Viewpoint

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Will swine veterinarians lead by meeting the next-generation needs of our industry?

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ABSTRACT

The US swine industry is currently challenged by the potential of transboundary animal disease (eg, African swine fever) entry to the national herd and the relentless pressures of domestic diseases (eg, porcine reproductive and respiratory syndrome). The task of the swine veterinarian is to biosecure both the national herd and their customers' local farms to mitigate these risks. This Viewpoint raises 4 questions that swine veterinarians, including practicing (private and corporate), industry, research, academic, and regulatory (state and federal) veterinarians who spend a portion of their time controlling, treating, preventing, or eradicating diseases of swine, must answer to meet the needs of their farms to compete globally and survive. In addition, it appears that there is sufficient science-based information to move forward in a collaborative manner and that the goals of prevention of African swine fever and elimination of porcine reproductive and respiratory syndrome virus are technically possible. Therefore, as previous generations of swine veterinarians led the US industry in the elimination of foot-and-mouth disease virus, classical swine fever virus, and pseudorabies virus from the national herd, the central challenge is whether the next generation of veterinarians will provide the necessary leadership to deal with the current industry and its next-generation challenges.

As of this writing, a pathogen known as African swine fever virus (ASFV) is looming on the island of Hispaniola in the Caribbean,[1] 721 miles from Miami, Florida. Introduction of ASFV to the US swine national herd would immediately stop the exportation of pork, with long-term projections of $50 billion in losses.[2] At the same time, an endemic viral disease known as porcine reproductive and respiratory syndrome (PRRS) is costing the domestic swine industry approximately $663 million annually in production losses and increased costs,[3] with costs up to $6 per pig following lateral introduction of PRRS virus (PRRSV) into local herds, in the author's experience (GS). Therefore, it is the duty of swine veterinarians, defined in this manuscript to include practicing (private and corporate), industry, research, academic, and regulatory (state and federal) veterinarians who spend some or all of their time controlling, treating, preventing, or eradicating diseases of swine, to work together to biosecure borders to prevent the entry of ASFV into the US and biosecure their local farmers from the effects of PRRSV through virus elimination and prevention of reinfection. As the long-term goals for managing these viruses are different (prevent entry vs elimination and prevent reinfection), different approaches to biosecurity (transboundary vs domestic) are required to achieve success. As the common ground here is freedom from both pathogens, educating the industry on science-based biosecurity principles is needed to properly implement efficacious prevention strategies at the level of both the national herd and local herd.

In the late 1980s, biosecurity in the US swine industry consisted primarily of the disinfection of footwear (rubber boots) and changing of clothing (coveralls) between farms, with the occasional seedstock producer having a shower-in entry protocol and quarantine and testing program for incoming animals, in the authors' (GS and SD) experience. With the emergence of PRRSV, many new routes of transmission were identified, including direct routes (ie, infected genetic material [eg, infected pigs and contaminated semen]) and indirect routes (ie, contaminated fomites [eg, incoming farm supplies, boots, coveralls, and transport; virus-positive aerosols; and contaminated feed]).[4–9] On the basis of this information, the education and implementation of biosecurity took on greater importance, particularly at the level of the artificial insemination center and breeding herd, due to their position

in the pork production pyramid. As each route of transmission was identified, interventions were investigated, leading to the development of science-based biosecurity protocols, including the purchase of breeding stock and semen from a PRRSV-naïve source in combination with quarantine and testing, personnel shower-in procedures, decontamination of transport and incoming farm supplies, air filtration, and feed mitigation.[9–13]

Due to the economic impact of these diseases, the US swine industry is dependent upon swine veterinarians (as defined) to work together to mitigate their effects. However, many questions exist, including the following: will veterinarians collaborate and share field information? Has research delivered the necessary data to facilitate implementation of science-driven biosecurity at the transboundary and local levels? Have veterinarians transferred the technology to their farmers on how to manage these risks with proper on-farm implementation? To start the discussion, this Viewpoint raises the following 4 questions critical to success:

1. Can we prevent ASFV entry to North America?
2. Can we eliminate PRRSV from infected breed-to-wean farms?
3. Can we apply next-generation biosecurity protocols to breed-to-wean farms to prevent reinfection?
4. Can we apply first-generation biosecurity protocols to wean-to-market farms to prevent reinfection?

