Assessing the Impact and Prevention Strategies for African Swine Fever

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Abstract:
African swine fever is a significant threat to the food supply and the economy of the U.S. and other nations around the world. African swine fever is a highly contagious disease that affects domestic and feral pigs. There are currently no treatments or vaccines commercially available for this disease, which has a high mortality rate. Multiple outbreaks have facilitated the spread of the disease from East Africa to Asia, and later throughout Europe. African swine fever has devastated the Chinese pork industry, causing the loss of about half of its herd. U.S. pork production has increased in order to respond to the growing demand of pork and pork products in China. In recent years, annual pork exports to China generated over $6 billion to the U.S. economy. Multiple government agencies are working together to prevent the introduction of the disease into the U.S., as well as developing countermeasures to protect domestic herds. As the disease continues to spread throughout Europe and Asia, the demand and prices surge in China, and the production increases in the U.S. to new record highs. It is important to anticipate and prepare for the possibility of African swine fever impacting the pork industry in the US in the near future.

Introduction:
African swine fever (ASF) is a highly contagious swine disease which results from infection with African Swine Fever Virus (ASFV). Although it does not transmit to humans, ASF represents a significant threat to the food supply and the livelihood of people in the U.S. and around the world.

ASF causes hemorrhagic fever in domestic pigs and its mortality rate is close to 100% (Galindo & Alonso, 2017). The Center for Food Security and Public Health (CFSPH) reports the incubation time for ASF is between four days to over two weeks, which means infected animals may be transported or processed before they show clinical signs (Spickler, 2019). The same report indicates the symptoms of ASF vary widely from weakness, fever, and anorexia, to more severe effects as ulcerations, cyanosis (extremities, ears and tail), hemorrhage, vomiting, diarrhea, abortions, erythema and neurological signs; the animals often succumb to the disease within 10 days.

The disease was first documented in the early 1900s, in Kenya (Montgomery, 1921). From East Africa, the disease spread throughout sub-Saharan countries and by 1960 it had reached the Iberian Peninsula and the Caribbean (see fig. 1). After being mostly eradicated outside of Africa, ASF reemerged in the Republic of Georgia in 2007; from there, it spread through neighboring countries and reached as far as Estonia and Poland (Sánchez-Cordón et al., 2018). The Congressional Research Service[1] (CRS) indicated that the latest outbreak reported in China, between 2018 and 2019, caused the loss of more than 2 million pigs (Angadjivand & Greene, 2019).

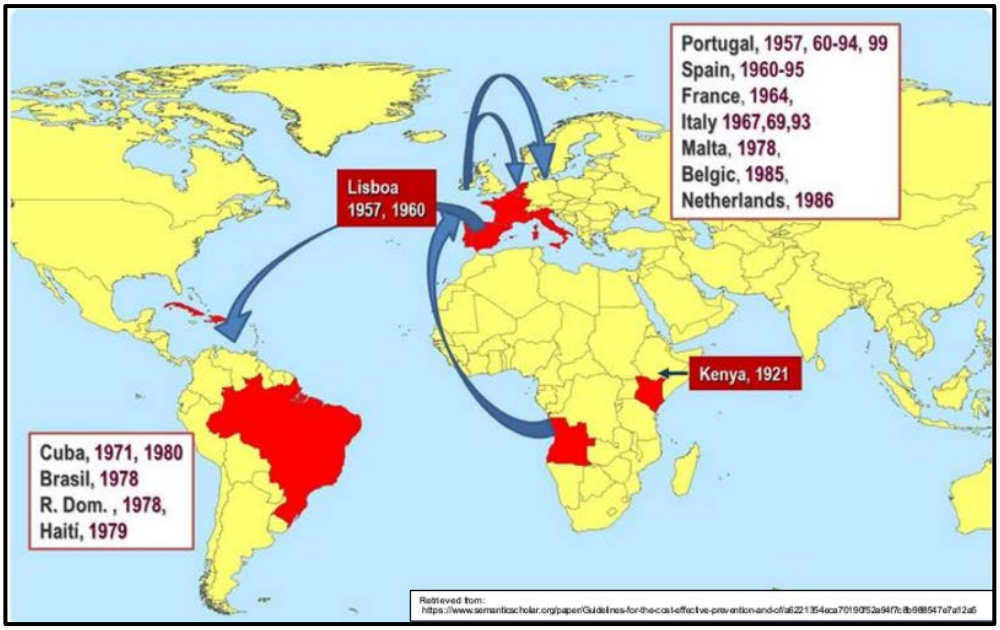


Figure 1
Figure 1 shows the spread of the Africa swine fever virus from the 1960s through 1990s, from Africa to Europe, South America and the Caribbean.

