Swine Health Information Center

2020 Progress Report

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Executive Summary

Swine Health Information Center

Swine Health Information Center Organization

The Swine Health Information Center (SHIC) began operation as a 501(c)(3) corporation on July 4, 2015. The mission of SHIC is to protect and enhance the health of the United States swine herd through coordinated global disease monitoring, targeted research investments that minimize the impact of future disease threats and analysis of swine health data.

The National Pork Board (NPB), National Pork Producers Council (NPPC) and the American Association of Swine Veterinarians (AASV) have each appointed two representatives to the SHIC Board of Directors. Three at-large producer representatives are also members of the Board. The Board approved a 2020 operating budget, a 2020 Plan of Work and a plan for FDIC insured investments, that is modeled after that of the National Pork Board.

A Monitoring and Analysis Working Group and a Preparedness and Response Working Group have been formed to provide program oversight and decision-making. Each are actively meeting via conference calls to fulfill their respective objectives.

When the Swine Health Information Center was formed July 1, 2015 by a grant from the National Pork Board, it was with the understanding it was a five-year project. The proposal language surrounding the Center's formation stated, "Funding of the Center past its five-year life will depend on it being able to demonstrate a sufficient return on the investment to justify keeping it running." Following presentation and approval of SHIC's 2019 Progress Report on January 7, 2020, the National Pork Board's Board of Directors voted to extend the project for two more years, to July 1, 2022, using SHIC's existing funds.

Swine Health Information Center 2020 Outreach

There has been personal outreach to pork producers, veterinarians, academics and researchers, allied industry and state and federal animal health officials to foster collaboration, develop projects, increase understanding of SHIC and its mission and inform them about the research and programs. Their feedback has helped focus and refine SHIC responsibilities, research and programs. Presence and participation in international meetings and with international organizations have helped to monitor swine diseases and issues around the world.

Progress on the Swine Health Information Center 2020 Plan of Work

Preparedness

Swine Viral Disease Matrix

1) SHIC posted an updated Diagnostic Assay Catalog on February 20, 2020. Two new PCR tests have been added to the SHIC Diagnostic Assay Catalog and it is necessary to periodically update assay developers' contact information for other diagnosticians' access to the tests. SHIC has had personal communications from veterinary diagnostic laboratory's diagnosticians asking for contact

information that has made the SHIC-funded diagnostic tools available for additional emerging disease investigation. (Additional information on page 18)

2) 2020 research continued to fill in identified preparedness gaps for Viral Matrix priority pathogens:
    a. Swine Acute Diarrhea Syndrome Coronavirus
    Swine acute diarrhea syndrome coronavirus (SADS-CoV), related to the bat coronavirus HKU2, was associated with severe outbreaks of diarrhea with high mortality rates in pigs in China starting in 2018. A SHIC-funded project has produced a real-time multiplex PCR for SADs-CoV, PEDV, and PDCoV as well as development of antibody reagents for the virus. Preliminary qPCR validation has been completed and polyclonal antibodies specific for the SADS-CoV proteins are now available. (page 18)
    b. PRV diagnostics
    A collaborative research project among the Canadian Food Inspection Agency (CFIA), USDA Agricultural Research Service (ARS), and Iowa State University addressed the need for PRV PCRs for swine oral fluids. This project evaluated the detection of PRV in swine oral fluids collected from vaccinated and/or inoculated pigs using two contemporary real-time PCR assays targeting PRV gB and gE genes. Results showed that PRV DNA could be detected in swine oral fluid specimens using PRV gB and gE real-time PCRs, giving the potential to differentiate wild-type from vaccine strain viruses in the fluids. (page 19)
    c. Porcine circovirus type 3
    A study on porcine circovirus type 3 (PCV3) funded by SHIC mined diagnostic data obtained by the University of Minnesota Veterinary Diagnostic Lab during the last two years to look for associations between the presence of PCV3 (and its viral load) and specific lesions and clinical conditions. Results from this study suggest PCV3 may cause death in fetuses and myocarditis and systemic vasculitis in pigs. (page 19)
    d. Porcine parvovirus type 2
    A project funded by SHIC will develop understanding of the prevalence and phylogenetic relationships of porcine parvovirus type 2 (PPV2) infections in swine farms. Researchers at South Dakota State University will explore the role PPV2 infection plays in important diseases such as pneumonia, immune deficiency, reproductive failure, and lameness. Other specific project objectives include development of research and diagnostic assays, including in situ hybridization and real-time PCR, for the detection, identification, and differentiation of PPV type 1 and PPV2. (page 20)
    e. Porcine sapovirus
    Researchers documented the discovery of porcine sapovirus (SaV) of genogroup III as the cause of the enteritis and diarrhea. A highly sensitive and specific real-time RT-PCR for detecting porcine SaV of genogroup III was then developed using SHIC funding. In addition, a prevalence survey of more than 500 samples from both pigs with clinical diarrhea and clinical healthy pigs suggests that porcine SaV III plays an important role in causing swine enteritis and diarrhea and rRT-PCR is a reliable method to evaluate the pathogenicity role of porcine SaV. (page 20)

Monitor and Mitigate Risks to Swine Health

Identify and mitigate swine disease risks by international monitoring

Global Swine Disease Monitoring Reports

1) The SHIC Global Swine Disease Monitoring Report provides near real-time information on swine diseases and is communicated to the US pork industry through SHIC's monthly e-newsletter and posting online on the SHIC website. The project created and now maintains a public, private, academic partnership for its reporting. The project has been successful in collecting, organizing, critically reviewing, and communicating the expansion of ASF through Asia and Europe. (page 20)

Improve screening following international travel

2) SHIC, AASV, NPB, and NPPC met multiple times with DHS-Customs and Border Protection (CBP) during 2020 to voice concerns about secondary screening after travelers declare contact with foreign farms or animals. In collaboration with the other pork industry associations, SHIC is collecting information from travelers about their entry customs experience. The industry associations are then sharing it with DHS-CBP to help them assess performance and improve prevention of foreign disease introduction. (page 21)

Improve transport biosecurity from first points of concentration

Prevent pathogen transfer during market events

1) SHIC funded a study conducted by Iowa State University to try to objectively assess if implementing a staged loading procedure for market pigs is effective at preventing transfer of swine pathogen contaminated particles from livestock trailers to the barn. Fluorescent powder (Glo Germ) was used as a marking agent to be able to see traffic patterns. Four out of the five measuring points in the center alleyway of the barn had a level of contamination that measured significantly lower ($p<0.05$) for the staged loading protocol compared to the conventional loading protocol. (page 21)
2) To be transmitted to groups of growing pigs during the wean-to-market phase of production pathogens must be carried by some carrying agent. No studies have been done to assess which carrying agent entry events are most frequently associated with the introduction of pathogens to growing pigs during the wean-to-market phase of production. The objective of an ongoing SHIC-funded study is to detect the introduction of wild-type PED, PDCoV, TGE and PRRS into groups of growing pigs and to associate the timing of the introductions with the frequency and timing of carrying agent entry events. Results will come in 2021. (page 22)

Improve farm biosecurity

Investigate biosecurity procedures to mitigate disease risk

1) A SHIC-funded working group developed a report on ultraviolet light (UVC), a type of electromagnetic energy invisible to humans, that provides recommendations on how it can be used on farms to exclude pathogens from being introduced into a herd. The full report contains detailed information on the physics of UVC, dose calculations, factors affecting effectiveness, detailed maintenance and safety requirements and a section on best practices in the field. A brief Fact Sheet on UVC use has been published as well. (page 22)

Investigate the ability of common inputs to production to act as biologic or mechanical vectors for disease introduction onto farms

Feed Safety Task Force

1) A Feed Safety Task Force with USDA, FDA, CFIA, US and Canadian feed industries, national pork organizations, academics, veterinarians, and pork producers has been formed and met virtually in 2020 to discuss possible risks associated with viral contamination of feed or feed components. USDA and FDA believe there are currently many unknowns and data gaps that should be identified to help define or validate feed risk. At this time, it is up to the pork industry to address potential risk of foreign animal disease introduction into the US from imported feed ingredients. (page 23)

ASF, CSF and PRV feed risk and mitigation

2) In a recently published SHIC-funded study researchers' work to determine the stability of CSF and PRV in feed ingredients under transpacific shipping conditions was detailed. The objectives of this study were to 1) identify animal feed ingredients which support survival of CSF and PRV when exposed to transpacific shipment conditions, 2) improve the half-life calculations of ASF in feed ingredients when exposed to transatlantic shipment conditions, and 3) investigate antiviral chemical mitigants as a tool for reducing the risk of introduction and transmission of CSF, ASF and PRV in feed and feed ingredients. The half-lives of ASFV in all feed ingredients range between 9.6 and 14.2 days with 12.2 days being the average. Overall, this research has improved our ability to quantify risk of ASF, CSF and PRV in feed, implement science-based storage times to mitigate possible ASF contamination in feed, and identify effective feed additives for risk mitigation of foreign animal diseases through feed. (page 23)

Feed holding time mitigation

3) On February 5, 2020, SHIC joined with other pork industry organizations to release the most current feed holding time recommendations for disease mitigation. Based on the conditions of transoceanic shipment, the mean holding times calculated to provide 99.99% ASF degradation at 54 degrees F was 125 days in conventional soybean meal. (page 24)

Feed additive mitigation research

4) SHIC funded a study to evaluate the mitigation potential of chemical feed additives following natural consumption of contaminated feed. The results suggest that chemical mitigation alone may not be able to prevent transmission of pathogens through feed. Consequently, if or when compounds gain FDA approval for feed viral mitigation, adding them onto alternative strategies such as storage time and importation of feed ingredients from known and trusted sources should be considered to safeguard the US swine industry from unwanted viral pathogens. (page 24)