Following answering these questions, the final goal will be to answer the central question: will swine veterinarians lead by meeting next-generation needs of our industry?

Question 1: Can We Prevent ASFV Entry to North America?

A recent paper by Carriquiry et al[2] summarized that should ASFV incursion to the US take place, the exportation of pork would immediately stop, resulting in a surplus of domestic supply and a series of negative impacts throughout the food supply system, specifically long-term projections of $50 billion in losses, nationwide employment losses of 140,000 jobs, and downsizing of the swine industry. Therefore, it is imperative that swine veterinarians at all levels do everything possible to keep the virus out of the country. While great effort is being applied by the USDA Animal and Plant Health Inspection Service and US Customs and Border Protection to detect the importation of ASFV via smuggled meat and contaminated food products from ships and planes,[14,15] a recently identified risk factor is the importation of soy-based products from ASFV-positive countries.[16–18] The basis of this concern is that ingredients such as soybean meal and soy oil cake have been demonstrated to be highly protective for many viruses of veterinary significance, such as ASFV, foot-and-mouth disease virus, classical swine fever virus, Senecavirus A, PRRSV, and pseudorabies virus.[19–22] Over the period of January 2019 to July 2022, 6.39 million metric tons of soy products entered the US, with approximately 99.3% (6.33 million metric tons) originating from 4 of 23 ASFV-positive countries: Russia, China, Ukraine, and India **(Table 1)**. This is important because transmission of ASFV has been demonstrated following the feeding of diets formulated with soybean meal and inoculated with ASFV, and ASFV DNA has been detected in the commercial feed systems of endemically infected countries that import feed and feed ingredients to the US.[23,24]

To document this risk of feed imports, case studies[25–27] describing transmission of porcine epidemic diarrhea virus (PEDv) into swine herds in Latin America and Asia, along with the initial introduction of Senecavirus A into a historically naïve national swine herd following importation of soybean meal from a known positive country have been published. While it is fortunate that this was not ASFV or foot-and-mouth disease virus, these cases are occurring across multiple continents, validating published data on feed risk generated at the laboratory level and raising awareness that this is occurring worldwide.

As a means to manage the risk of feed, the US swine industry has adapted the practice of Responsible Imports, a procedure that isolates and stores feed imports for designated time and temperature prior to use at the mill.[28,29] This approach has been adapted throughout North America, and since 2019, a national program of managing high-risk feed imports such as grains and oil seeds from ASFV-positive countries

Table 1—Total soy imports in million metric tons into the US from 23 African swine fever virus–positive countries over the period of January 2019 to July 2022, as compiled by the authors of the present Viewpoint.

Country	Year 2022 (January–July)	2021	2020	2019	Total 2019–2022	% of total
India	229,703	1,009,127	1,706,487	1,584,008	4,529,324	70.87%
Russia	271,902	306,511	257,910	82,643	918,966	14.38%
Ukraine	191,162	200,505	224,389	160,581	776,637	12.15%
China	46,745	40,618	7,582	24,734	119,679	1.87%
All others*	2,693	5,822	10,091	27,860	46,466	0.73%
Total	**742,205**	**1,562,583**	**2,206,459**	**1,879,826**	**6,391,072**	**100.00%**

The top 4 countries (India, Russia, Ukraine, and China) shipped 6,344,607 of the 6,391,073 (99.3%) metric tons of soy-based products imported to the US over this time.