Problem definition:
African swine fever is not a new problem. It is a serious problem not given enough attention and urgency for many years. Although the host and means of transmission for ASF have been known for decades, inconsistent funding for research of this disease has slowed down progress towards its eradication. According to a Government Accountability Office[2] (GAO) report (2005), due to budget reductions the USDA Agricultural Research Service[3] (ARS) terminated the research on ASF conducted in Plum Island Animal Disease Center[4] in 2004. Research on this disease did not resume until 2010, and in 2018 the ARS allocated "$324,000 toward ASF vaccine development" (Seddiq, 2019).

African swine fever is transmitted via multiple mechanisms, which makes its containment very challenging (see fig. 2). According to USDA (2019), ASF can be transmitted by:

- Sick to healthy animals through body fluids and excretions,
- Soft ticks (*Ornithodoros moubata),*
- Wild boars feeding on carcasses of infected animals, and
- Feeding contaminated garbage to domestic pigs.

The virus is very resistant to environmental conditions and can survive in excretions from sick animals for about a week (USDA, 2019), in processed meats (e.g. ham) made from infected animals for more than a year, and even survive repeated freeze-thaw cycles (Mazur- Panasiuk et al., 2019). This makes feeding garbage to domestic herds a dangerous practice when trying

to prevent or contain ASF. Ticks act as vectors, contributing to spreading ASF between domestic and feral pigs. Currently there are no treatments or commercially available vaccine for ASF (USDA, 2019), which is a makes the disease a looming threat to countries that heavily consume or export pork and pork products.

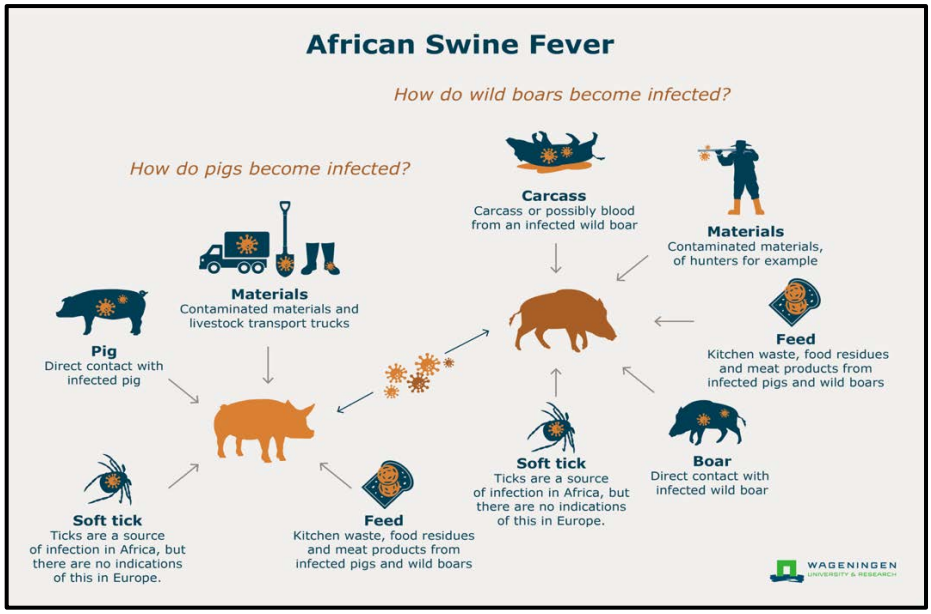


Figure 2

Figure 2 shows the possible infection routes for African swine fever, in both domestic and feral pigs.

The consumption of pork and pork products in China has been increasing over the years, and so have the prices for this meat. In 2019, the per capita consumption of pork was estimated to be over 66 lbs. in China, which has not been able to keep up with the growing demand for pork (van der Zee and Standeart, 2019). As the consumption increased, in recent years the production has drastically decreased. ASF has caused a tremendous impact to China's pork industry, leading to a deficit in their domestic supply and the inevitable surge in prices (van der Zee and Standeart, 2019). According to a CRS report the shortage of pork in China is attributed to the latest outbreak of ASF which, in less than a year, killed over 2 million pigs (Angadjivand & Greene, 2019). The reported number of animals China has lost due to ASF vary from source to source. The *Financial Times* reported that about 100 million pigs have died from ASF in China since the beginning of the outbreak (Terazono et al., 2020). What is certain is that these dramatic losses will inevitably impact other markets around the world. As a result of the latest outbreak, China's pork imports from the U.S. have tripled, despite tariffs imposed by the current administration (Angadjivand & Greene, 2019).

