	….	N/A					
United Kingdom	Sep-00	13,455	….	….	….	….	N/A	X				X
United Kingdom	Sep-00	5,509	6	1	…..	….	Veterinary Laboratories agency, Weybridge	X	X	X		
United Kingdom	Sep-00	6,940	250	13	….	….	Veterinary Laboratories agency, Weybridge	X	X			
Austria	Oct-00	50 Wild Boar	1	1	0	0	Federal Veterinary Research Institue, Modling		x w/ NPLA			
Romania	Apr-01	552	14	7	7	0	Institute for Diagnosis and animal helath (national reference Laboratory for Classical Swine Fever)		x			

Spain	Jun-01	2,053	195	65	1,988	0	National refernce Laboratory for CSF, Madrid			X	X	
Spain	Jun-01	5,143	630	509	4,634	0	N/A					
Spain	Jun-01	5,213	1,019	52	5,131	0	N/A					
Germany	Jun-01	822	1	1	821	0	EU Reference Loaboratory for CSF, Hannover		X			
Spain	Jun-01	966	87	5	961	0	N/A					
Slovakia	Jun-01	612	30	14	598	0	State Veterinary Institute, Zvolen		X			
Spain	Jul-01	3,907	467	33	3,873	0	N/A					
Germany	Jul-01	2,100	1	1	2,099	0	N/A					
Ukraine	Jul-01	Wild boar	….	…..	…..	….	Tcherkassy State Zonal Specialized Laboratory of Veterinary Medicine	X	X			
Spain	Jul-01	5,592	874	438	5,154	0	N/A					
Spain	Jul-01	739	82	16	723	0	N/A					
Spain	Aug-01	4,409	122	30	4,379	0	N/A					
Spain	Sep-01	401	….	15	386	0	N/A					
Spain	Sep-01	626	0	0	626	0	National refernce Laboratory for CSF, Madrid			X		
Germany	Oct-01	2	1	0	2	0	Department for Research in Veterinary Medicine and Food Safety		X			
Germany	Oct-01	2,105	>651	51	2,054	0	Rhineland-Palatinate Veterinary research Service, Koblenz		X			
Germany	Oct-01	651	….	….	651	0	Rhineland-Palatinate Veterinary research Service, Koblenz		X			
Luxembourg	Oct-01	Wild boar	….	5	…..	…..	Veterinary and Agrochemical Research Center, Brussels Belgium	X				

Spain	Dec-01	9,707	270	33	9,674	0	CISA-INIA			X	X	
Germany	Jan-02	198	2	2	196	0	Rhineland-Palatinate Veterinary research Service, Koblenz		X		X	
Germany	Feb-02	1,383	….	12	1,371	0	Rhineland-Palatinate Veterinary research Service, Koblenz		X		X	
Germany	Feb-02	526	31	7	519	0	Rhineland-Palatinate Veterinary research Service, Koblenz	X	X		X	
Luxembourg	Feb-02	148	2	1	147	0	Veterinary and Agrochemical Research Center, Brussels Belgium	x	X		x	
Luxembourg	Feb-02	2,910	….	….	2,910	0	Veterinary and Agrochemical Research Center, Brussels Belgium	x	X		x	
Germany	Mar-02	1,187	….	17	1,170	0	Rhineland-Palatinate Veterinary research Service, Koblenz	X	X		X	
Bulgaria	Mar-02	38	3	3	35	0	Central research Institute, Sofia		X		X	
Luxembourg	Mar-02	1,371	….	….	1,371	0	Veterinary and Agrochemical Research Center, Brussels Belgium	x	X* x*		x	
Germany	Apr-02	13	4	0	13	0	Rhineland-Palatinate Veterinary research Service, Koblenz	X	X		X	
Romania	Apr-02	282	61	30	132	120	Institute of Diagnosis and Animal Health, Bucharest		X			
Bulgaria	Apr-02	5	3	0	3	0	National Diagnostic and Research Veterinary Institute, Sofia		X		X	
Bulgaria	Apr-02	250	23	8	242	0	National Diagnostic and Research Veterinary Institute, Sofia		X		X	

Bulgaria	Apr-02	62	28	5	52	5	National Diagnostic and Research Veterinary Institute, Sofia		X		X	
France	Apr-02	395 piglets	5	5	390	0	French Agency for Food Safety, Ploufragen	X		X	X	
Germany	Apr-02	273	150	20	253	0	Rhineland-Palatinate Veterinary research Service, Koblenz	X			X	
Bulgaria	May-02	16	8	2	14	…..	National Diagnostic and Research Veterinary Institute, Sofia		X		X	

Appendix 5.3: Example questions related to CSF laboratories used in qualitative survey

1. Are current laboratories able to conduct CSFV testing?
2. What is the current number of samples that could be tested in your lab per day for CSFV using FAT, VI, ELISA, etc.?
3. What is the best sampling strategy during an outbreak to prevent overcapacity at labs?
4. What will be the role of the National Animal Health Laboratory Network (NAHLN) in regards to CSF surveillance?
5. If CSF is suspected, where do you send the samples? How long does it take for samples to arrive at the lab? Would there be potential problems in sending samples with certain weather events, such as hurricanes? How long could a diagnosis be delayed?
6. Are labs in Puerto Rico able to conduct CSF testing? If so, what tests are run, what is the turnaround time, what are the lab capacities?
7. What are our emergency/contingency plans?
8. What is the sequence of events that happens between a suspected isolated case compared to emergency reaction to an epidemic?
9. What are the lab's triage procedures?
10. Will there ever be a more rapid test that can substitute for Virus Isolation (VI)?
11. Where do you get positive/negative controls at? How long does it take to get the reagents? Will this change once the hub labs are established?

12. Do you know of current testing of feral swine for CSF from Puerto Rico/Costa Rica at the South Carolina lab; Canada/Europe at New York lab; slaughterhouse samples in Texas?

13. In your opinion, should we check all animals, or profile and test animals that have certain masking respiratory diseases/ just slaughter / or all imports?

14. Once a sample of a possible CSF case comes in, what are the procedures the lab goes through from receiving it to testing/recording results/notifying appropriate individuals? Would these procedures be different if a sample was sent in from the feral swine population?

15. Do samples go into containment, are they split up, how are they dispatched to Plum Island Diagnostic Lab? What is the current procedure and how will it change once hub labs are established? Who is able to run the different tests? Would teams be set up based on the tests to be run? Would these procedures be different if a sample was sent in from the feral swine population?

16. How many trained individuals do we have that can accurately diagnose CSF?

17. Do we have a centralized system for processing samples before they are sent to the lab during an outbreak to speed up turn around time or confirm a possible outbreak?

18. What happens if the sample is CSF positive?

19. For low and high pathogen CSF, how far can the virus disseminate? What is its survival in the environment?

20. Do you know of any difference in the virulence of the different genotypes for CSF?

    The Veterinary Record, 2003 explains that the virus was introduced in June of 2000, but the first diagnosis did not occur until August of 2000. Why was this so? Are the current diagnostic tests in use for CSF good enough to pick up the early infection of CSF or Low pathogen CSF or is this a problem with surveillance?