Feed data and information to help support an objective risk assessment

5) With funding provided by SHIC, a Phase 1 demonstration project to reproduce the results found in lab studies under real world conditions was completed using inoculated feed component samples shipped for 21 days, involving 107 hours of transport, crossing 14 states, and covering approximately 6,000 miles. In the report summary, results indicated the presence of viable PRRS virus, Senecavirus A (SVA), and PED virus in both organic and conventional soy products, while

viable SVA – a surrogate for foot and mouth disease virus – was recovered from all five tested feed ingredients. (page 25)

6) Funded in 2020, with completion scheduled during January 2021, Phase 2 of the above project will further evaluate virus viability in feed ingredients using a demonstration project designed to simulate commercial conditions of transport, bulk sampling of feed, and natural feeding behavior. In addition to evaluating viral survival, the project will also test a published method to sample bulk feed ingredients for viral contamination and further validate a National Pork Board funded PCR extraction methodology specifically designed for plant-based feed ingredients. (page 25)
7) Epidemiological evidence of previously naïve farms breaking with porcine deltacoronavirus in November 2020 suggested a potential role of feed. Three production farms experienced new disease outbreaks, with the two initial outbreaks occurring at facilities fed by the same feed mill. The objective of this study was to use environmental sampling to conduct an emergency investigation of the feed supply chain in the transmission of porcine deltacoronavirus among Kansas swine farms. Preliminary results are pending. (page 26)
8) SHIC has contracted with Kansas State University for a Master's degree student to do a comprehensive look at production, importation and uses of soybean meals. This will include their possible role in introduction and/or dissemination of swine viral pathogens, monitoring for fecal contamination indicators and 'Best Practices' for the importation of organic soy products. (page 26)

Feed mill SVA transmission study in Brazil

9) Three partner feed mills located in Brazil reported high levels of Senecavirus A (SVA) in finishing barns fed from their associated mills, and samples of soybean meal as well as meat and bone meal collected from the mill were confirmed to contain SVA. SHIC funded an investigation into the possibility that the mill itself and/or its ingredients could be a source of SVA transmission. Without finding a definable connection between SVA in the feed mill and the farms, attention was diverted to Enterobacteriaceae (EBAC) as an indicator of fecal contamination and overall hygiene of the feed or feed ingredients. That information was then used as a method of identifying feed-related and other biosecurity gaps in the feed mill and on the farm. Results showed compliance with biosecurity protocols had a substantial impact of EBAC prevalence and distribution throughout the feed mill. (page 26)

In coordination with other industry organizations, help to fill in the gaps of research and information needed to prevent, prepare and respond to foreign or emerging diseases.

Strengthen national biosecurity and protect the US from foreign transboundary diseases like ASF

1) NPB and SHIC, with the collaboration of NPPC and AASV, are funding a 12-month long project to identify gaps in US pork industry national biosecurity. The goal is to prevent entry of foreign animal disease into the country by addressing any identified biosecurity gaps. Among the many areas being considered for study are foreign imports, entry of foreign travelers, domestic transportation of animals, common inputs to US production, domestic market channels and others. The outcomes will include details, if biosecurity gaps are identified, including data sources and uncertainty in risk estimates. (page 27)

African Swine Fever – literature review of molecular epidemiology to inform preparedness and control strategies

2) As ASF circulates around the world, reports of varying degrees of pathogenicity bring into question the possibility of the current, epidemic strain drifting into different, related strain(s). SHIC has funded a proposal to report the current state of knowledge regarding pathogenicity and possible strain differences. This report, to be published in a peer-reviewed journal early in 2021, aims to synthesize the current state of knowledge and the remaining gaps regarding the molecular epidemiology of African swine fever to inform appropriate preparedness and surveillance strategies. The review will focus on establishing the extent to which existing research has progressed towards clarifying specific challenges regarding genetic diversity of strains, the association between sequence data and pathogenic features, and development and performance of molecular diagnostic tools. (page 27)

African Swine Fever – transferring experience with ASF to US preparedness

3) Two US-based practitioners who have experience with ASF management practices in China shared their perspectives with SHIC, which communicated them via the AASV e-letter and the SHIC e-newsletter. Using test-and-removal protocols based on farm design have been successful for some Chinese companies. Depending on the situation and how quickly ASF is recognized, there has been a success rate of 70% to 80%. Following test and removal, generally there is three weeks of cleaning and disinfecting that area of the farm, after which the area can open back up. (page 28)

African Swine Fever – International coordination of ASF research

4) Swine Innovation Porc, a non-profit corporation in Canada, facilitates research in the Canadian swine sector. In 2019, Swine Innovation Porc developed a Coordinated ASF Research Working Group and SHIC was invited to participate. Over six months, the ASF Working Group created an ASF-related research priorities document which was completed in December 2019 and further refined during 2020. The Canadian Pork Council will use the document in its strategic planning activities for ASF. (page 28)

African Swine Fever – Coordination of enhanced surveillance in non-control areas

5) A "72-Hour Task Force" has been formed from a larger National Assembly of State Animal Health Officials (NASAHO) ASF Working Group. The 72-Hour Task Force is made up of federal animal health officials and the state animal health officials and state pork association representatives of Indiana, Iowa, North Carolina, and Oklahoma along with representatives of the national pork organizations. The purpose of the Task Force is to discuss data or surveillance needs to give states and USDA confidence in "non-control areas" and moving pigs around these areas without the need for permits, as is done now. (page 29)

African Swine Fever – oral fluids PCR sensitivity

6) Recent unpublished, observational research indicates oral fluids (OF), when collected by rope as an aggregate sample, could be a good sample for rapid detection of ASF. However, this experimental data also suggests that there is potential for false negative test results. Therefore, SHIC published a call for proposals to develop methods to improve the detection of low levels of nucleic acid in OF through enhancements to pre-extraction treatment(s) of samples or through improved extraction

methodologies compatible with the high throughput testing currently done in NAHLN laboratories. Two projects were selected for funding, with work beginning in 2020 and results expected in 2021. (page 29)

Building capacity to support the control of African Swine Fever (ASF) in Vietnam

7) With active support from NPPC, a grant was awarded to SHIC in 2019 to start a dialogue between the US and Vietnamese officials, sharing veterinary knowledge and ways to prevent ASF from further spreading. The approximately $1.7 million grant from the USDA's Foreign Agricultural Service division will fund the multi-phase project, helping to build strategic partnerships while increasing trade of US pork to the region. The work includes 2020 swine health field projects, with collection and analysis of tissue samples, which will help inform North American pork producers about effective ASF preparedness and response.

   Due to the COVID-19 pandemic, planned in-person workshops have been delayed. The Vietnamese Department of Animal Health has requested that they now be held during the latter part of 2021 and the first part of 2022. However, field projects are underway with some modifications needed because of travel restrictions. USDA-FAS has approved a 1-year extension of the end date of the project to August 31, 2022. (page 29)

   a. *Section 1: Sharing knowledge and ideas. Strengthening veterinary services capacity for mitigating African Swine Fever impact on Vietnam*
   The goal is to create a capacity building program to train veterinarians, laboratory workers, and/or farm advisors or managers on topics described by the OIE as necessary for assurance of functional national veterinary services organizations, with a focus on ASF prevention and control. (page 30)

   b. *Section 2: Implementation of field projects, and collection and analysis of samples*
   SHIC published an open call for research proposals to address priorities for ASF research in Vietnam. The objectives of these researchable priorities were to help Vietnamese pork production respond and recover from the ASF epidemic and to help US pork producers learn lessons about ASF epidemiology and management, in preparation, should the virus enter the US. (page 30)
      i. Proposals were received, reviewed by subject matter experts and reviewed and selected for funding by the SHIC Preparedness and Response Working Group. The Center supported US-based researchers with research memorandums of understanding or direct contacts with university or pork production animal health researchers in Vietnam.
      ii. Projects address ASF antibody tests, the possible transmission role of rats and mice, baking time for disinfection, epidemiological analysis of pathways of entry onto the farm, composting, targeted test and removal of individual animals, pen-side ASF tests, feed transport and mill biosecurity and oral fluids as a monitoring and surveillance tool. (pages 31 – 33)

Improve Swine Health Information

Develop the industry capacity for detection of emerging disease, rapid response and continuity of business

Morrison Swine Health Monitoring Project

1) Primarily funded by SHIC, The Morrison Swine Health Monitoring Program (MSHMP) continues to expand its capacity and, as a result, delivers more and higher quality information on health status of US swine herds. Sow data is now being complemented with growing pig site information from participants. Presently, a total of 922 growing pig sites in seven states are included in MSHMP databases. These sites include the production flow of 68 sow farms (252,900 sows). MSHMP successfully added *Mycoplasma hyopneumoniae* to its reporting, its work has resulted in a successful PRRSv sequence capturing process, and pig flow management information is now included for analysis. With enhanced capacity to help the pork industry respond to emerging pathogens MSHMP delivers timely data used by practitioners and producers to enhance herd health. (page 33)

Analysis of MSHMP data

2) Analysis of MSHMP's data helps to control and prevent swine diseases. Projects during 2020:
    a. Development of a biosecurity screening tool to identify breeding herds' risk to PRRS outbreak using a short survey. The objective of this study was to measure and benchmark the relationship between key biosecurity aspects and PRRS outbreaks in breeding herds, while validating a short biosecurity screening survey. The best machine learning algorithm predicted PRRS occurrences with an accuracy of 78.5%. (page 34)
    b. SHIC funded a study of MSHMP participants' data to applying machine-learning to predict PED outbreaks on sow farms. As a result, a predictive machine-learning model that estimates the probability of a PED break biweekly has been developed. Thus, the goal is farm-level forecasts for two weeks in the future that can be updated and delivered as new data emerges each week allowing ample time to mitigate the risk or minimize the impact. (page 34)
    c. High-resolution maps to identify current and future PED risk in North Carolina have been developed. The efficiency and likely success of possible biosecurity and mitigation steps that could be taken in advance of the outbreak are also being analyzed. (page 35)
    d. The capacity to capture PRRS sequencing data from cooperating veterinary diagnostic labs (VDLs) has been added to the MSHMP database and the analysis is being shared. This data is being used to develop analytic methods for understanding PRRSV, giving producers the opportunity to respond to emerging, highly virulent strains. Maintaining an updated database has allowed MSHMP to quickly respond to sequence comparison requests from participants throughout the year during their outbreak investigations. (page 35)