China has not been able to eradicate or even contain outbreaks of ASF, which normally involves culling entire herds. Consequently, in order to fill its deficit of pork production, China rolled back some trade restrictions and increased meat imports by 63% last year (Terazono et al., 2020). This increased demand has put more pressure on farmers in countries like Brazil and Australia (Terazono et al., 2020), in addition to their suppliers in the U.S., Canada, and the EU; which is likely to raise meat prices globally (Angadjivand & Greene, 2019). Australia, for example, increased its meat exports to China by 81% in 2019, and diverted production that was previously being shipped to Japan and other countries (Terazono et al., 2020). The environmental impact derived from the accelerated increase of meat production in these countries is still unknown.

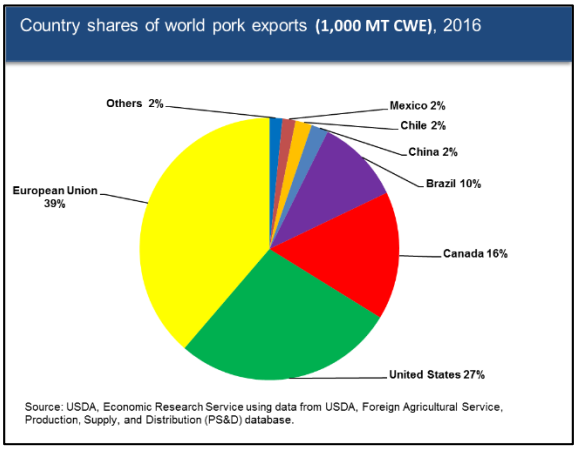
On the other hand, a shrinking swine population in China means it may require far less feeds than in years prior to ASF outbreaks (Wang & Bray, 2019). Soybeans are a valuable crop to produce animal feeds in China, which was taking in “over 90 million metric tons” annually; making it the world’s largest soybean importer (Angadjivand & Greene, 2019). Until recently, soybeans used to be the “largest agricultural export” of the U.S, generating over $20 billion annually (Choe et al., 2019).

The combined effect of reduced demand for animal feeds due to ASF and the ongoing trade war between China and the U.S., have led to a steep decline in soybean exports to China. In 2018, the U.S. Trade Representative (USTR) determined that practices and policies of the Chinese government related to intellectual property and technology transfer “burden or restrict the U.S. commerce”, and imposed tariff actions in accordance with the Trade Act of 1974, 19 U.S.C. § 2411 section 301 (USTR, 2020). The most recent trade war escalation between China and the U.S. resulted in 50% tariffs on soybean imports from the U.S. (van der Zee and Standeart, 2019). Soybean producers in the U.S. have turned to “government aid programs, slashing prices, and finding new markets” to make up for their losses, after the exports dropped close to 75% (Choe et al., 2019). These losses however, are not the only way the U.S. could be affected by ASF.

Production of pork and pork products have significantly increased in the U.S. in recent years, which responds to an increased demand in both domestic and foreign markets. The *Farm Journal* reported that the annual per capita consumption of pork in the U.S. was estimated at 51 lbs. in 2019. The production was estimated to exceed 27 billion lbs. during that same year, and is only expected to increase (Peel, 2019). In the U.S. the production of pork matched the production of beef in 2018, and the export of pork products accounted for $6.4 billion, according to the USDA Economic Research Service[5] (ERS).

Satisfying this increasing demand has driven companies to expand their operations. For example, two new plants in Iowa would increase the daily production by 30,000 hogs (Dewey, 2017). The U.S. is now among the top-3 exporters of pork and pork products in the world, (see fig. 3 and 4) (ERS, 2019). Considering the volume of international trade, frequency of transoceanic commercial flights, and most importantly, the resilient characteristics of the virus, it is conceivable that sooner or later this disease will show up among swine herds in the U.S.

Should ASF appear in U.S. in pig farms, the most likely response from other countries would be to restrict the import of pork products (ERS, 2019). Additionally, disease outbreaks have proven challenging to contain in other countries. The loss of revenue to U.S. producers due to closed markets would be in the billions of dollars. According to the USDA Animal and Plant Health Inspection Service[6] (APHIS), wild boars are an invasive species in the U.S., threaten crops like soybean, corn, and peanuts, and are present in 35 States (APHIS, 2020). Since wild boars are known to carry and spread ASF, they would be a significant obstacle in containing a potential outbreak in the U.S.