21. Do your swine diagnosticians and swine practitioners know how many swine diseases there are which could mimic the signs for CSF?

22. What are the signs, symptoms and pathology for a low pathogen CSF?

23. At which stage of the disease do sows start showing obvious clinical signs for the high pathogen CSF and the low pathogen CSF?

24. Were all 75,000 samples tested at Veterinary Laboratories Agency? How many individuals were involved in diagnosing this outbreak at the Laboratory level? What are the best sampling strategies, especially following an outbreak of CSF, to limit over-capacity concerns?

25. How many swine cases does Veterinary Laboratories Agency (VLA) report annually? Of these how many are Erysipelas, Salmonella, Septicemias, Porcine Respiratory and Reproductive Syndrome (PRRS), Porcine Dematotis and Nephropathy Syndrome (PDNS), and/or Post Weaning Multi-symptomatic Wasting Syndrome (PWMS)?

26. What diagnostic tests do you run for AI (artificial insemination) on boars?

27. How effective do you feel the marker vaccines are for CSF? How specific/sensitive are the ELISA's toward these vaccines? Would the U.K. use marker vaccines if there was another outbreak of CSF?

28. Do you feel there is an international market to make new vaccines and diagnostic tests for large animals? (i.e. Classical Swine Fever)

29. Can the strains for CSF be modified? Do you have monoclonal antibodies against surface proteins or the virus? If so, are you using these antibodies to classify isolates?

30. Do any of your labs have mobile labs that can go into the quarantine zone? What would be the pros and cons of having such a lab?

31. Are there any drawbacks to using real time PCR during and outbreak situation?

32. What do you feel is industry's role in disease prevention, especially in regards to foreign animal diseases?

33. Do you know of any new technologies for border surveillance or on-farm diagnosis using pen-side assays for CSF? Do you know of any other countries working on this?

34. How effective do you feel the marker vaccines are for CSF? How specific/sensitive are the ELISA's toward these vaccines?

35. Do you feel there is an international market to make new vaccines and diagnostic tests for large animals? (i.e. Classical Swine Fever)

36. Are there true low virulent strains of CSF or is what we see as low virulent strains more of a function of CSF being in an endemic area? Would a strain seen as low virulent, such as from Mexico, become the classic high virulent CSF strain if introduced into the United States?

37. How long can people carry the CSF virus? Do other species act as vectors/carriers besides swine? What is the carrier state of the vaccinated animal?

38. For low and high pathogen CSF, how far can the virus disseminate? What is its survival in the environment?

39. Are there any drawbacks to using real time PCR during and outbreak situation?

40. What tissue samples would be most effective for diagnosing CSF?

41. Is there any new type of vaccine research occurring for marker vaccine or prophylactic use?

42. What are the problems between the state and federal labs besides the money issue for running the NAHLN? What happens if a state lab gets 14 out of 27 swine samples positive for CSF?

43. A list of all of the tests run, positive controls, protocols, cell lines used, reagents etc.

44. How much communication is there between state and national labs?

45. Will all hub labs be standardized in equipment? What are you opinions on ring vaccination? Do you feel the USDA will ever move away from depopulation? Why or Why not? If we got CSF into the U.S. would we vaccinate?

46. Where do you feel the USDA is the most short staffed for detecting a foreign animal disease?

47. How easy could low virulence CSF go undetected at a slaughter plant? How much testing is done on condemned swine at slaughter plants?

48. Do you feel CSF has come into the U.S. since it has been eradicated, but has not found the right pathway to become established?

49. Do you feel that real-time PCR would be a feasible approach for border surveillance? How confident are you in using real-time PCR for CSF diagnosis? How many samples would be required to confirm a positive herd?

50. What conditions would be required before state veterinarians in charge stop movement of animals or initiate slaughtering of swine? Would they wait for confirmation from PIADC first?

51. What are your concerns about low virulent strains of CSF? Does our current CSF surveillance take the possibility of low virulent CSF into account? Do you think there are truly low virulent strains out there, or is it just a function of the virus being in an endemic area? Would a "low virulent "CSF strain, such as from Mexico, become high virulent if introduced into a naïve population, such as in the United States?

52. What are your concerns about misdiagnosing CSF, especially if it is low virulent? How easy could low virulent CSF come into the U.S.?

53. What are your feelings on database integration in regards to CSF surveillance?

54. How often are ill/poor-doing pigs seen by practitioners? What are the common clinical signs seen (high fever, constipation, diarrhea, abortion, not eating, etc.)?

55. How much training do practitioners have in PR to identify CSF?

56. How easy could low virulence CSF go undetected at a slaughter plant? How much testing is done on condemned swine at slaughter plants?

57. What are the current procedures for diagnosing CSF in Mexico? Is it diagnosed at the state level, or is there a central lab? What is your role in this procedure? Do you select the reagents/strains? Where do they come from? Do you have a strain bank? What are the protocols?

58. What are current (new) diagnostics, research, etc, going on in Mexico regarding CSF?

Appendix 5.4: Laboratory survey

Classical Swine Fever Survey

1. Assuming that FADDL has given you all of the reagents to run Classical Swine Fever (Hog Cholera) in your laboratory, please fill the following table.

Test	Number of samples that could tested per day.	Test would be done manually (M)/using robots (R) or both (B)	Turnaround time manually(M)/using robots (R) or both (B)	Number of individuals trained to diagnose CSF
FAT		• M: • R: • B:	• M: • R: • B:	
PCR		• M: • R: • B:	• M: • R: • B:	
VNT		• M: • R: • B:	• M: • R: • B:	
ELISA		• M: • R: • B:	• M: • R: • B:	
VI		• M: • R: • B:	• M: • R: • B:	

2. What diagnostic test(s) is the government going to allow you to run for Classical Swine Fever? Check all that apply.

______FAT
______PCR
______Virus Neutralization (NPLA, FAVN)
______ELISA
______Virus Isolation (VI)

3. Is your lab able to run real time PCR for classical swine fever?

A) Now:

Yes___________

Number of individuals trained to run the test__________

No_________

B) Once your lab receives the reagents from Plum for Classical Swine Fever
Yes__________
Number of individuals trained to run the test__________
Expected date reagents for CSF are to be received from FADDL_________
No__________

4. Do you feel that the current real-time PCR machine is currently the best diagnostic tool to use in the face of a CSF outbreak to handle a large volume of samples?
Yes__________
Why____
____
____
____

No__________

Why____
____
____
____

5. Do you feel the current real-time PCR machines would be a feasible diagnostic tool for use by practicing veterinarians?
Yes__________
No__________

Why____
____
____
____
____

6. Is your lab planning on building a bio-level 3 Lab, or does it already have one?
________Yes, we already have a bio-level 3 Lab
________Yes, we are in the process/planning of building a bio-level 3 lab
Expected date of completion:_____________
________ No, we will not have a bio-level 3 lab

7. A sample from a diseased pig comes in for regular testing (i.e. Erysipelas, Salmonella, Pseudorabies) that is CSF infected, but not realized at the time. What would be the sequence of events that would take place before CSF is suspected?

____
____
____
____
____
____

8. Do you feel there is any need/possibility for a surveillance program for the feral swine population within the United States?