Make industry swine health information available to help uncover, communicate, and mitigate regional and national risks to herd health

World Organization for Animal Health (OIE)

1) The COVID-19 pandemic caused the annual general assembly meeting to be virtual with only the official country delegates participating. However, communication with the US delegate continues as does review and comment on relevant OIE issues and papers. (page 36)

Provide context and analysis to press information about swine health advancements

2) A paper with information on a new ASF vaccine from the Chinese Harbin Laboratory was published online on March 1, 2020. SHIC asked two US experts in ASF to review the paper and provide comments. The Chinese ASF vaccine looks very promising for protecting against the currently circulating Georgia 2007 strain. Both reviewers offered that they assume the data presented in the manuscript are accurate and reproducible. (page 36)
3) There was significant press attention paid to an influenza study published in the *Proceedings of the National Academy of Sciences*. Veterinarians and animal health experts from the USDA, SHIC, NPB, NPPC, AASV, and U.S. universities reviewed the study published in the *Proceedings of the National Academy of Sciences*, and agree the study has scientific rigor. However, it does not contain important context essential for complete understanding of the present situation overseas nor the potential threat to the U.S. swine herd and consumers. Finally, it was the opinion of the experts who reviewed this paper that if this virus were in the U.S. pig population, it would be detected by the diagnostic tests available at U.S. veterinary diagnostic labs and USDA surveillance. (page 37)

Feral Swine Disease Management

4) This year, USDA estimates there are 6 million feral swine in the US creating issues for traditional livestock production, natural resources, and other species. To address these ongoing issues, including domestic and foreign disease surveillance priorities of feral swine, USDA convened a technical working group consisting of swine industry representatives, state and federal animal health officials, university, and wildlife experts. The published review and recommendations report was a collaborative effort between USDA and the other groups for the purpose of addressing the feral swine threat to domestic swine health. (page 37)

Swine health webinars to "keep pace with industry chatter"

5) SHIC offered a series of webinars in 2020, with collaboration of AASV and conducted by the ISU Swine Medicine Education Center. The intent of the webinars was to respond to "industry chatter" about current swine health issues. Topics of the webinars included hemorrhagic tracheitis syndrome (336 registered, 234 unique views), coccidiosis management strategies (333 registered, 201 unique views), swine lameness investigation (232 registered, 146 unique views), and porcine astrovirus type 3 (PoAstV3) which has been causing central nervous system syndrome (292 registered, 149 unique views). (page 38)

Continue to evolve and refine domestic swine disease monitoring and reporting

6) SHIC continues to support a domestic swine disease monitoring program, the "Swine Disease Reporting System". The Swine Disease Reporting System reports monthly dynamics of pathogen detection by VDL-performed assays over time, specimen, age group, and geographical area.

Beginning in June 2020, there was a new element included in the report – specific state-by-state pathogen trends. Information for each state regarding the change from baseline, the number of total, positive submissions, and percent of positive results are recovered from the models and transferred to Microsoft Power BI for geographic visualization. The dashboards for state-by-state pathogen trending can be accessed on the SHIC website or by visiting Iowa State University's site for the Swine Disease Reporting System. (page 38)

Surveillance and Discovery of Emerging Disease

Investigate newly identified agents associated with disease

Porcine sapovirus

1) Next Generation Sequencing was directly applied to the fecal and intestinal tissue samples from chronically diarrheatic nursing pigs and a new variant of porcine sapovirus was identified. This appears to be the first detection of a porcine sapovirus single etiology in piglets with diarrhea in the United States. A real time RT-PCR to detect viral RNA in clinical samples and determine the viral load from intestine tissue and fecal samples and the ability to test for the virus directly in fixed tissues has been developed to assist diagnosticians with other investigations. (page 39)

Ensure detection of emerging disease to facilitate rapid response.

Improving swine disease surveillance

1) Current statistical methods for selecting sample size, i.e., how many pigs and which pigs to sample, worked well for traditional farms, but does not work for modern farms because of industry evolution since they were developed. Progress during 2020 investigated potential improvements that can be made toward a nationally coordinated swine health surveillance system to prepare, detect and rapidly respond to emerging and foreign animal diseases. (page 39)

Offer diagnostic fee support to help detect emerging diseases.

2) There continues to be incidents of high morbidity/high mortality where an etiology is either not identified or there is a strong supposition that the identified pathogen is not the likely cause of the outbreak. For these cases, SHIC offers diagnostic fee support when the initial, producer-funded diagnostics are unrewarding.
    a. The Iowa State University Veterinary Diagnostic Lab confirmed *Streptococcus equi ssp zooepidemicus* in two recent, potentially related cases of high mortality in sows for slaughter and feeder pigs in assembly yards in the Midwest. SHIC funded a project conducted by researchers from Iowa State University and the National Veterinary Services Laboratory for a genomic epidemiological analysis on the limited outbreak. The study revealed eight isolates were clustered together with a strain causing the outbreaks with high mortality. (page 40)
    b. In 2020 SHIC continued further diagnostic work into understanding a hemorrhagic tracheitis syndrome. Supported by SHIC, diagnosticians at Iowa State University, Animal Health Laboratory at the University of Guelph and the Ministère de l'Agriculture, des Pêcheries et de l'Alimentation Québec (MAPAQ), in Québec City have collaborated to develop a standardized diagnostic test plan for swine tracheitis cases that allows thorough, consistent testing of these cases. (page 40)

Responding to Emerging Disease

Support a rapid, unified industry response to emerging disease outbreaks.

National Swine Disease Council

1) The US pork industry has aligned its efforts to be better prepared to quickly respond to foreign animal and transboundary production disease by creating the National Swine Disease Council. The council is made up of key industry leaders, the North American Meat Institute, and representatives from SHIC, NPB, NPPC, and AASV. USDA, as well as state animal health officials, attend meetings and provide input. The NSDC focuses on providing recommendations, in collaboration with state and federal animal health officials and other industry stakeholders, to respond to emerging swine diseases that could potentially threaten herd health and negatively affect the US pork industry. (page 41)

Identify high risk events likely to be responsible for introducing emerging diseases onto farms.

Rapid Response Program

1) In August 2016, SHIC funded development of the Rapid Response Program (RRP) for epidemiological investigations of emerging, transboundary and endemic swine disease outbreaks, including recruitment and training of the Rapid Response Corps (RRC), who responds in the event of an outbreak. There were no active RRC investigations during 2020. During 2020, SES Incorporated created and implemented an exercise to provide refresher training for the RRC on the objectives, procedures, and implementation of the RRP. A series of virtual drills focused on the key phases of an RRC investigation: pre-investigation, investigation, and post-investigation (reporting). SHIC will be acting on the recommendations of the participants to continually improve the RRP, ensuring readiness in the event of a transboundary or newly emerging swine disease outbreak. (page 41)

Swine Health Information Center Communications

To broadly disseminate SHIC information to stakeholders, a variety of communications tools are employed including the SHIC website, e-newsletter, articles prepared for partners, news releases, interviews, social media, a new SHIC Talk podcast, and webinar series. SHIC also participates in industry events – virtually in 2020 – to provide access to information essential to protection of the US swine herd. Google Analytics of SHIC website traffic are used to measure impact of media efforts.

1) Activity on www.swinehealth.org (page 42)
    - Google Analytics of the SHIC website traffic are used to measure impact of communications efforts. All e-newsletters, postings, and media releases communicate to the desired SHIC audiences, providing timely and relevant information, as well as activities of the center. Top pages on SHIC website (January 1-December 15, 2020) with (number of visits):
        - Global Disease Monitoring Reports (5,878)
        - Chinese Swine Acute Diarrhea Syndrome Coronavirus (SADS-CoV) Spurs SHIC Response (3,559)
        - Seneca Valley Virus Summary (2,091)
    - There were over 26,800 individual SHIC website sessions during 2020, a 13% increase over 2019. Most visitors were from the US, Philippines, Canada, India, the UK and Australia with

a total of 46,058 page views, an decrease of 19% from 2019. Average pages viewed per session and average session duration for 2020 was the same as in 2019.

2) Press releases (page 43)
   - Five press releases were issued in 2020. Emails were sent to 250 ag news outlets for each press release. Farm broadcasters continued as a very important media outreach for SHIC with follow-up interviews requested after each press release was deployed. Individual emails are sent to the top five pork media editors as well as five farm broadcasters with each press release. Nearly 100% of the press releases were picked up by these national editors and farm broadcasters covering the US pork industry, many times resulting in one-on-one interviews with the executive director.
3) Articles for Partners (AASV) (page 44)
   - As of December 16, 2020, 40 articles have been provided for the AASV weekly e-letter and other partners. Additionally, organizations like the US Animal Health Association (USAHA) are using SHIC information gleaned from media and the e-newsletter to share with their audiences. With USAHA, this means distribution to state animal health officials as well as key federal animal health officials.
4) SHIC Talk Podcast (page 45)
   - In 2020, SHIC Talk was developed and launched. The podcast is hosted by Barb Determan and features guests on “industry chatter” topics as well as comments by SHIC’s executive director. Four episodes have been produced so far with the fifth in production. SHIC Talk is available on the SHIC website as well as Apple Podcasts, Google Podcasts, Spotify, Pandora, Amazon Music/Audible, TuneIn/Alexa, and iHeart Radio. 2020 Episodes included “ASF Test-and-Remove Protocol for Disease Management in China”, “Coccidiosis Diagnosis and Management”, “SHIC Rapid Response Program”, and “ASF Research in Vietnam Update”.
5) The SHIC e-newsletter (page 46)
   - A monthly SHIC e-newsletter publication schedule continued in 2020. Just under 3,000 subscribers are in the distribution database. “Percent opens” for the e-newsletter was 28.6% (Constant Contact benchmark is 10.0%) and “percent clicks” through to articles on the SHIC website was 18.4% (Constant Contact benchmark is 9.0%).