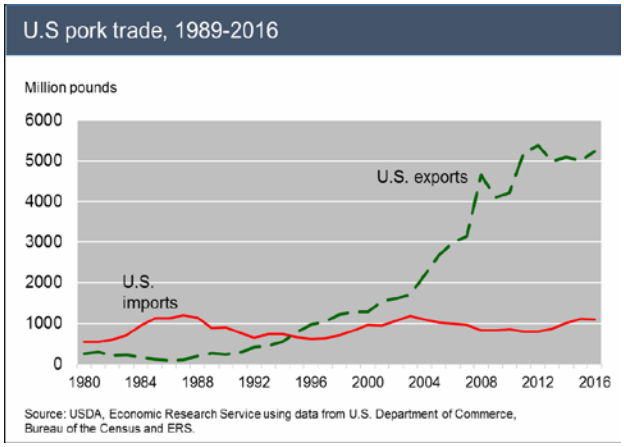


Figure 3 *Figure 4*

Figure 3 shows the U.S. among main pork exporters in 2016. Figure 4 shows growing trend of U.S. exports since the 1990s

Solution:

Protecting the pork industry in the U.S. from ASF should address three main areas of concern:

- Preventing the disease form entering the U.S. by detection of potential vehicles of the virus,
- Increasing surveillance of domestic herds for early detection of the disease and supporting research initiatives to develop countermeasures, and
- Implementation of rapid and coordinated containment strategies at Federal, State, and local levels of government.

APHIS is responsible for the prevention and control of animal diseases. To address the threat of ASF, APHIS builds partnerships with the Food and Drug Administration (FDA), Environmental Protection Agency (EPA), Customs and Border Protection (CBP), and individual states as well as its neighboring counterpart, the Canadian Food Inspection Agency (CFIA) (Angadjivand & Greene, 2019).

The CBP (2019), through agricultural experts and officers, prevents the entry of items that could threaten the U.S. agriculture, environment, and economy. According to the CRS, airline

baggage and mail pose the greatest risk for ASF entering the U.S., and to further increase detection capability, highly trained dogs known as “Beagle Brigade” are deployed at ports of entry (Angadjivand & Greene, 2019). CBP considers beagles an ideal dog breed not only for their acute sense of smell, but also their size and disposition; which allows them to rapidly maneuver through bags without intimidating passengers (CBP, 2016). An example of their detection capability came in 2018, when a roasted pig head brought by a passenger at Hartsfield-Jackson International airport, Atlanta was spotted by the Beagle Brigade (USDA, 2018). This highlights not only the effectiveness of these dogs in detecting illegal food products, but also the necessity to better educate the general public. The dangers of introducing animal diseases should receive more media coverage, and not rely merely on signs that exhausted passengers may or may not feel compelled to read.

CRS reports that in recent years ASF testing has been implemented for herds considered at higher risk due to “exposure to feral swine or garbage feeding.” Diagnostic tests for ASF are performed in specialized laboratories in Plum Island Animal Disease Center, using blood or various animal tissues (Angadjivand & Greene, 2019). Current testing methods include:

- Virus isolation is used in diagnosis from blood or tissue samples. It involves ‘growing’ the virus in cultured cells and can take 21 days to complete (USDA, 2019).
- Laboratory tests like ELISA and IFA work by detecting for the presence of viral proteins (antigens) in serum samples. The process takes ~1 day (USDA, 2019) but is less sensitive in samples from chronic infections (Spickler, 2019).
- Real time PCR can detect viral DNA in blood or tissue samples, like spleen and lymph nodes, takes ~3 hours to analyze a specimen, and is more sensitive (USDA, 2019).

Rapid and sensitive tests are important to detect the presence of ASF and the extent of a possible outbreak. Equally important is having the capability to contain the disease once it has been identified circulating in domestic herds. Because of its high impact, if ASF is detected in the U.S., it must be communicated to the State Animal Health Official (USDA, 2019) and the World Organization of Animal Health (OIE) (2020). The primary means of containing ASF, in absence of therapeutics, is depopulating affected and exposed animals, according to APHIS (2020). In 2019, the USDA drafted the “Disease Response Strategy for African Swine Fever”, which provides guidance to animal health emergency responders at State and Federal level, and covers epidemiology, surveillance, quarantine, disposal, and biosecurity considerations for ASF (USDA, 2019).