Yes_______

Why____
____
____
____

No_______

Why____
____
____
____

9. Do you have any suggestions for increasing the education/awareness of practitioners and the public of the consequences and economic impacts of foreign animal diseases (i.e.Classical Swine Fever) as well as their role in foreign animal disease detection?

____
____
____
____

10. What are the lab's emergency/contingency plans for a foreign animal disease (i.e. CSF)?

____
____
____
____

This survey will be used anonymously in our report to the USDA and we will provide you a draft of the report before it is submitted. Please feel free to contact us if you have any questions concerning this project.

Appendix 5.5 National Animal Health Laboratory Network Laboratory Test Capacity and Turnaround Time

		Laboratories within the National Animal Health Laboratory Network (NAHLN)							
		1	2	3	4	5	6	7	8
Direct Flourescent Antibody Test (FAT)	Number of Samples	NR[1]	25	NR	100	NR	NR	30	100
	Mode of diagnosis (M/B/R)[2]	NR	M	NR	M	NR	M	M	M
	Turnaround time per sample	NR	2 days	NR	12 hours	0	NR	1 day	1-2 days
	Individuals Trained	NR	0	NR	5	NR	NR	2	3
Reverse Transcriptase (RT)- PCR	Number of Samples	NR	40	NR	1300	NR	NR	80	400
	Mode of diagnosis (M/B/R)	NR	M	NR	B	NR	B	R	B
	Turnaround time per sample	NR	2 days	NR	8 hours	NR	NR	1-2 days	1-2 days
	Individuals Trained	NR	0	NR	5	0	NR	4	2
Virus Neutralization Test (VNT)	Number of Samples	NR	20	NR	1200	NR	NR	NR	20
	Mode of diagnosis (M/B/R)	NR	M	NR	M	NR	M	NR	M
	Turnaround time per sample	NR	4 days	NR	5 days	NR	NR	NR	2-3 days
	Individuals Trained	NR	0	NR	8	0	NR	NR	2
Enzyme Linked immunosorbent Assay (ELISA)	Number of Samples	NR	200	NR	2000	NR	NR	50	1000
	Mode of diagnosis (M/B/R)	NR	B	NR	B	NR	B	R	B
	Turnaround time per sample	NR	2 days	NR	5 hours	NR	NR	NR	1-2 days for both
	Individuals Trained	NR		NR	12	0	NR	0	NR
Virus Isolation (VI)	Number of Samples	NR	20	NR	100	NR	NR	20	20
	Mode of diagnosis (M/B/R)	NR	M	NR	M	NR	B	M	M
	Turnaround time per sample	NR	14 days	NR	9 days	NR	NR	7-14 days	3-5 days
	Individuals Trained	NR	0	NR	8	0	NR	0	NR

1.) NR- No Response
2.) (M/B/R)- Manually/Both/Robotic Automation

Appendix 5.6
Classical Swine Fever (CSF) Surveillance Fiscal Year (FY) 2004 and Beyond

Revision 2

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last revision date: 12-2-2003

Veterinary Services' (VS) Objectives for CSF Surveillance

Should CSF be introduced into the United States, enhanced surveillance will:

- Allow for the early identification of the disease;
- Interrupt its transmission; and
- Facilitate its eradication and control.

Serology and Its Drawbacks

The last available national CSF surveillance approach is described in VS Notice 99-13. That Notice directs that "a sample of 10 percent of the specimens collected for Pseudorabies virus testing at the lab will be submitted to APHIS' NVSL FADDL for CSF testing as well." While serology allows the detection of surviving animals beyond the viremic stage, that method of identification of CSF in domestic slaughter swine surveillance has drawbacks:

- This method of surveillance does not target high risk swine or those animals most likely to be infected first. Thus, the identification of the introduction of CSF into the United States could be delayed until the disease has spread. Because of routinely high standards of production and accompanying biosecurity, domestic slaughter surveillance may have very little importance in CSF surveillance. Therefore, the focus should be on other areas deemed to be at greater risk for CSF introduction.
- Serological surveillance does not target domestic swine displaying clinical signs consistent with CSF.
- Serological surveillance does not meet the objective of early detection. Previous studies suggest that using serology could delay the detection of a CSF introduction by several months or more.
- Current surveillance methods at slaughter plants only target sows and boars, so market swine are not tested for CSF titers. Market swine are believed to be a more sensitive indicator of CSF virus (CSFV) exposure.
- Better tag retention and compliance with tagging regulations for transported animals is necessary for appropriate surveillance. Tagging and traceback are only as good as tag retention and compliance will allow.

Working Smarter

How will VS enhance and improve CSF surveillance? How will we work smarter than we have in the past? The following steps are necessary for more effective surveillance:

1. *Focus on High Risk Populations*

USDA APHIS VS will seek to focus its surveillance efforts on the swine populations at highest-risk for CSF. Using the high risk swine populations for targeted surveillance will involve searching out premises characterized by management practices that allow CSFV pathways to be unprotected. Targeted surveillance provides an early warning notification of open pathways for CSFV into the United States. Non-targeted (scanning) surveillance is also useful for verification of targeted surveillance despite sampling in a lower risk swine population.

If a low pathogenic strain of CSF should gain entry to the U.S. and not be detected via antigen-based sampling of clinically ill swine, it is important that a back-up system of serological testing be in place to detect infection. Conversely, limited serological sampling would ensure that our aggressive antigenic surveillance program is effective. It is important that epidemiologists evaluate how swine populations, particularly from high risk areas, might be validly sampled on an ongoing basis for freedom from CSF.

A combined effort of targeted and scanning surveillance provides the most comprehensive assurance of freedom from CSF in the United States. Collections of targeted surveillance samples provide for better surveillance reliability compared to scanning surveillance collections due to the difference in the risk factor exposure in the sampled populations. Area Veterinarians in Charge (AVICs) are urged to place the greatest collection efforts and resources on targeted surveillance, but not to disregard the importance of scanning surveillance.

Scanning surveillance utilizing statistical sampling procedures and assuring that an array of many different producers from various areas is collected would enable better surveillance in slaughter plants rather than a large number of samples from just a few producers. AVIC's need to assure that surveillance strategies enable a wide ranging view of swine production within the state keeping sampling priorities focused on high risk animals for CSF introduction.

In some cases, State law may prevent VS from collecting samples we deem essential. For example, Florida law states that all swine in the State shall be available for bleeding should State or Federal officials deem it necessary. In contrast, current New Jersey law does not allow blood sampling if a premises owner declines our request to enter and bleed animals. This presents difficulties given the high concentration of immigrant labor in that State; many swine premises should be sampled to test for the possible entry of the CSFV brought in by the immigrant labor force from CSF-affected countries like Cuba and Mexico.

AVICs in each State should work cooperatively with the state veterinarian and the state veterinary staff to insure authority exists to collect samples targeted for appropriate high risk surveillance in that state. Given the current focus on food security and the risks of intentional introduction of agents, communications regarding protocol and procedure for surveillance sampling should be established as quickly as possible.