Swine Health Information Center 2020 Progress Report

Swine Health Information Center Organization

1) The Swine Health Information Center is a 501(c)(3) corporation governed by a Board of Directors. The producer members of the Board of Directors are active pork producers or representatives of pork producing companies or allied industry that have an interest in the mission of the Center and that serve as champions for the Center's objectives and goals.

   On November 2, 2020 Bill Luckey resigned from the SHIC Board of Directors. Dr. Jeremy Pittman, originally appointed as an at-large Board member, was elected to the National Pork Producers Council Board of Directors and was appointed by NPPC to represent NPPC on the SHIC Board of Directors, filling the position previously held by Bill Luckey. Mark Greenwood was moved to the open at-large position previously held by Dr. Pittman, leaving a National Pork Board representative position open. The National Pork Board will name a person for this position to start January 1, 2021.

   Currently there are eight Board of Directors members:
   a. Two named by the National Pork Board
      i. Gene Noem, pork producer and Director, Genus PLC, Iowa
      ii. Open – to be filled January 1, 2021
   b. Two named by the National Pork Producers Council
      i. Dr. Howard Hill, pork producer and NPPC past-president, Iowa
      ii. Dr. Jeremy Pittman, Smithfield Hog Production, North Carolina
   c. Two named by the American Association of Swine Veterinarians
      i. Dr. Matt Anderson, Suidae Health and Production and AASV past-president, Iowa
      ii. Dr. Daryl Olsen, AMVC and AASV past-president, Iowa
   d. Three at-large producer members
      i. Mark Schwartz, pork producer, Minnesota
      ii. Dr. Matthew Turner, JBS USA, Colorado
      iii. Mark Greenwood, Compeer Financial, Minnesota

2) A 2020 operating budget and investment portfolio was developed.

The SHIC Board of Directors approved an operating budget for 2020 and has reviewed and modified the budget during the year to best meet the SHIC mission. The approved operating budget addressing the 2020 Plan of Work was $2,659,000.

Extra funds not needed for the operating budget were invested in securities with Wells Fargo Bank and modeled after NPB's investment plan. The investments are a series of FDIC insured Certificates of Deposit, laddered to provide on-going operating funds as the certificates reach maturity.

3) SHIC Working Groups have been formed to provide input and oversight as the Center fulfills its mission.

The Working Groups give the opportunity to provide program oversight and decision-making, supplemented and informed by subject matter expertise. To complete the SHIC Plan of Work, two working groups have been formed.

The Monitoring and Analysis Working Group is charged with assessing foreign, transboundary production disease risk using information from a variety of sources. The outcome of this assessment is the on-going prioritization of the Swine Viral Disease Matrix (Appendix A) and Swine Bacterial Disease Matrix (Appendix B). It is also responsible for improving the health of the nation's swine herd through the development and oversight of on-going projects. These include monitoring for domestic diseases affecting swine health and analyzing health and other data to support on-farm and prospective producer decision making. The Working Group reviews and selects research and program activities that address its Plan of Work.

The Preparedness and Response Working Group is responsible for oversight of the swine viral and bacterial disease matrices research. It is responsible for funding decisions to fulfill other matrices-related research objectives. It also provides advice and oversight of SHIC's role in the emerging swine diseases response plan. That includes the appropriate SHIC response to an emerging swine disease and for the information and analysis necessary to support the proportional pork producer and pork industry response to these emerging diseases. The Working Group reviews and selects research and program activities that address its Plan of Work.

4) No cost extension of the Swine Health Information Center, Inc.

When the Swine Health Information Center (SHIC) was formed July 1, 2015 by a grant from the National Pork Board, it was with the understanding it was a five-year project. The proposal language surrounding the Center's formation stated, "Funding of the Center past its five-year life will depend on it being able to demonstrate a sufficient return on the investment to justify keeping it running." Following presentation and approval of SHIC's 2019 Progress Report on January 7, 2020, the National Pork Board (NPB) Board of Directors voted to extend the project for two more years, to July 1, 2022, using SHIC's existing funds.

Swine Health Information Center 2020 Outreach

1) There has been personal outreach to pork producers, veterinarians, academics and researchers, allied industry and state and federal animal health officials to foster collaboration, develop projects, increase understanding of SHIC and its mission and inform them about the research and programs. The feedback has helped to focus and refine SHIC responsibilities, research, and programs. Following is a list of organizations and meetings where SHIC's research and programs were presented or discussed.

a. Pork producers
    i. AMVC Swine Health Services; Carthage Veterinary Service; Christensen Farms; JBS; The Maschoff's; Iowa Select Farms; Pipestone; Prestage Farms; Schwartz Farms; Seaboard Foods; Smithfield Foods, Hog Production Division; Suidae Health and Production; Swine Vet Center; 21st Century Strategic Forums, 21st Century Pork Club
    ii. Canadian Pork Producers Association
    iii. NPB's Board of Directors, ASF Crisis Team, ASF Working Group, Surveillance Research Working Group
    iv. NPB/AASV Depopulation Working Group
    v. National Pork Producers Council's Animal Health and Food Security Committee
    vi. National Swine Disease Council
    vii. South Dakota Pork Producers Association
    viii. UMN Allen D. Leman Swine Conference
b. Allied industry
    i. Advanced Animal Diagnostics
    ii. American Feed Industry Association
    iii. Antitox Corporation
    iv. APC
    v. Aptimunne Biologics
    vi. Boehringer Ingelheim Vetmedica
    vii. Gate Scientific
    viii. IDEXX
    ix. Institute for Feed Education and Research
    x. Kemin Industries
    xi. MatMaCorp
    xii. Medgene Laboratories
    xiii. Merck Animal Health
    xiv. Misset International
    xv. National Association of Farm Broadcasters
    xvi. National Coalition for Food and Agriculture Research
    xvii. National Grain and Feed Association
    xviii. Tetracore, Inc.
    xix. Thermo Fisher Scientific
    xx. United Soybean Board
    xxi. Washington Ag Roundtable
    xxii. Zoetis
c. Veterinarians
    i. 2020 AASV annual meeting
    ii. AASV Board of Directors meetings
    iii. Iowa Vet Med Association Winter Conference
    iv. Iowa State University James D. McKean Swine Disease Conference 2020
    v. Swine Medicine Education Center, Iowa State University

   vi. US Animal Health Association, including allied industry, USDA and State Animal Health Officials
      1. Swine Health Committee
      2. Global Animal Health and Trade Committee

d. Veterinary Diagnostic Laboratories, Colleges of Veterinary Medicine, and Academics
   i. Colorado State University Research Acceleration Office
   ii. Colorado State University Infectious Disease Research Center
   iii. Conference of Research Workers in Animal Disease
   iv. Kansas State University Veterinary Diagnostic Laboratory
   v. Iowa State University Veterinary Diagnostic and Production Animal Medicine
   vi. South Dakota State University Veterinary Diagnostic Laboratory
   vii. Texas A&M University Institute for Infectious Animal Diseases
   viii. Texas Tech University
   ix. University of Arizona College of Veterinary Medicine
   x. University of Minnesota Veterinary Diagnostic Laboratory
   xi. University of Saskatchewan

e. USDA
   i. Ag Research Services
   ii. Ag Research Services Virus Prion Research Unit
   iii. Animal and Plant Health Inspection Service (APHIS), Administrator
   iv. APHIS, Deputy Administrator, Veterinary Services
   v. APHIS, Veterinary Services Leadership Team and Veterinary Services staff
   vi. Center for Epidemiology and Animal Health
   vii. Center for Veterinary Biologics
   viii. National Animal Health Laboratory Network
   ix. National Import Export Services
   x. National Wildlife Services
   xi. National Veterinary Services Laboratory, Foreign Animal Disease Diagnostic Laboratory

f. Department of Homeland Security
   i. Customs and Border Protection

g. Food and Drug Administration
   i. Center for Veterinary Medicine

h. State animal health officials and state agencies
   i. National Association of State Animal Health Officials ASF Working Group
   ii. National Association of State Animal Health Officials ASF Working Group 72-Hour Subcommittee
   iii. National Association of State Animal Health Officials COVID-19 Swine Industry Group

i. International
   i. Canadian Innovation Pork ASF Working Group
   ii. Canadian Farm Health Guardian
   iii. Canadian West Swine Health Intelligence Network
   iv. OIE, International Organization for Animal Health
   v. Ontario Animal Health Network

Progress on the Swine Health Information Center 2020 Plan of Work

Preparedness

1. Swine Viral Disease Matrix

In 2016, SHIC matrix research focused on the ability to detect the viral matrix pathogens via nucleic acid detection, using PCR testing – a platform that is commonly available in the major US veterinary diagnostic laboratories. 2017-funded research focused on the development and validation (analytic and diagnostic) of antibody detection assays for monitoring for emerging diseases, determining freedom from disease (after an outbreak), or defining the extent of disease spread. During 2018 and 2019, and now 2020, development of additional tests helped to fill in gaps in diagnostic preparedness.