Aside from planning, infrastructure, and reliable funding for research, there is a need for more proactive and science-based regulations that could assist in the prevention and containment of high-consequence diseases. For example, an aggressive population control program for wild boars would facilitate the containment of an ASF outbreak. Additionally, a nationwide ban on feeding garbage to domestic swine herds would reduce even further the possibility of introducing the disease. At the time of this report, only 22 States had made the practice of feeding garbage to pigs illegal (Angadjivand & Greene, 2019).

Business benefits:
Developing treatments against high-consequence diseases is a long and costly process, and requires uniquely-designed buildings to prevent exposure to personnel and accidental release of a pathogen into the environment. Maintaining these facilities, and funding research projects, might seem expensive, and it is. According to a report from the World Health Organization (WHO) (2018), the operating cost for maximum-containment laboratories runs between $8-13 million a year. It should be noted that this type of laboratory is used to conduct research on other severe diseases, such as Foot-and-mouth disease[7] (ARS, 2020), and not only on ASF.

There are currently no treatments or commercially available vaccines for ASF. Vaccines have been tried in the past in other countries but have not been successful at protecting animals against the disease (USDA, 2019). In 2019 APHIS (2020) allocated $5.2 million to the prevention, detection and response of animal disease from entering the U.S. It is hard to quantify the financial impact that ASF could cause, should it enter the U.S. For example, one report estimates the losses to the pork industry would be between $1-7 billion annually (Lusk, 2019). In recent months, investigators from Plum Island reported in the *Journal of Virology* the development of an experimental vaccine able to confer immunity against ASF in pigs. This vaccine is very promising for the prevention of ASF, because it was tested against the virus strain involved in the most recent outbreaks (Borca et al., 2020). This puts us one step closer towards eradicating a disease that can jeopardize the livelihood of farmers in the U.S., as it has in nations around the world.

Conclusion:
With no treatments available, containing ASF means sacrificing millions of animals, which increases pressure on the pork industry around the world. As Europe and Asia struggle to contain ASF outbreaks, the U.S. has prepared an aggressive response to prevent the disease from spreading, if detected among local herds. Research of high-consequence diseases, like ASF, should receive substantial uninterrupted funding. Additionally, maintaining specialized research facilities can help not only address the threat of ASF, but also better respond to novel infectious diseases that might emerge in the future. [8]

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Notes:

[1] The Congressional Research Service (CRS) is a federal agency, within the Library of Congress, that assists members of Congress in legislative processes "from the early considerations that precede bill drafting, through committee hearings and floor debate, to the oversight of enacted laws and various agency activities." https://crsreports.congress.gov/

[2] The Government Accountability Office (GAO) is an "independent, nonpartisan agency that works for Congress. Often called the 'congressional watchdog', GAO examines how taxpayer dollars are spent and provides Congress and federal agencies with objective, reliable information to help the government save money and work more efficiently." https://www.gao.gov/

[3] The Agricultural Research Service (ARS) is an agency within the U.S. Department of Agriculture that conducts research to find solutions to agricultural problems from field to table. https://www.ars.usda.gov/

[4] Plum Island Animal Disease Center (PIADC) is a facility that conducts research on high-consequence foreign animal disease and develops diagnostic tools, vaccines, and other means for preventing these diseases. https://www.dhs.gov/publication/st-piadc-fact-sheet

[5] The Economic Research Service (ERS) is a component of the U.S. Department of Agriculture that conducts research on "emerging issues in agriculture, food, the environment and rural America" to inform decision makers. https://www.ers.usda.gov/

[6] The Animal and Plant Health Inspection Service (APHIS) is an agency under the U.S. Department of Agriculture that regulates genetically engineered organisms, administers the Animal Welfare Act, carries out wildlife damage management activities, and protects U.S. agriculture from pests and disease. https://www.aphis.usda.gov/aphis/home/

[7] Foot-and-mouth disease (FMD) is a highly contagious infectious disease that affects cows, pigs, sheep, goats, deer, and other animals. This disease was eradicated from the U.S. in 1929. It is caused by a virus and does not affect humans. The virus can survive in the environment for months. There is a vaccine available and can be used in the event of an outbreak, but it must be a perfect match to the specific subtype of virus. There are 60 known subtypes of FMD. https://www.aphis.usda.gov/publications/animal_health/2013/fs_fmd_general.pdf

[8] At the time of this report the U.S., and the entire world, are in the midst of a COVID-19 pandemic caused by SARS-CoV-2. The impact this disease will have on global trade, food supply, and the economy are hard to anticipate. As funding and efforts are prioritized to combat this pandemic, it is impossible to determine at this time how the funding for research initiatives on ‘less urgent’ diseases like ASF will be affected.