2. Concentrate Resources in High Risk States

VS will concentrate its surveillance testing resources on high risk States; lesser resources will be devoted to low risk States. VS Notice 99-13 (currently inactive) addresses the criteria for determining a high risk State. High risk areas for CSF include those with garbage feeding operations, backyard swine operations, feral swine hunting clubs, military bases, international air or sea ports, farming operations utilizing an international labor force, corporations engaging in international movement of swine, etc. Many avenues for CSFV entry exist beyond what is suggested here. Adequate CSF Surveillance is dependent upon the AVIC and state veterinarian knowing what risks exist in his/her state and ensuring that targeted surveillance is carried out in those swine populations. Scanning surveillance (non-targeted in its methods) is not sufficient as a stand-alone surveillance strategy to accomplish early detection, but would compliment targeted surveillance.

The following territories will be identified as **very high risk:**

Puerto Rico (total = 1)

The following states will be identified as **high risk**:

Eastern Region: total = 8 **Western Region: total = 10**

Florida	Arizona
Georgia	California
Illinois	Hawaii
Indiana	Iowa
Minnesota	Kansas
New Jersey	Nebraska
New York	New Mexico
North Carolina	Oklahoma
	Texas
	Washington

The remaining unlisted states will be designated low risk. (total = 32)

High risk is partly a function of the number of swine in each state and the number of swine imports in each state. The number of swine is important because that affects the risks and consequences of exposure. Swine imports are important because they directly control a pathway for CSF virus. Funding levels, as shown in Appendix 2, are determined by the swine population levels and the number of annual swine imports in each state. The pathways for exposure of a susceptible population of swine to CSFV in any state are the substantial variables in the funding equation to determine risk level.

3. Develop a Targeting Strategy for Each State

AVICs will be tasked with developing a plan appropriate to CSF high risk sampling for their respective States. The current serological testing methodology should be gradually enhanced by emphasis on clinical surveillance (sampling of animals displaying clinical signs consistent with CSF) and high risk non-clinical surveillance (CSF infections can range in clinical signs from non-clinical to generalized unthriftiness). Examples of high risk non-clinical surveillance might include swine production areas surrounding illegal boat landings in Puerto Rico and swine production units using an immigrant labor force. Scanning serology remains our stop-gap identification measure in case low path CSF escapes diagnosis based on clinical signs (diagnostic tests can pick up low and high virulent strains), albeit slower to alert us through positive tests due to seroconversion. Base-line serology should be enhanced by testing in high risk populations using virus detection techniques. These statements are not intended to suggest that double sampling of animals is necessary. Virus detection methods remain the recommended first choice for testing in high risk animals, however serology should continue in other groups of swine not readily lending themselves to sampling by tissue harvest, nasal swabbing, or tonsil scraping.

In instances where facilities are inadequate and/or the safety of personnel is a concern, sampling from high risk premises by purchase of piglets may be the best option.

Sampling regimens should be oriented toward nasal swabs, tonsil scraping, whole blood buffy coat virus isolation/detection from sick animals, or tissues from slaughter, euthanasia, or diagnostic laboratory animal submissions, and should be given first priority purposely to facilitate the early detection of CSF. Serology will continue to be used for surveillance when nasal swab, tissue sample submissions, or whole blood collection is not possible after exhausting all of these other options. *Appendix 1* provides more detail on sampling procedure and shipping of samples to a Foreign Animal Disease Diagnostic Lab (FADDL).

AVICs and State Veterinarians must continue to develop good working relations with private practice veterinarians, diagnostic laboratories, and swine producers to gain their trust and increase sample collection possibilities. Public awareness through teaching sessions should become a routine part of VS' foreign animal disease prevention mission. It is important to discuss with industry, producers, and veterinarians the fact that sampling does not automatically lead to quarantines and swine movement restrictions. Rather, traces through the proper identification of positive animals to infected premises are essential to locating and removing infected animals in the interest of protecting the security of our nation's food supply and viability (profitability) of the industry. Drs. Don Rush and Mark Schoenbaum will consult with Eastern and Western Region AVICs on surveillance activities as needed.

Targeted surveillance utilizes a 2-step process as described below. Step 1 targets high risk animals or herds by asking the following questions:

1. Is the farm a garbage feeding premise?
2. Does the farm employ foreign workers?
3. Have any employees traveled internationally in the previous 2 weeks?
4. Have there been any foreign visitors or contract laborers on the farm in the previous 2 weeks?
5. Is the consumption of foreign meat products allowed on the farm?
6. Is the farm located near a military or cruise ship base?

An affirmative answer to any one or more of the Step 1 questions leads to Step 2. Step 2 provides screening criteria to narrow our focus in the attempt to find CSF.

Step 2: A combination of two or more of the following signs/lesions can be consistent with CSF infection: (two or more signs may be found in a number of other diseases, as well)

1. Persistent high fever
2. Conjunctivitis – crusty eyes
3. Constipation, occasionally followed by diarrhea
4. Staggering gaits, often followed by posterior paresis
5. Purple discoloration over the skin of the abdomen, snout, ears and inner side of limbs
6. Multiple hemorrhages with various sizes throughout the body, commonly in the lymph nodes and kidneys.
7. Multiple necrotic foci in tonsil and splenic infarcts are indicative of CSF infection, but not consistently present
8. Growth retardation-runted pigs
9. Not eating or responding to antibiotics
10. Abortion in pregnant sow or neonatal death / mummification
11. Low white blood cells or platelets counts
12. History of high mortality and sudden death

Other clinical signs that might be associated with CSF infection:

1. Coughing and respiratory problem
2. Dullness, reluctant to move and reduced appetite
3. Convulsion
4. Raised hair
5. Vomiting

With positive responses to both Step 1 and Step 2, clinical signs consistent with CSF are tied to international connections. Forwarding of targeted CSF tissue and blood samples to FADDL is important to the early detection effort of the CSF Surveillance in every state and territory.

Although generalized unthriftiness ranging to sub-clinical illness is part of the CSF variability seen with infections depending upon strain virulence, the consensus of opinion is that a targeted approach is more efficient for early detection. AVICs and State Veterinarians will make the ultimate decision as to the necessity of capturing samples with clinical signs suggestive of CSF. The other limiting factor is FADDL's ability to process samples. Should FADDL become overwhelmed, some adjustments in lab resources at FADDL and state sampling regimes may be necessary. The team members previously listed will assist as necessary.

4. Work with State and University Diagnostic Laboratories

In light of our recommendations to concentrate resources on high risk populations, AVIC's are encouraged to seek agreements with State and university veterinary diagnostic laboratories. The veterinary diagnostic laboratories in many States process large numbers of swine samples for the commercial swine industry (a sizable proportion do not receive a conclusive diagnosis). Some Midwestern laboratories (like those in Iowa, Kansas, Minnesota, and Missouri) may receive samples from nearly 40 States. Clearly, these laboratories have wide coverage. Agreements with State and university laboratories to make a percentage of their samples available for testing at FADDL on Plum Island is an appropriate avenue to sample domestic swine with suggestive CSF clinical signs. Targeting swine demonstrating clinical signs consistent with CSF enables the earliest possible detection while theoretically keeping samples at a manageable level. AVICs in high risk areas should negotiate agreements with the laboratories to provide free or low-cost post-mortem examinations on sick or dead back-yard or transitional animals.