PCR Assay Catalog Update
SHIC posted an updated Diagnostic Assay Catalog on February 20, 2020. SHIC's catalog provides diagnosticians with pertinent information about new and existing PCR and ELISA tests available, including confirmed contact information for the experts who developed the tests, allowing for questions about availability and use. The Diagnostic Assay Catalog includes six Enzyme Linked Immunosorbent Assays (ELISAs) in addition to 18 Polymerase Chain Reaction (PCR) Assays developed in response to SHIC's prioritized Swine Viral Disease Matrix. The catalog also summarizes the research behind the test development and covers technical background information including sample types as well as analytical and diagnostic sensitivity and specificity. These additional tools may provide means to uncover emerging diseases.

Two new PCR tests have been added to the Swine Health Information Center (SHIC) Diagnostic Assay Catalog. A highly sensitive and specific RT-PCR for detecting porcine sapovirus (SaV) genotype III for neonatal diarrhea investigation and a single-tube triplex RT-PCR assay for differential detection of variant strains of pseudorabies virus (PRV), including the Chinese high path strain, gives diagnosticians previously unavailable valuable tools. Each is now available to all veterinary diagnostic labs for use and fits with SHIC's mission to make sure the US swine industry is prepared for emerging diseases.

The most recent update also addresses the reality researchers sometimes change their employment or location; therefore, it is necessary to periodically update their contact information for access to the tests. SHIC has answered personal communications from veterinary diagnostic laboratory's diagnosticians asking for contact information that has made the SHIC-funded diagnostic tools available for additional emerging disease investigation.

Continued Viral Matrix Pathogen Research
2020 research continued to fill in identified gaps in preparedness for Viral Matrix priority pathogens:

a. *Swine Acute Diarrhea Syndrome Coronavirus*
Swine acute diarrhea syndrome coronavirus (SADS-CoV), related to the bat coronavirus HKU2, was associated with severe outbreaks of diarrhea with high mortality rates in pigs in China starting in 2018. Porcine epidemic diarrhea virus (PEDV) and porcine delta coronavirus (PDCoV)

are closely related to SADS-CoV. The emergence of SADS-CoV in Asia as a potential concern. Should SADS-CoV be introduced into the US as PEDV and PDCoV were, the industry must be prepared to rapidly implement adequate control strategies to mitigate the impact of the disease to pork producers.

One of the first tools to combat emerging infectious disease agents is a diagnostic assay capable of rapidly detecting such pathogens. This includes a real-time multiplex PCR for SADs-CoV, PEDV, and PDCoV as well as development of antibody reagents for the virus. Preliminary qPCR validation has been completed and polyclonal antibodies specific for the SADS-CoV proteins are now available.

Availability of a multiplex real-time PCR for SADS-CoV, PEDV and PDCoV will allow precise and rapid diagnosis of specific swine enteric coronaviruses associated with outbreaks of enteric disease in pigs. Antibodies developed will allow the development of serological assays as well as antigen detection assays for SADS-CoV sero-surveillance or for the direct detection of the virus.

b. PRV diagnostics

Pseudorabies virus (PRV) ranks fourth on the SHIC swine disease matrix due to the potential for introducing highly pathogenic PRV into the US from Asia, as well as its potential negative impact on exports. Improvements in PRV diagnostics, surveillance, control, and elimination remain relevant. A collaborative research project among the Canadian Food Inspection Agency (CFIA), USDA Agricultural Research Service (ARS), and Iowa State University addressed the need for PRV PCRs for swine oral fluids.

This project evaluated the detection of PRV in swine oral fluids collected from vaccinated and/or inoculated pigs using two contemporary real-time PCR assays targeting PRV gB and gE genes. Results showed that PRV DNA could be detected in swine oral fluid specimens using PRV gB and gE real-time PCRs, giving the potential to differentiate wild-type from vaccine strain viruses in the fluids. Additionally, comparisons of detection rates in nasal swab vs oral fluid samples suggested that oral fluid could be used as an alternative to individual pig (nasal swab) sampling for PRV surveillance. However, further improvements in the performance of both the gB and gE PCRs would be recommended.

c. Porcine circovirus type 3

A study on porcine circovirus type 3 (PCV3) funded by SHIC mined diagnostic data obtained by the University of Minnesota Veterinary Diagnostic Lab during the last two years to look for associations between the presence of PCV3 (and its viral load) and specific lesions and clinical conditions. Results from this study suggest PCV3 may cause death in fetuses and myocarditis and systemic vasculitis in pigs.

In summary, this study provided an objective view of the relationship between PCV3 and disease, based on a large dataset of diagnostic cases. PCV3 is a very common virus that circulates in healthy populations and can be detected in around 20% of the pigs submitted to the diagnostic laboratory. Therefore, it is important to differentiate when PCV3 plays a significant role and when it does not.

The results from this study support previous studies that suggested that PCV3 may cause death in fetuses and myocarditis and systemic vasculitis in pigs.

b. Porcine parvovirus type 2

A project funded by SHIC will develop understanding of the prevalence and phylogenetic relationships of porcine parvovirus type 2 (PPV2) infections in swine farms. In addition, researchers at South Dakota State University will explore the role PPV2 infection plays in important diseases such as pneumonia, immune deficiency, reproductive failure, and lameness, all causes of concern and lost productivity for pork producers. Other project objectives include development of research and diagnostic assays, including in situ hybridization and real-time PCR, for the detection, identification, and differentiation of PPV type 1 and PPV2.

With answers to the questions posed by researchers for this project, valuable information will be made available to pork producers and swine practitioners to help understand the etiological significance of this virus, helping to prevent production losses.

c. Porcine sapovirus

In a case from a farm experiencing an ongoing problem with piglet diarrhea in the lactation phase for more than 2 years, pigs exhibited a self-limiting diarrhea starting around 10 days of age and typically lost 1-2 lbs. of expected weaning weight. With a grant from SHIC, researchers documented the discovery of porcine sapovirus (SaV) of genogroup III as the cause of the enteritis and diarrhea by using four independent lines of evidence: metagenomics analysis, real-time RT-PCR, histopathology, and in situ hybridization. To the best of their knowledge, this is the first evidence that SaV likely serves as the sole etiological agent causing enteritis and diarrhea of piglets in the field in the United States.

In addition, a highly sensitive and specific real-time RT-PCR for detecting porcine sapovirus of genogroup III was developed using SHIC funding. And a prevalence survey of more than 500 samples from both pigs with clinical diarrhea and clinical healthy pigs suggests that porcine SaV III plays an important role in causing swine enteritis and diarrhea and rRT-PCR is a reliable method to evaluate the pathogenicity role of porcine SaV.

Monitor and Mitigate Risks to Swine Health

1. Identify and mitigate swine disease risks by international monitoring

Global Swine Disease Monitoring Reports

The SHIC Global Swine Disease Monitoring Report has provided near real-time information on swine diseases regularly since November 2017 and is communicated to the US pork industry through SHIC's monthly e-newsletter and posting online on the SHIC website, as well as being published using channels available to authors at the University of Minnesota Department of Veterinary Population Medicine. The project created and now maintains a public, private, academic partnership for its reporting.

This reporting system identifies hazards and subsequently scores them using a step-wise procedure of screening for issues that potentially represent a risk for the US. A combination of unofficial and official data is actively and passively collected and organized. Following successive screening steps in which data and information are modified, edited, corrected, and expanded in collaboration with USDA-APHIS-CEAH and selected stakeholders, a report describing the outputs has been routinely available to the public. In addition to the three USDA-classified tier 1 reportable foreign animal diseases of swine, ASF, classical swine fever, and foot-and-mouth disease, which represent the main content, reports of significant changes in the epidemiological situation of production diseases such as PRRS or PRV have been included.

The project has been successful in finding and communicating a number of potential threats to the US pork industry. In particular, the project came in time to collaborate with relevant stakeholders in collecting, organizing, critically reviewing, and communicating the expansion of ASF through Asia and Europe.

Improve screening following international travel
SHIC, AASV, NPB, and NPPC met multiple times with DHS-Customs and Border Protection (CBP) during 2020 to voice concerns about secondary screening after travelers declare contact with foreign farms or animals. In collaboration with the other pork industry associations, SHIC is collecting information from travelers about their customs entry experience. The industry associations are then sharing it with DHS-CBP to help them assess performance and improve prevention of foreign disease introduction.

International travelers returning to the US, or those arriving from other countries, after visiting a farm or being in contact with animals in a country (or countries) with ASF, or any other foreign animal disease, should declare this information to DHS-CBP via written form, airport kiosk, or verbally. SHIC received a report from a person who traveled to Ecuador, visited several pig farms, and then returned to the US. This person re-entered in Atlanta, declared the farm visits, and was not diverted for secondary screening. This person did not see signage directing this process nor any beagle brigade teams working. SHIC, AASV, NPB, and NPPC continue to ask international travelers to report if they are not diverted for secondary screening upon arrival in the United States.

2. Improve transport biosecurity from first points of concentration.

Prevent pathogen transfer during marketing events

a. Because groups of pigs in the United States are typically marketed over several weeks, the opportunity exists for pigs still on feed to become infected during a marketing event. The pigs remaining in the group are then subject to the production losses and become a source of virus for other swine farms. For example, it has been demonstrated that livestock trailers can serve as a source of transmission for PRRS and PED.

   SHIC funded a study conducted by Iowa State University to try to objectively assess if implementing a staged loading procedure for market pigs is effective at preventing transfer of swine pathogen contaminated particles from livestock trailers to the barn. Fluorescent powder (Glo Germ) was used as a marking agent to be able to see traffic patterns. The study compared a conventional method of loading to a staged loading procedure.