*Austria, Belgium, Benin, Bulgaria, Burma, Central African Republic, Côte d'Ivoire, Dominican Republic, Estonia, Germany, Hong Kong, Indonesia, Iran, Italy, Laos, Moldova, Nepal, Nigeria, Poland, Romania, Rwanda, Singapore, Slovakia, South Africa, South Korea, Taiwan, Thailand, and Vietnam.

has been in place in Canada.[30] In addition, initiatives such as the US Swine Health Improvement Plan (US SHIP) incorporate multiple standards, including traceability, surveillance, and premise biosecurity as well as a feed biosecurity standard, with the goal being to validate freedom from ASFV and classical swine fever virus across participating farms.[31] In conjunction with the Responsible Imports initiative is the opportunity to use feed additives to mitigate the risk of viral transmission via feed, and multiple products have been shown to reduce the risk of Senecavirus A, PEDv, PRRSV, and ASFV in feed.[9,32–33] However, this is extralabel, as none of these products have been approved by the FDA for use against viruses. Finally, in support of these activities, the FDA Center for Veterinary Medicine has recently updated and finalized Guidance for Industry No. 245, stating that viruses may be hazards in animal feed, similar to what has been written about *Salmonella* and toxoplasmosis.[9,34] Therefore, it is our opinion that keeping ASFV out of the US is technically possible and the answer to the question is yes.

Question 2: Can We Eliminate PRRSV From Infected Breed-to-Wean Farms?

A breed-to-wean farm is defined as a facility where sows are bred, gestate, farrow, and lactate their piglets. It is also a site where replacement gilts are raised. Elimination of PRRSV from an individual breed-to-wean site has been well-documented. Successful elimination of PRRSV from breeding populations was first described in 1997 by use of a technique known as Test and Removal.[35] Shortly thereafter, a more efficient, less invasive approach known as herd closure was developed and validated.[36] This procedure involves immunization of the breeding herd and on-site replacement gilts to eliminate subpopulations of naïve animals in the population through application of vaccines or live virus inoculation and preventing the continuous introduction of replacement gilts for an extended period of time (ie, 250 days or more). Herd closure, the current industry gold standard, is widely applied and highly efficacious, with successful viral elimination documented at > 95% (Pipestone Veterinary Services internal data). Therefore, since the ability to eliminate PRRSV from an individual breed-to-wean farm is technically possible, the answer to the question is yes. The challenge has historically been to prevent reinfection with a new variant, which is clearly an issue of biosecurity and segues nicely into the next question.

Question 3: Can We Apply Next-Generation Biosecurity Protocols to Breed-to-Wean Farms?

The concept of next-generation biosecurity is defined as a comprehensive, science-based means to biosecure the breed-to-wean population (as previously defined in question 2), combining protocols designed to mitigate the direct and indirect routes of pathogen transmission.[24] A next-generation biosecurity plan consists of 4 levels and includes protocols to manage the direct routes of PRRSV transmission, such as quarantine and testing of genetic material purchased from negative sources (level 1); followed by application of protocols targeting the indirect routes, first through the management of fomite-based risk (transport sanitation, personnel shower in and out, and supply entry; level 2); followed by management of aerosol risk through the use of air filtration (level 3); and finally management of the feed risk through the use of validated feed additives (level 4). The cumulative effect of all 4 levels has been validated through published studies[8,37] across both experimental facilities and field-based breed-to-wean populations.

The challenge facing swine veterinarians in the industry today is the wide degree of variation regarding the level of application across farms. For example, while the majority of commercial breed-to-wean farms in the US have successfully completed levels 1 and 2, not all have advanced to levels 3 and 4. Obviously, air filtration is difficult to apply in areas of warm climates and to naturally ventilated facilities. In addition, the risk of viral transmission via feed is a new area of science, first described[38] in 2014; not all farmers and swine veterinarians are aware of the information, prepared to deal with this risk, or both. Fortunately, due to numerous peer-reviewed publications, as well as a recently published, open access special issue[39] on the topic of feed risk, information is readily available to veterinarians. Clearly, the application of the concept of next-generation biosecurity to breed-to-wean farms is technically possible and has brought about a positive effect in controlling PRRS; therefore, the answer to this question is yes.

Question 4: Can We Apply First-Generation Biosecurity Protocols to Wean-to-Market Farms?