5. Coordinate with the Food Safety and Inspection Service (FSIS) and non-inspected slaughter/rendering establishments

USDA APHIS VS will coordinate with FSIS regarding the forwarding of condemned swine tissues to FADDL for virus detection. This coordination will become part of the new cooperative effort between FSIS and VS. Facilitation of custom kill, state inspected slaughter plant, or rendering plant collections by the AVIC will target appropriate high risk CSF surveillance in certain states.

The sow-boar blood sampling program most likely samples a sub-optimal population for CSF testing. Market swine are killed relatively quickly after potential exposure to CSF or other regulatory diseases of concern (e.g. PRV), making them a more appropriate sample population versus sows. Identification issues are minimized because producer payment is based on carcass tattoos in most cases.

AVIC's may be able to facilitate market swine collections with packing plant management depending upon line speeds, available plant facilities and personnel, and cooperative agreements with local FSIS personnel. Meat juice testing (MJT) of market swine for CSF will be an available option in the future.

6. Coordinate with APHIS, Wildlife Services (WS)

Wildlife Services is implementing a wildlife disease monitoring and surveillance system that will include conducting biological sample collection in coordination with existing operational and research activities. Sampling in coordination with other organization's activities will also occur. Wildlife Services personnel work with feral swine is often conducted in States that are considered high risk States. This provides additional opportunity for testing in high risk populations of swine.

7. Improve Swine Tagging

USDA APHIS VS will work on swine tagging to achieve better retention and more complete identification of swine in transport vehicles and arriving at slaughter establishments. Currently, better tagging compliance and tag retention methods are being pursued by Dr. John Wiemers.[1] This effort does not affect the current budget, but contributes to the overall objective of making the entire slaughter population available for sampling and traceable to source premise.

8. Conduct a Formal Pathway Assessment

The Centers for Epidemiology and Animal Health (CEAH) has contracted with a consortium[2] to conduct a formal pathway assessment for the risk of the introduction of CSF. The objective is to prioritize our focus and funding so that potential avenues of entry for CSFV are most targeted. Dr. Ken Forsythe and Mr. Tim Clouse will take the lead and provide information to better direct VS' CSF surveillance program. CEAH will cover the

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[1] Animal identification efforts will start in 2004-2005. See http://www.usaip.info/ for details.
[2] Kansas State University, Texas A&M University, Purdue University, and Sandia National Laboratories.

necessary budgeting for this activity. It will, therefore, not draw funding from the CSF surveillance plan dedicated funds. A draft of the report will be available in December 2003 – January 2004, and the final report should be published in August 2004 (or earlier).

Determining High Risk Groups:

Sampling priorities in each State will be determined by the AVIC and State Veterinarian. The following suggestions on sampling priorities should be modified depending on the unique circumstances and environment in each State. CEAH will work with AVIC's to develop a county-level listing by state that will rank counties by using various criteria, such as:

- International water and air landings: passengers and fomites with viable CSFV or illegal transport of live swine from CSF-affected areas. Swine farms with immigrant farm laborers;
- Sick swine calls (foreign animal disease investigations would involve sampling, but are funded under a different category);
- Illegal garbage feeders and legal feeders with inadequate biosecurity and unhealthy swine;
- Feral/backyard swine;
- Domestic swine: veterinary diagnostic laboratories and condemned slaughter swine tissues.

Facilitating better surveillance activity in very high risk areas

In Puerto Rico, special efforts need to be made to assist Animal Health Technicians (AHTs) in providing non-FAD diagnoses to area producers to engender team-building concepts with the local waste-feeding producers in a very high risk environment. Local veterinary service is non-existent, leaving producers without means of veterinary support outside of cooperative program contact.

Determining Funding Levels:

Currently, the CSF Surveillance Plan is funded for fiscal year (FY) 2004. Funding levels (except for Puerto Rico) are based on a formula that allocates funds based on the number of swine in each State and the number of swine imports. However, each State will get at least $2,000. See ***Appendix 2*** for the funding schedule.

Why This Surveillance Plan Works:

This Surveillance Plan is more appropriate for early detection of CSF. Moreover, it demonstrates to our trading partners that the United States is free, and intends to remain free, of CSF. This Plan has the following specific advantages:

- Aggressively implements both targeted and non-targeted/scanning surveillance to demonstrate freedom from CSF;
- Emphasizes the collection of clinical and laboratory-related diagnostic information targeting swine at higher risk of CSF infection allowing ***earlier detection, containment, and elimination;***
- Maintains scanning serological surveillance at low levels as a secondary detection system.

Database Reporting

Surveillance sampling will be reported by state (quarterly for low risk and monthly for high and very high risk) into the CSF database in Lotus Notes. Access to this database and other operational details are shown in Appendix 3.

Future reporting of surveillance will occur in a yet-to-be named IT database that would ultimately collect all swine disease surveillance information. This database reporting for CSF would collect epidemiological information, lab submission data and results. As per Dave Kinker at NVSL, this is projected to be available in summer 2004.

Promoting Targeted and Non-targeted Surveillance of swine by contacts with swine producer groups and practitioners

Increased activity to raise awareness and promote practitioner, producer and youth group reporting. It is mandatory for AVIC's to provide an outreach program through their office. We are fully aware that practitioners, producers and others are unaware of whom to call and what will happen to them when they call. Field contact will mimic what the California Department of Food and Agriculture (CDFA) proposes for increased participation by practitioners. This involves periodic calling of practitioners to give an update of our programs (subject to the discretion of the AVIC), contribute to public relations between USDA and private practices, and initiate awareness of our concern for FAD's. It would also give us the opportunity to reduce the timidity involved when practitioners or producers pick up the phone to call us with information on sick swine to be sampled. The more we communicate, the easier it is for the practitioners to phone in possible FAD suspects. Due to the marked reduction in swine practitioners in most states except some Midwestern states, FAD teaching sessions also need to be held with producers and industry representatives, and with youth groups like FFA and 4-H. In each of these sessions, FAD materials, currently in the works at CEAH, will be handed out to provide information and point of contact phone numbers. All in all, we need to create public relations contacts such that we remove the fear in reporting and explain the substantial benefit we expect by reducing the spread of FAD's. Even though endemic disease look-alikes are going to be called in, we want to impart the value of those call-ins to people working around swine.

Future considerations

The surveillance for any foreign animal disease including CSF is a rapidly evolving project. As new technologies become available and are evaluated, the CSF Surveillance Plan will be modified to incorporate this technology in an effort to provide for reliable reporting and early notification. Testing strategies may change as new testing methods come on-line.

As the National Animal Health Laboratory Networks (NAHLN) phase-in begins and Real Time - Polymerase Chain Reaction (RT-PCR) testing becomes available to NAHLN labs following validation, national surveillance for CSF will evolve to new levels of efficiency. NAHLN capability for CSF RT-PCR testing may become available at some point in mid 2004. At the time the CSF Review Team is notified that the NAHLN labs are on-line and the RT-PCR testing is available, an addendum to this FY 2004 CSF Surveillance Plan will be provided to explain procedures, a protocol for confirmation of positive test results, and any necessary information related to sampling.