The staged loading procedure completely eliminated contamination within the center alley measurements in one replicate but did not completely eliminate contamination in all other replicates. However, four out of the five measuring points in the center alleyway of the barn had a level of contamination significantly lower ($p<0.05$) for the staged loading protocol compared to the conventional loading protocol. The difference at the fifth measuring point in the center alleyway of the barn was nearly significant ($p=0.0573$).

b. PRRSV, PEDV, PDCoV, and TGE and other swine pathogens are not capable of locomotion. Therefore, to be transmitted to groups of growing pigs during the wean-to-market phase of production they must be carried by some carrying agent. Carrying agents may be infected or contaminated with a pathogen. Carrying agent entry events occur when a potential carrying agent enters the premises where pigs are growing. Every time a carrying agent entry event occurs, there is an opportunity for a pathogen to be introduced.

For many of the carrying agents that enter growing pig sites, including live swine, livestock trailers, clothing, footwear, tools, supplies, other animals, insects, and/or food and water, experimental studies have demonstrated that they are capable of transmitting pathogens. However, no studies have been done to assess which carrying agent entry events are most frequently associated with the introduction of pathogens to growing pigs during the wean-to-market phase of production.

The objective of this SHIC-funded study is to detect the introduction of wild-type PED, PDCoV, TGE and PRRS into groups of growing pigs and to associate the timing of the introductions with the frequency and timing of carrying agent entry events. Knowing which carrying agent entry events are most frequently associated with introduction of wild-type PED, PDCoV, TGE and PRRS will help producers and veterinarians decide where to allocate resources spent on biosecurity, reduce the vulnerability of growing pig sites and reduce the frequency with which growing pigs become infected with PED, PDCoV, TGE and PRRS during the wean-to-market phase of production. Results will come in 2021.

3. Improve farm biosecurity

Investigate biosecurity procedures to mitigate disease risk
A SHIC-funded working group report on ultraviolet light (UVC), a type of electromagnetic energy invisible to humans, provides guidance on how it can be used on farms to exclude pathogens from being introduced into a herd, a process known as bio-exclusion. When utilized and maintained properly, UVC germicidal chambers can be an effective component of comprehensive biosecurity programs.

However, proper construction and use of the chambers is necessary to obtain the full benefit UVC bio-exclusion. UVC lights need to be working properly to provide the intensity of light exposure or dose necessary to inactivate the micro-organism. Items must be placed in a way the light can impact all surfaces of the items. In addition, safety should be a top priority when utilizing UVC chambers. The working group involved in this project examined UVC properties, related equipment, practices, and pathogens resulting in recommending best practices for use of ultraviolet light for bio-exclusion on the farm.

The full report contains detailed information on the physics of UVC, including wavelength details and how it inactivates pathogens. Information on dose calculations is incorporated along with specifics on measurement of UVC with a UV meter, factors affecting effectiveness, light system components, and a discussion of different light bulbs. In addition, detailed maintenance and safety requirements are included for optimum results using UVC in germicidal chambers. The report concludes with a section recommending best practices in the field as well as extensive tables and resources on inactivation results. A brief Fact Sheet on UVC use has been published as well.

4. Investigate the ability of common inputs to production to act as biologic or mechanical vectors for disease introduction onto farms

Feed Safety Task Force

After PED was introduced into the United States in 2013, a USDA pathways analysis concluded that the most likely route of introduction was from contaminated containers moving between countries and being used to import feed or feed ingredients. However, the pattern of the US outbreak was such that a more direct involvement of imported feed needed to be investigated. As ASF continued to move across China, Southeast Asia, and Western Europe in 2020, SHIC collaborated with several industry partners to continue to assess potential feed-related risks of introduction and dissemination.

A Feed Safety Task Force with USDA, FDA, CFIA, US and Canadian feed industries, national pork organizations, academics, veterinarians, and pork producers was formed and met virtually in 2020 to discuss possible risks associated with viral contamination of feed or feed components. The Task Force objective says, "There is agreement that there is risk of introduction of pathogens into and within the US via imported feed products. The Task Force will evaluate the risk and help decide what actions need to be taken to protect the US pork industry from that risk. Actions should be achievable, based on science and minimize trade disruptions."

USDA and FDA believe there are currently many unknowns and data gaps that should be identified to help define or validate feed risk. In the absence of information regarding the predictive ability of unvalidated test results to accurately determine the potential risk associated with feed, they believe the design and implementation of a testing strategy is not feasible. At this time, it is up to the pork industry to address potential risk of foreign animal disease introduction into the US from imported feed ingredients.

ASF, CSF and PRV feed risk and mitigation

Significant attention has been given to mitigating the risk of ASF transmission in feedstuffs. In a recently published SHIC-funded study (https://wwwnc.cdc.gov/eid/article/25/12/19-1002_article), researchers' work to determine the stability of CSF and PRV in feed ingredients under transpacific shipping conditions was detailed. Understanding the risk and mitigation of foreign animal diseases such as ASF, CSF and PRV in feed and feed ingredients is critical to protecting the health of the US swine herd.

The objectives of this study were to 1) identify animal feed ingredients which support survival of CSF and PRV when exposed to transpacific shipment conditions, 2) improve the half-life calculations of ASF in feed ingredients when exposed to transatlantic shipment conditions, and 3) investigate antiviral chemical mitigants as a tool for reducing the risk of introduction and transmission of CSF, ASF and PRV in feed and feed ingredients.

In the first step of this mitigation study, animal feed ingredients were contaminated with CSF or Chinese strain of PRV and subjected to varying temperature and humidity conditions to simulate transpacific shipment over a 37-day period. Feed ingredients were then tested for virus at the conclusion of the model by PCR, virus isolation, and/or pig bioassay.

Second, ASF was quantified in animal feed ingredients at several time points throughout a 30-day model simulating transatlantic shipment. Improved ASF half-life estimates in feed ingredients were calculated to include both standard error and 95% confidence intervals.

Third, antiviral chemical mitigants were tested for efficacy against foreign animal diseases in 1) in vitro cell culture models and 2) transboundary shipping models.

Results confirmed that ASF Georgia 2007 is capable of surviving transoceanic shipment conditions in conventional soybean meal, organic soybean meal, soy oil cake, choline, pet foods, pork sausage casings, and complete feed. The half-life of ASF in all feed ingredients range between 9.6 and 14.2 days, with 12.2 days being the average. Researchers also determined that both CSF and PRV survive in feed ingredients subjected to a 37-day transoceanic shipment. Overall, this research has improved our ability to quantify risk of ASF, CSF and PRV in feed, implement science-based storage times to mitigate possible ASF contamination in feed, and identify effective feed additives for risk mitigation of foreign animal diseases through feed.

Feed holding time mitigation

On February 5, 2020, SHIC joined with other pork industry organizations to release the most current feed holding time recommendations for disease mitigation. Ongoing research caused SHIC, NPB, NPPC, and AASV to offer updated and revised information for feed holding times to mitigate virus transmission. Based on the conditions of transoceanic shipment, the mean holding times calculated to provide 99.99% ASF degradation at 54 degrees F was 125 days in conventional soybean meal. (Stoian, A., Zimmerman, J., et al. Half-Life of African Swine Fever Virus in Shipped Feed. Emerging Infectious Diseases. 2019;25(12):2261-2263. doi:10.3201/eid2512.191002).

Feed additive mitigation research

SHIC funded a study to evaluate the mitigation potential of chemical feed additives following natural consumption of contaminated feed. Prompted by concern over feed biosecurity and other research results suggesting feed can harbor viable viral pathogens and potentially serve as source of infection to susceptible pigs, this study was completed, and the full report is posted on the SHIC website.

Results show chemical mitigation alone may not be able to completely prevent transmission of pathogens through feed. Under the conditions used in the animal clinical trial, in which every animal in the study ingested contaminated feed via natural feeding, the efficacy of the mitigants was low. Out of the three mitigants tested, only mitigant A reduced SVA infection when a low contamination dose (10^5 TCID50) of the virus was used, as evidenced by lower levels of virus shedding and viral load in tonsil of exposed animals. When the contamination levels were increased to 10^6 or 10^7 TCID50, no significant differences were observed between the mitigated and non-mitigated treatment groups, with all animals presenting similar levels of virus shedding and viral load in tonsil.

These results suggest that chemical mitigation alone (with mitigants A, B, and C) may not be able to prevent transmission of pathogens through feed. Consequently, if or when these compounds gain FDA approval for feed viral mitigation, adding them onto alternative strategies such as storage time and importation of feed ingredients from known and trusted sources should be considered to safeguard the US swine industry from unwanted viral pathogens.

Feed data and information to help support an objective risk assessment

a. With funding provided by SHIC, Pipestone Applied Research began studying the risk of virus movement in feed. Early work was all completed in the laboratory and confirmed the survivability of PED virus in feed as the vehicle for transmission and transport. More recently, a Phase 1 demonstration project to reproduce the results found in lab studies, only under real world conditions, was completed using inoculated feed component samples shipped for 21 days, involving 107 hours of transport, crossing 14 states, and covering approximately 6,000 miles. The trip exposed the virus-spiked feed to mountainous, western, gulf coast, eastern, and New England environments as well as Midwestern. The amount of feed in this demonstration was small – just 30 grams per test. This allowed for the entire quantity of feed to be tested at the conclusion of the journey to prevent false negative results.

   In the report summary, results indicated the presence of viable PRRS virus, Senecavirus A (SVA), and PED virus in both soy products, while viable SVA – a surrogate for foot and mouth disease virus – was recovered from all five tested feed ingredients. In contrast, survival was limited in the vitamins and amino acid ingredients. The results for PED and PRRS showed they survived in whole feed as well. This demonstration also confirmed lab results showing soy-based products being supportive of viruses as both organic and conventional soybean meal were included.

b. Funded in 2020, with completion scheduled during January 2021, Phase 2 of the above project will further evaluate virus viability in feed ingredients using a demonstration project designed to simulate commercial conditions of transport, bulk sampling of feed, and natural feeding behavior. Phase 1 acknowledged limitations, all to be addressed in Phase 2, included the use of small sample volumes of feed ingredients (30g), the use of a proportionally large volume of liquid to inoculate feed (2 mL/30g feed), the inability to test a representative method for the testing of bulk feed, and no use of natural feeding behavior to evaluate viability (bioassay only).