This question refers to the growing pig population (ie, pigs raised from weaning to marketing). Although this is the next logical step following the application of next-generation biosecurity to the breed-to-wean farm, it is a path far less traveled, with historically little effort applied over time and therefore is a "first-generation" concept. Typically, growing pig populations have been determined to be of low risk as they are depopulated regularly following the sale of market weight animals, and many wean-to-market farms have yet to apply known interventions to prevent pathogen transmission. However, since the ability of wean-to-market populations to become infected and transmit pathogens such as PRRSV, PEDv, and influenza A virus of swine has been documented,[40–42] it makes sense to determine what can be done to reduce area spread and protect surrounding breed-to-wean and wean-to-market farms. At first glance, it seems that the primary risk factors from pathogen spread associated

with wean-to-market population are contaminated transport, fomites (such as equipment used for power washing), personnel (boots and coveralls),[10,43] feed, and air, suggesting that we could begin to apply what we already know. If this is the case, a first-generation biosecurity program could include the sanitation of transport vehicles following delivery to processing facilities (level 1), fomite-based interventions such as stopping the movement of equipment between sites and the changing of boots and coveralls between sites (level 2), and the use of feed mitigants (level 3). Since we already understand how to mitigate these risks, it may be more productive to first educate, instill discipline, provide evidence of the cost-benefit ratio, and then seek new information, as needed. Clearly, the ability to apply first-generation biosecurity protocols to wean-to-market farms is technically possible and the answer to this question is yes.

Summary and Conclusions

The goal of this Viewpoint was to answer 4 specific questions and ultimately bring clarity to the central question: will swine veterinarians lead by meeting the next-generation needs of our industry? Since we answered yes to each of the previous 4 questions, the answer to the central question is also yes. Now, what are the next steps? What can be applied at the farm immediately? Let's look at each question and develop a plan:

1. Keep ASFV out of the US.

Plan—Encourage farmers to enroll their farms in the US SHIP program. US SHIP is the best chance of mounting a coordinated plan to prevent the introduction of trade limiting diseases, such as ASF. The initiative to fast-track implementation of US SHIP is gaining momentum with strong buy-in from producers around the US and has the support of state and federal veterinary agencies. Success or failure of the program is based on producer engagement. Continue to develop programs that identify and interdict illegally imported pork products into the US, and expand Responsible Import use.

2. Eliminate PRRSV from breed-to-wean farms.

Plan—Conduct a survey of your current customer base, and organize farms according to PRRS status. Prioritize elimination efforts on the basis of likelihood of success, evaluating farm location, current level of biosecurity, facility design, and economic benefit. Once organized, start the process of elimination using published, validated methods of herd closure and call on experienced colleagues for advice as needed. It is our experience that swine veterinarians are very willing to collaborate and help each other.

3. Apply next-generation biosecurity to breed-to-wean farms.

Plan—In conjunction with your PRRS-based survey, evaluate the current biosecurity practices of your breed-to-wean customers. At what level are they operating? Do they have direct routes managed properly with interventions in place? What about the mechanical risks? Can an aerosol and feed biosecurity plan be implemented? Are audit results reviewed and protocols improved? Again, seek advice from experienced colleagues as needed. We all need to work together.

4. Apply first-generation biosecurity to wean-to-market farms.

Plan—As this is an emerging area, educational efforts will be important as new information comes forward. In the meantime, use the knowledge we already have and start discussions on implementing what we already know, such as washing market trucks and changing clothing and footwear between sites, stopping movement of equipment, and using composting for carcass disposal rather than rendering trucks. This is very "common sense–based" decision-making, and the sooner we begin the educational process, the faster the adaptation across the industry.

In closing, these types of discussions with customers and working together to improve biosecurity are effective ways to build strong, lasting relationships between the swine veterinarian and the farmer. If there is one thing common to swine veterinarians, it is the ability to meet a need, seek to understand a problem, and work to develop a solution to benefit the farmer. Therefore, our answer to the central question of "Can swine veterinarians lead by meeting the next-generation needs of our industry?" is an affirmative YES.

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