Revisions to the CSF Surveillance Plan are expected to occur on an annual basis. As the NAHLN labs come on-line and other mid-year revisions become necessary, an addendum to the current surveillance plan will be issued. It is expected that updates on animal identification, on the CSF pathways consortium recommendations and conclusions, and on database collaborative efforts will be provided in annual revisions.

Attachments:

Appendix 1: Samples for CSF Surveillance

Appendix 2: CSF Funding Allocations

Appendix 3: The CSF Lotus Notes database.

Appendix 1 of CSF surveillance document

Swine tonsil

Samples for CSF surveillance

Samples for CSF detection or isolation:

1. Tonsil is the primary organ for virus detection/isolation during acute and chronic infection. Tonsils will be screened by DFA/ABC, and virus isolation would follow to confirm suspect or positive DFA/ABC results
2. Nasal swab in 1.5 ml of DMEM broth with high antibiotics will be tested by VI and realtime PCR
3. Spleen and lymph node are secondary tissues for detection of CSF and **won't** be examined for a routine CSF surveillance unless the results on other samples are doubtful.
4. Whole blood in green (heparin anticoagulant) or purple (EDTA anticoagulant) top tube for PCR or green top (heparin anticoagulant) for VI. This sample will be considered for testing if no other organs can be submitted.

General instruction:

1. Tissue or swab is **preferably** stored at 4^{o} C (39^{o} F)(refrigerated) and shipped on ice packs within 1-2 days of collection.
2. If a tissue or swab cannot be shipped within 1-2 days, they can be stored at -70^{o} C (-94^{o} F)(diagnostic labs) or in a blast freezer (processing plants) for a maximum of 3-7 days. Frozen samples should be shipped on ice packs or dry ice (if available) by FedEx. Only VI will be conducted on tissues frozen prior to shipping.
3. Minimum amount of tissues should **not be less than 1 x 1 inch** in size or **not less than 1 gm** in weight. Tonsils from 2-3 animals from the same pen or farm can be pooled in one bag.

4. Tonsil scraping should be preserved in a minimum amount of transport media (DMEM or BHI). Store at 4° C (39° F) until shipped.
5. Minimum of 1 ml serum or 2 ml of red top tube (clot tube) of blood is required to conduct the serological tests. Store serum at 4 C (39° F) until shipped.
6. Minimum of 5 ml of whole blood (green top and/or purple top tube) is required to conduct virus isolation. Store at 4° C (39° F) until shipped.
7. All samples should be properly labeled.
8. Fill out the VS 10-4 form including history and lesion descriptions, definitive diagnosis (if determined by diagnostic labs) and contact number for the submitter.
9. Place a copy of the submission form on the outside and the inside of shipping container.
10. Ship samples by overnight FedEx, do **NOT** use regular UPS or postal service.

Materials:

Sterile dacron swabs are available through the supply network and are preferable for nasal swabbing. Cotton swabs do not maintain viral titers as well, thus less desirable for accurate results.

Nasal swab:

Type of swab:

Dacron swab is recommended for VI and PCR for a better chance of virus recovery.

Nasal swab collection:

The sterile dacron swab should be introduced no more than 1 inch into both nostrils making circular moves (five times) to wipe the surface of the nasal mucosa. Then, the swab is introduced into a refrigerated sterile tube containing 2 ml DMEM media. Swab can be discarded after it has been swirled in the media for 5-6 times.

Source for swab and media

Dacron swab and DMEM media will be provided in the FADD kit or they can be purchased from the following source:

Dulbecco's Minimal Essential Medium (DMEM) (Gibco, cat# 12430-054), phone 1-800-874-4226. This medium can be stored at 4 C (39° F) for 12 months. Please do not freeze.

Sterile Dacron swabs polyester fiber tipped with plastic shafts (FisherBrand, cat#14-959-90), phone: 1 800 766-7000.

Sample for serology:

Serum or blood in red top tube. (minimum 1 ml serum / 2 ml whole blood)

Laboratory results:

All laboratory reports will be faxed to the AVIC's office of the submitting State.

Turn around time for test results:

Serology takes 3-10 days

Immunohistochemistry (DFA and ABC) on frozen sections takes 3 days

Virus isolation takes 3-7 days

Abbreviations:

ABC: avidin-biotin complex

BHI: brain-heart infusion

DFA: direct fluorescent antibody test

DMEM: Dulbecco/Vogt modified Eagle's minimum essential media for cell culture

PCR: polymerase chain reaction

VI: virus isolation

Special Notes applicable to sample collections:

1) Cotton swabs only suitable for virus isolation, not PCR.
2) Tonsil scrapings may be suitable in a live animal. Tonsil biopsy does not conform to animal welfare considerations.
3) Tissue and blood collection priorities for diagnostics.
    a. Slaughter / euthanasia / diagnostic lab necropsies:
        i. 1st. Tonsil is the primary tissue. Secondary tissues are lymph node, spleen, liver, kidney, distal ileum. Note: distal ileum is never to be enclosed in the same container as other tissues. Ship these tissues, and
        ii. 2nd. nasal swab, and
        iii. 3rd. whole blood (green or purple-topped tubes) and sera.
        iv. Note: It is expected that these animals be fully utilized by collecting <u>all</u> possible tissues. It may save a diagnosis that otherwise would not be possible. The laboratory can always discard unnecessary tissues.
    b. Live animal:
        i. nasal swab, and/or
        ii. tonsil scraping, and/or
        iii. whole blood, or
        iv. serum.
    c. Recently dead suspect animal (based on clinical signs and/or history):
        i. 1st. nasal swab, and
        ii. 2nd. unclotted blood, or
        iii. clotted blood if too much time has elapsed, and
        iv. tissues (especially tonsil) from necropsy specimen as above and as available.

Shipping address:

To: Tom McKenna
USDA, APHIS, VS, FADDL
Route 25, Orient Point Warehouse
579 Edwards Ave
Calverton, NY 11933

FADDL phone numbers:

Main: 631 323 3206/3256

Cell (after hours):

(631) 871-3112

(631) 375-5314

Appendix 2 of CSF surveillance document

CSF Funding Allocation

Budget is $500,000 - $60,000 (PR) - $3,000 (Misc) =	**$437,000**
Minimum of $2,000 / state	
Less $2,000 /state minimum (50 * $2,000) =	**$337,000**
No state gets more than $40,000	