Ingredients to be inoculated will consist of 1-ton totes of conventional soybean meal (2 totes), 1-ton totes of organic soybean meal (2 totes) and 1-ton totes of complete finishing feed (2 totes) along with 1 uninoculated control tote. In addition to evaluating viral survival via a combination of virus isolation and bioassay using natural feeding behavior and injection, the project will also test a published method to sample bulk feed ingredients for viral contamination and further validate a National Pork Board funded PCR extraction methodology specifically designed for plant-based feed ingredients.

c. Epidemiological evidence of previously naïve farms breaking with porcine deltacoronavirus in November 2020 suggested a potential role of feed. Three production farms experienced new disease outbreaks, with the two initial outbreaks occurring at facilities fed by the same feed mill. The objective of this study was to use environmental sampling to conduct an emergency investigation of the feed supply chain in the transmission of porcine deltacoronavirus among Kansas swine farms.

   Four different two-person response teams were deployed to one of four sites (Site A, B, C, and D) located within the state of Kansas. A total of 133 samples were collected. At the feed mills associated with Site A and D, the teams conducted a biosecurity audit and aseptically swabbed suspect locations using paint rollers or cotton gauze that are pre-wetted with phosphate buffered saline. Sampling locations included feed-contact surfaces and non-feed contact surfaces.

   Because all farms were confirmed to contain porcine deltacoronavirus, animal-contact surfaces were assumed positive and were not sampled. Farm sampling consisted of feed, feed equipment and environmental collections.

   Preliminary results are pending.

d. SHIC has contracted with Kansas State University for a Master's student to do a comprehensive look at production, importation and uses of soybean meals. This will include their possible role in introduction and/or dissemination of swine viral pathogens, monitoring for fecal contamination indicators and 'Best Practices' for the importation of organic soy products.

Feed mill SVA transmission study in Brazil

Three partner feed mills located in Brazil reported high levels of Senecavirus A (SVA) in finishing barns fed from their associated mills, and samples of soybean meal as well as meat and bone meal collected from the mills were confirmed to contain SVA. SHIC funded an investigation into the possibility that the mill itself and/or its ingredients could be a source of SVA transmission. The objectives were to assess the distribution and mitigation of SVA, an FMD surrogate, in a swine feed mill and evaluate potential risk of pathogen entry into the United States from Brazilian feed ingredients.

Without finding a definable connection between SVA in the feed mill and the farms, attention was diverted to Enterobacteriaceae (EBAC) as an indicator of fecal contamination and overall hygiene of the feed or feed ingredients. That information was then used as a method of identifying feed-related and other biosecurity gaps in the feed mill and on the farm.

Results showed compliance with biosecurity protocols had a substantial impact of EBAC prevalence and distribution throughout the feed mill. As facilities begin to transition biosecurity from the farm to the feed mill, using environmental monitoring to evaluate risk for biosecurity gaps, as well as success in their mitigation, will be useful and necessary. The results also emphasize the need for producers to evaluate feed ingredients as potential swine disease vectors, using resources provided by SHIC and industry partners to examine their suitability for use in rations.

5. **In coordination with other industry organizations, help to fill in the gaps of research and information needed to prevent, prepare, and respond to foreign or emerging diseases.**

African Swine Fever – Strengthen national biosecurity and protect the US from foreign transboundary diseases like ASF

NPB and SHIC, with the collaboration of NPPC and AASV, are funding a 12-month long project to identify gaps in US pork industry national biosecurity. The goal is to prevent entry of foreign animal disease into the country by addressing any identified biosecurity gaps. The National Swine Disease Council will be helping to provide oversight to the project.

The project will not only identify and prioritize biosecurity gaps within the US pork industry, but it will also provide direction for corrective or additional mitigations. ASF will be used as a model for other FADs due to the virus's resiliency as well as the great concern surrounding it in the industry. Among the many areas being considered for study are foreign imports, entry of foreign travelers, domestic transportation of animals, common inputs to US production, domestic market channels and others. The outcomes will include details, if biosecurity gaps are identified, including data sources and uncertainty in risk estimates.

African Swine Fever – literature review of molecular epidemiology to inform preparedness and control strategies

As ASF circulates around the world, reports of varying degrees of pathogenicity bring into question the possibility of the current, epidemic strain drifting into different, related strain(s). SHIC has funded a proposal to report the current state of knowledge regarding pathogenicity and possible strain differences.

This report, to be published in a peer-reviewed journal early in 2021, aims to synthesize the current state of knowledge and the remaining gaps regarding the molecular epidemiology of African swine fever to inform appropriate preparedness and surveillance strategies. The unprecedented expansion of ASF during the last five years has produced a significant increase in the volume of scientific publications on the subject (218% increase compared to the previous five years (2010-2014)).

There is a need to synthesize available scientific evidence to support and facilitate research results translation into updates for regulations and policy framework, and management recommendations for the industry. There is also a need to identify relevant research gaps in disease prevention and control, with the ultimate goal of supporting the design of experiments and projects to provide answers to those gaps. This review will focus on establishing the extent to which existing research has progressed towards clarifying specific challenges regarding genetic diversity of strains, the association between sequence data and pathogenic features, and development and performance of molecular diagnostic tools.

African Swine Fever – transferring experience with ASF to US preparedness
ASF was diagnosed in China in August 2018, veterinarians have been studying the virus's epidemiology and learning how to manage barns. SHIC is monitoring these experiences as part of its mission of preparedness for foreign animal disease management for the US national herd. Two US-based practitioners have experience with ASF management practices in China and shared their perspectives with SHIC, which communicated them via the AASV e-letter and the SHIC e-newsletter.

In China, when ASF initially broke, there was the mindset that it needed to be eradicated. Anytime ASF broke on a farm, the whole population would be euthanized, the premises cleaned and disinfected, and then the site repopulated to start over. When it became clear ASF was going to become endemic, depopulation, just because there was a positive test, was not an economically viable solution. Due to the economics, production companies started working on test-and-removal since the virus does not spread as quickly as originally believed, especially in a sow herd where animals are individually housed.

The goal is to stop transmission because the virus moves relatively slowly. What has developed in China through experience is better detection of early clinical signs of an animal that is infected. And there are readily available PCR diagnostics so they can very quickly confirm the presence of infection. They lockdown that gestation area of infected animal(s) by the individual stall or stalls if there's a solid pen divider between groups. If there are no solid dividers between the stalls, the lockdown is by the trough. If the suspect or positive animal is in finishing, they lock down the individual pen with the animal and the pens on each side. In both situations, they lock down the barn until further testing can be done and decisions made. When they have a suspect animal or animals and are waiting for confirmation, they totally lock that building down for people movement, traffic in and out, and animals in and out, until they get the test result. They take great care in removing those positive animals to prevent transmission. They have learned to focus on containment to stop the spread.

Using test-and-removal protocols based on farm design have been successful for some companies. Depending on the situation and how quickly ASF is recognized, there has been a success rate of 70% to 80%. Following test and removal, generally there is three weeks of cleaning and disinfecting that area of the farm, after which the area can open back up.

African Swine Fever – International coordination of ASF research
Swine Innovation Porc, a non-profit corporation in Canada, facilitates research in the Canadian swine sector. Their goal is enhancing the profitability and sustainability of the Canadian pork industry. In 2019, Swine Innovation Porc developed a Coordinated ASF Research Working Group and SHIC was invited to participate. The Group facilitates ASF research coordination between scientific experts, industry leaders, and Canadian federal agency partners.

Over six months, the ASF Working Group created an ASF-related research priorities document which was completed in December 2019 and further refined during 2020. The Canadian Pork Council will use the document in its strategic planning activities for ASF. Coordination with our international neighbor is valuable as both countries work to achieve prevention and preparedness.

African Swine Fever – Coordination of enhanced surveillance in non-control areas
A "72-Hour Task Force" has been formed from a larger National Assembly of State Animal Health Officials (NASAHO) ASF Working Group. The NASAHO ASF Working Group is made up of federal animal health officials, SAHOs of the 15 states with the largest pork production, representatives of the state pork associations of those states, representatives of AASV, NPB, NPPC and SHIC, and the North American Meat Institute. The 72-Hour Task Force is made up of federal animal health officials and the state animal health officials and state pork association representatives of Indiana, Iowa, North Carolina, and Oklahoma along with representatives of the national pork organizations.

The purpose of the Task Force is to discuss data or surveillance needs to give states and USDA confidence in "non-control areas" and moving pigs between these areas without the need for permits, as is done now. The current discussion of the Task Force centers on post-outbreak "enhanced passive surveillance" in the non-control areas with the possible incorporation of some combination of mortality testing and the surveillance and biosecurity recommendations that are part of the Secure Pork Supply.

The recommendations of the Task Force will be brought back to the broader NASAHO ASF Working Group for their discussion and consideration.

African Swine Fever – oral fluids PCR sensitivity
Recent unpublished, observational research indicates oral fluids (OF), when collected by rope as an aggregate sample, could be a good sample for rapid detection of ASF. However, this experimental data also suggests that there is potential for false negative test results. Therefore, SHIC published a call for proposals to develop methods to improve the detection of low levels of nucleic acid in OF through enhancements to pre-extraction treatment(s) of samples or through improved extraction methodologies compatible with the high throughput testing currently done in NAHLN laboratories.

Proposals were received, reviewed by subject matter experts and then reviewed and selected for funding by the SHIC Preparedness and Response Working Group. Two projects were selected for funding, with work beginning in 2020 and results expected in 2021.