	FY 02 Imports		1999 Population (Thousands)	% of Imports	% of Population	Total %/2	Funding
Alabama	8,618	AL	175	0.1%	0.3%	0.2%	$2,743
Alaska	436	AK	1	0.0%	0.0%	0.0%	$2,016
Arizona	1,362	AZ	140	0.0%	0.2%	0.1%	$2,436
Arkansas	532	AR	710	0.0%	1.2%	0.6%	$4,031
California	326,253	CA	190	5.5%	0.3%	2.9%	$11,839
Colorado	3,333	CO	910	0.1%	1.5%	0.8%	$4,679
Connecticut	37	CT	4	0.0%	0.0%	0.0%	$2,011
Delaware	31	DE	27	0.0%	0.0%	0.0%	$2,078
Florida	316	FL	40	0.0%	0.1%	0.0%	$2,123
Georgia	72	GA	480	0.0%	0.8%	0.4%	$3,365
Hawaii	7,782	HI	28	0.1%	0.0%	0.1%	$2,301
Idaho	44,599	ID	22	0.8%	0.0%	0.4%	$3,334
Illinois	122,128	IL	4,050	2.1%	6.8%	4.4%	$16,981
Indiana	170,057	IN	3,250	2.9%	5.5%	4.2%	$16,075
Iowa	2,255,322	IA	15,400	38.1%	26.0%	32.1%	$40,000
Kansas	1,786	KS	1,460	0.0%	2.5%	1.2%	$6,197
Kentucky	80,842	KY	460	1.4%	0.8%	1.1%	$5,610
Louisiana	0	LA	29	0.0%	0.0%	0.0%	$2,082
Maine	1,559	ME	7	0.0%	0.0%	0.0%	$2,064
Maryland	2,235	MD	55	0.0%	0.1%	0.1%	$2,220
Massachusetts	2,410	MA	20	0.0%	0.0%	0.0%	$2,125
Michigan	68,368	MI	980	1.2%	1.7%	1.4%	$6,731
Minnesota	1,087,353	MN	5,500	18.4%	9.3%	13.8%	$40,000
Mississippi	0	MS	280	0.0%	0.5%	0.2%	$2,795
Missouri	4,239	MO	3,150	0.1%	5.3%	2.7%	$11,065
Montana	9,842	MT	155	0.2%	0.3%	0.2%	$2,721
Nebraska	224,297	NE	3,000	3.8%	5.1%	4.4%	$16,911
Nevada	0	NV	8	0.0%	0.0%	0.0%	$2,021
New Hampshire	277	NH	4	0.0%	0.0%	0.0%	$2,018
New Jersey	160	NJ	15	0.0%	0.0%	0.0%	$2,047
New Mexico	29	NM	6	0.0%	0.0%	0.0%	$2,018
New York	3,554	NY	40	0.1%	0.1%	0.1%	$2,215
North Carolina	3,162	NC	9,500	0.1%	16.0%	8.0%	$29,065
North Dakota	101,630	ND	190	1.7%	0.3%	1.0%	$5,436

	FY 02 Imports		1999 Population (Thousands)	% of Imports	% of Population	Total %/2	Funding
Ohio	93,211	OH	1,480	1.6%	2.5%	2.0%	$8,859
Oklahoma	2,428	OK	2,260	0.0%	3.8%	1.9%	$8,486
Oregon	108,939	OR	30	1.8%	0.1%	0.9%	$5,190
Pennsylvania	62,467	PA	1,050	1.1%	1.8%	1.4%	$6,762
Rhode Island	180	RI	3	0.0%	0.0%	0.0%	$2,012
South Carolina	0	SC	245	0.0%	0.4%	0.2%	$2,696
South Dakota	767,882	SD	1,260	13.0%	2.1%	7.6%	$27,464
Tennessee	75,711	TN	250	1.3%	0.4%	0.9%	$4,868
Texas	12,982	TX	870	0.2%	1.5%	0.8%	$4,840
Utah	1,831	UT	520	0.0%	0.9%	0.5%	$3,529
Vermont	1,701	VT	3	0.0%	0.0%	0.0%	$2,057
Virginia	2,619	VA	370	0.0%	0.6%	0.3%	$3,125
Washington	21,834	WA	30	0.4%	0.1%	0.2%	$2,708
West Virginia	0	WV	12	0.0%	0.0%	0.0%	$2,034
Wisconsin	227,337	WI	570	3.8%	1.0%	2.4%	$10,098
Wyoming	0	WY	105	0.0%	0.2%	0.1%	$2,298
Totals	**5,911,743**		**59,342**			**1**	**$358,381**

Not Budgeted and Available $78,619

Appendix 3 of CSF surveillance document

The Lotus Notes CSF database

Access to the CSF database:

File ➔ database ➔ open ➔ set server to data 01 or data 02 ➔ allow time to load and then look for CSF folder under the database window ➔ double click CSF

How to enter information:

At the top, hit the 'Create New report' button.

Entries into the New Report:

1) Enter state from drop-down box
2) Enter date of report
3) Enter type of report as monthly or quarterly (low risk reporting is quarterly and high or very high risk reporting is monthly)
4) Enter reference number: example 2003KYCSF02. First enter the fiscal year as in 2003, enter the state postal code, enter CSF, and then enter the sequential numbering for reports made for that fiscal year (1 through 12 in high and very high risk states; 1 through 4 in low risk states).
5) Enter surveillance period dates
6) Under Surveillance Sampling: enter number of samples, type of sample from drop-down box, source of samples from drop-down box, and risk category of samples. Note: risk categories are determined by AVIC and state veterinarian based upon a CSF Surveillance Plan approved at the Regional Level.
7) Comments and e-mail information for notifying others of the report is available as needed.
8) When finished entering data, hit the 'save and close' button at the top of the document. The document will no be entered into the CSF database.

Additional information:

The CSF Surveillance activities can be viewed VS-wide by any person interested in looking at the surveillance activities nationally. It is in the best interest of the AVIC to assure that this documentation is up-to-date.

Appendix 5.7 Example CSF Surveillance Questions

1. What type of surveillance is going on in each state for CSF? (Samples collected/sampling methods, amount of samples sent to Plum, population sampled, turnover time, etc.)
2. What type of sampling strategy should we use within the USDA for CSF for domestic and feral swine? Should it be based on clinical reporting only? What are the relative merits of active vs. passive surveillance?
3. Are states receiving money for the surveillance they are doing?
4. Which states do you feel should participate in CSF surveillance?
5. What are the planned surveillance strategies for CSF? Any new surveillance methods, such as sentinel herds?
6. Is there any type of surveillance going on at the borders or ports of entry?
7. What is your view of programmatic decisions affecting the border? Do these decisions affect inspectors' ability to "sense" possible contraband (i.e. complacency due to profiling, decreased "sense")? How do you feel is the best way to educate veterinarians of FADs?
8. Do you feel that real-time PCR would be a feasible approach for border surveillance? How confident are you in using real-time PCR for CSF diagnosis? How many samples would be required to confirm a positive?
9. Are any states actively sampling the feral pig population? If so, which states, where are they sampling, and how often?
10. Do you feel there is a need to do surveillance for CSF in the feral population? What is the best way to sample feral swine? Do you think industry should play a role in this especially for trying to detect low virulence CSF?
11. What are your concerns about low virulent strains of CSF? Does our current CSF surveillance take the possibility of low virulent CSF into account? Do you think there are truly low virulent strains out there, or is it just a function of the virus being in an endemic are? Would a "low virulent "CSF strain, such as from Mexico, become high virulent if introduced into a naïve population, such as in the United States?

12. Do you feel CSF has come into the US since it has been eradicated, but just has not found the right pathway to become established?
13. Are results from the states testing for CSF kept in a national database? State database?
14. What are your feelings on database integration in regards to CSF surveillance?
15. What will be the role of the National Animal Health Laboratory Network (NAHLN) in regards to CSF surveillance?
16. How well to states know what other states are doing in regards to CSF surveillance?
17. Do you feel that there is enough communication between the federal, state and local government in regards to FAD's? How could this be improved?
18. What is the best sampling strategy during an outbreak to prevent overcapacity at labs?
19. What would you suggest is the best way to conduct surveillance for CSF?
20. If you could develop your own CSF surveillance program what areas would you target? What new types of surveillance strategies would you include in your program?
21. What preventative measures do you feel we should take in order to keep CSF out of the US?
22. Do you think we should target surveillance, such as in high risk areas, during certain times of the year, etc.? Where would you target and why?
23. Do you think there should be more surveillance in slaughterhouses for foreign animal diseases (FAD), specifically Classical Swine Fever (CSF)? What do you feel needs to improve? What is the best sampling strategy to detect FADs?
24. How do you prevent CSF instead of waiting and responding to it? Will we ever move away from making response the number one action to making prevention the number one action?
25. What do you feel are the advantages/disadvantages of using sentinel herds as part of surveillance?
26. In a country that is not endemic do you feel there should be CSF surveillance on animals that are being checked for swine diseases that can mask CSF?
27. How do you feel the US surveillance is compared to other countries that are endemic with CSF or are free of the disease?
28. What country is the best at CSF surveillance?
29. How long do you feel CSF could go undetected without the hogs showing any clinical signs for CSF? How often do you think heat stroke could mask CSF especially if it is in its low virulence form?

30. Is there a targeted type of surveillance for CSF going on in endemic countries/ non-endemic countries such as the feral population, high risk geographical areas, and garbage feeders etc? What are the relative merits of passive versus active surveillance for CSF, such as clinical reporting versus serological reporting? Are there new surveillance strategies for CSF being planned?
31. Is there a reporting system for smuggled goods into the US? Illegal goods? Is there an obligation to report this? Where do you think are the high risk areas for smuggled/illegal goods? Do you think the US should let the public know about an increase of confiscated goods, especially vets and interested parties, so that a "red flag" goes up if there is an increase?
32. Do you feel FSIS is ready for a CSF outbreak? Where do you FSIS is vulnerable in detecting Foreign Animal Diseases?
33. What is the process of when inspectors see a diseased carcass? Is it tested right away? How is the diseased carcass disposed of? What is done with suspicious carcasses?
34. What is the overall ethnicity of workers in slaughterhouses in the US?
35. How do you feel about the training of inspectors for identifying diseased carcasses?
36. Where do you feel the USDA is the most short staffed for detecting a foreign animal disease?
37. How often are ill/poor-doing pigs seen by practitioners? What are the common clinical signs seen (high fever, constipation, diarrhea, abortion, not eating, etc.)?
38. Do you think sick feral swine are reported?
39. Do you think veterinarians have a false sense of security regarding CSF since it has been eradicated from the US for so long?
40. How well educated is industry in regards to CSF? What are producer's attitudes/concerns towards CSF?
41. What do you think is industries responsibility in FAD prevention? How do you feel government and industry should work together in disease prevention?
42. How often are pigs transported across the US…is this monitored?
43. How well do farms follow biosecurity measures? What do we need to improve?
44. What are your feelings about biosecurity in pig operations? Should we have a standard swine health program? What would be your suggestions as to what should be included in this with regards to foreign animal disease prevention and surveillance?
45. Do you think there should be collaboration between the US and other countries to eradicate CSF in these countries?

46. What do you feel is the best eradication method for CSF?
47. How often do you feel feral pigs are moved between states (such as for hunting purposes?
48. Is there seasons when you feel feral hogs are hunted or trapped more often? When people catch feral hogs what do they do with them?
49. How often do feral swine come through slaughterhouses (legally and illegally)?
50. Where do you feel our knowledge is lacking in regards to the feral swine population?
51. If we had CSF in the feral population in Florida, how long do you feel it would take to eradicate? If just domestic? What about this same scenario in Texas?
52. If CSF got into our feral population, especially in Texas, Florida, or in North/South Carolina, how would you go about eradicating? How would we kill 1000s of feral swine if needed?
53. Do you think our feral swine population needs to be better controlled? How do you do this?
54. In ten years where do you see our feral population increasing/decreasing? In 20 years?
55. What do feel needs to be done with garbage feeding regulations?
56. What are your feelings about unregulated markets such as flea markets selling variety of animals?
57. What conditions would be required before state veterinarians in charge stop movement of animals or initiate slaughtering of swine? Would they wait for confirmation from Plum first?
58. If CSF came into the US, do you think pig owners would let their pigs free?
59. How well is our trace back for swine (commercial versus garbage and backyard operations)?
60. How well is trace back at the Southern Wild Game slaughter plant in Devine, TX that slaughters feral swine (about 95-99% of which gets shipped to Europe)? Would we know which feral swine came from Texas and which came from Florida or another state? Why are we not surveying for CSF at this slaughter plant and should we be?
61. Is there a distinction between commercial, backyard and feral swine recognized by government? How does government define swine in backyard operations and would government reimburse owners if these swine were to be slaughtered for CSF?
62. Puerto Rico (PR) is considered the highest risk for Classical Swine Fever (CSF) introduction into the United States. What are the reasons for this?
63. What are the high risk areas in PR for CSF introduction?

64. What are the most likely ways CSF will come into PR?
65. How often are small boats found along the coasts of PR? How significant of a threat is this? Where do most of the immigrants originate from (Dominican Republic, Haiti, etc.)? What do the immigrants bring with them (pig meat, live pigs, etc.)? Are there seasons where more boats are found?
66. What agency is responsible for regulating small boat traffic around PR? If immigrants are caught coming to PR, what happens? Are there records kept regarding the number of immigrants in the boat, what the immigrants had on them (i.e. pig meat, live pigs, etc.)?
67. Do you think it is likely CSF has come into Puerto Rico but has not found the pathways within PR to establish?
68. How do you think the first case of CSF will be diagnosed in PR?
69. How many pig operations/backyard pig operations/garbage feeders/pig owners/slaughterhouses are in PR?
70. How much training do practitioners have in PR to identify CSF?
71. Is there active sampling of the feral pig population? If so, where are they sampling, and how often?
72. Are there food inspectors in PR? Where do you think they are vulnerable in detecting Foreign Animal Diseases?
73. How well do farms follow biosecurity measures in PR? What do we need to improve?
74. Do you think there should be collaboration between the US and other countries to eradicate CSF in these countries?
75. What are your concerns about misdiagnosing CSF, especially if it is low virulent? How easy could low virulent CSF come into PR undetected? What are the clinical signs of low virulent CSF?
76. If CSF came into PR/US, do you think pig owners would let their pigs free?
77. Are there FADD in PR? How many?
78. If CSF suspected, where do you send the samples? How long does it take for samples to arrive at the lab? Would there potential problems in sending samples with certain weather events, such as hurricanes? How long could a diagnosis be delayed?
79. Do you think CSF prevalence is underreported in the Caribbean?
80. What current surveillance program is in place right not to ensure CSF is not in north Mexico? How is CSF being kept out of the north?