Building capacity to support the control of African Swine Fever (ASF) in Vietnam
With active support from NPPC, a grant was awarded to SHIC in 2019 to start a dialogue between the US and Vietnamese officials, sharing veterinary knowledge and ways to prevent ASF from further spreading. The approximately $1.7 million grant from the USDA's Foreign Agricultural Service division will fund the multi-phase project, helping to build strategic partnerships while increasing trade of US pork to the region. The work will include swine health field projects, with collection and analysis of tissue samples, which will help inform North American pork producers about effective ASF preparedness and response.

Due to the COVID-19 pandemic, planned in-person workshops have been delayed. The Vietnamese Department of Animal Health has requested that they now be held during the latter part of 2021 and the first part of 2022. However, field projects are underway with some modifications needed because of travel restrictions. USDA-FAS has approved a 1-year extension of the end date of the project to August 31, 2022.

Section 1: Sharing knowledge and ideas. Strengthening veterinary services capacity for mitigating African Swine Fever impact on Vietnam
The goal is to create a capacity building program to train veterinarians, laboratory workers, and/or farm advisors or managers on topics described by the OIE as necessary for assurance of functional national veterinary services organizations, with a focus on ASF prevention and control. The program is being developed as a collaborative effort led by the University of Minnesota. Students will be proposed by the Vietnamese Department of Animal Health in consultation with local partners, such as private companies and universities.

Scope of the work:

- The program will be implemented using a hybrid model, with two in-person interactions (workshops), one at the beginning and one at the end of the program, and four on-line courses covering the key aspects of ASF prevention and control.
- The courses implemented in the program will focus on:
  - Principles of epidemiology, disease diagnosis, and surveillance
  - Principles of biosecurity
  - ASF preparedness, response, and national and international animal disease regulation
- A certificate of approval, issued by the University of Minnesota's Center for Animal Health and Food Safety, as an OIE collaborating center, will be awarded to those who complete the program and pass a final comprehensive examination.
- Although the program will primarily focus on ASF, the principal lessons will be applicable to other swine diseases.
- Didactic training will occur over a six-month period.
- Approximately 20 veterinarians, laboratory workers, and/or farm advisors or managers from Vietnam will be trained.

Section 2: Implementation of field projects, and collection and analysis of samples
SHIC published an open call for research proposals to address priorities for African swine fever (ASF) research in Vietnam. The objectives of these researchable priorities were to help Vietnamese pork production respond and recover from the ASF epidemic and to help US pork producers learn lessons about ASF epidemiology and management in preparation, should the virus enter the US.

Research priorities for ASF study in Vietnam, in random order:

- Determining diagnostic specificity and sensitivity of ASF ELISA antibody detection.
- Understanding protocols for biocontainment of initial infection on the farm into one barn, allowing other biosecure barns to remain in production.

- Researching innovative disinfection protocols that result in disinfection and a negative result using a commercially available ASF PCR test.
- Verifying carbon composting materials, time and temperature under different environmental conditions that will result in ASF inactivation.
- Identifying pathways of entry of the virus onto farms to enhance information for improving biosecurity.
- Investigating biosecurity of feed, feed components and delivery as a risk for ASF introduction.
- Validating protocols for the targeted removal of individually housed sows when infected to move the herd to negative status.
- Researching the possible role of mice and rats as vectors for ASF infection.
- Comparing sensitivity and specificity of pen-side tests for ASF detection.
- Understanding ASF persistence in manure slurries or pits and identifying protocols or procedures to inactivate the virus in this material.

Proposals were received, reviewed by subject matter experts and reviewed and selected for funding by the SHIC Preparedness and Response Working Group. The Center supported US-based researchers with research memorandums of understanding or direct contacts with university or pork production animal health researchers in Vietnam. Projects selected for funding by SHIC or NPB include:

ELISA
"Full validation of two commercial ELISA assays for the detection of antibodies to African swine fever" and "Evaluation of the diagnostic performance of a ASF serum/oral fluid antibody ELISAs under field conditions in Vietnam." The objectives of these two projects include evaluating the performance of ASF serum and/or oral fluid ELISAs for use in the surveillance and monitoring of ASF outbreaks in commercial farms in Vietnam. More broadly, fulfillment of the project aims could bring the development of a comprehensive integrated swine surveillance system ("no single best diagnostic approach") based on the combination of molecular and antibody methods.

Rodents
"Potential of rodents to be a vector in the transmission of African Swine Fever in two commercial farms in Vietnam with differing biosecurity levels." The objectives are to determine if ASF virus can be detected in mice and rats, and if so, which tissues are the best to sample; to determine the impact of farm biosecurity level on rodents' ability to carry the disease; and to measure mouse-to-mouse transmission of ASF in a controlled laboratory situation.

Baking for disinfection
"Time and temperature required for complete inactivation of African swine fever virus." Objectives are to determine the optimal baking time and temperature required to completely inactivate ASF on aluminum surfaces contaminated with organic materials. This research is designed to simulate sanitation protocols currently used in the US to disinfect animal trailers.

Epidemiological analysis of pathways of entry
"Identifying pathways of entry of ASF virus onto farms to enhance information for improving biosecurity in Vietnam." Objectives are to use the rapid response outbreak survey of SHIC's Rapid Response Program to investigate ASF pathways on Vietnamese farms and to test an electronic format for completing the outbreak investigation forms.

ASF transmission via boar studs risk assessment
"Determining the pathways for ASF introduction into boar studs and risk of ASF transmission via semen movements during an ASF outbreak." This project will determine the risk of introducing ASF to a sow farm as a result of semen movement from apparently healthy boar studs located in an ASF disease control area. A pro-active risk assessment will be performed to systematically evaluate the potential risk of semen movements during an outbreak to investigate the pathways of ASF introduction into boar studs, the pathways of ASF introduction associated with semen movements into sow farms, the simulated spread of ASF in a sow farm in which multiple sows are simultaneously exposed to ASF via the AI process, and what surveillance is needed and how long should semen be held to increase the likelihood of ASF detection.

Composting
"Validating the Composting Process for ASF Virus Inactivation." Funded by the National Pork Board, this project will assess the effectiveness of the swine carcass composting process to inactivate the ASF virus by empirically estimating the degradation curve for ASF virus using composting as a management tool; will determine if regionally sourced carbon materials affect the composting process and subsequently the inactivation of ASF virus; and will determine if ASF virus survives in bone marrow during the compost process

Targeted test and remove
"Validating protocols for the targeted removal of individually housed sows when infected to move the herd to negative status." The objective of this project is to test sufficiency of current "Test and Remove" methodology for ASF elimination in Vietnam sow herds. Also, these field samples will be used to evaluate diagnostic performance of 4 commercially available ASF point-of-care, pen side assays for detecting ASF in ASF-suspect and non-clinical neighboring animals.

Pen-side tests
"Evaluate the diagnostic performance of pen-side tests for ASF detection." Three different pen-side tests will be evaluated and compared using both whole blood and oral swabs as collected tissues. This project will work to determine the time from infection to the earliest detection using pen-side tests and the sensitivity and specificity of the pen-side tests for detection of ASF in the field.

Feed transport and mill biosecurity
Initially proposed as "Investigating methods for decontamination of interior surfaces (cabs) of transportation vehicles" as those decontamination methods apply to the Vietnamese feed industry in that environment, a modified project has been funded by the National Pork Board. It will develop a model to evaluate methods of cleaning and decontamination of transportation vehicles at facilities located at Kansas State University using surfaces representative of real-world conditions and evaluate multiple strategies using PED virus in BSL-2 conditions at KSU. Those results should then be able to

apply lessons learned and build capacity to mitigate feed and delivery risk in Vietnam and the U.S., should the virus enter this country.

Oral fluids as a monitoring and surveillance tool
"Field evaluation of oral fluids as a convenient, aggregate sample for early detection of African swine fever." The objective is to conduct a field evaluation in Vietnam of oral fluids in conjunction with other sample tissues for early detection of African swine fever virus. A collaborative project of the Canadian Food Inspection Agency and USDA, the outcome will help evaluate the scientific appropriateness of using swine oral fluids as a monitoring or surveillance tissue for PCR analysis and inform U.S. surveillance plans through better understanding ASF disease outbreak dynamics.

Improve Swine Health Information

1. Develop the industry capacity for detection of emerging disease, rapid response and continuity of business

Morrison Swine Health Monitoring Project
Primarily funded by SHIC, the Morrison Swine Health Monitoring Program (MSHMP) continues to expand its capacity and, as a result, delivers more and higher quality information on health status of US swine herds. Recent MSHMP capacity expansion improves and enlarges the program's ability to collect and report pathogen data from an increasing number of volunteer cooperators. A MSHMP goal is have the capacity to manage data from as many producers as are willing to participate.

Sow data is now being complemented with growing pig site information from participants. Presently, a total of 922 growing pig sites in seven states are included in MSHMP databases. These sites include the production flow of 68 sow farms (252,900 sows). More growth with additional growing pig site inclusion is anticipated soon.

The MSHMP database was grown, with more data characteristics added. Staff has a plan to adapt to this growth and related demands, customizing the database and managing its increasing complexity. This includes the ability to add pathogens to the database when needed. Additionally, due to expansion efforts, the ability to assign a status based on a classification previously established by the program is now possible. MSHMP tested this ability by successfully adding *Mycoplasma hyopneumoniae* reporting to the database and MSHMP reports.

MSHMP's work has resulted in a successful PRRSv sequence capturing process. Analysis continues and the database currently has 30,603 sequences from 31 systems. Study of the different sequences will help researchers understand which of these viruses may change and continue to spread, providing preventive information to producers.

Pig flow management is another area where the MSHMP database was improved. The ability to link farms to connect sow and growing pig sites was tested with work ongoing to assign downstream flow status. The next step of expansion will be the inclusion of boar studs in the system, further connecting and tracking pathogen activity across sites, farms, and systems.

An additional layer of security was also added to the database. The present system allows few users to access the database, however, each time they do access and make changes, it is tracked. With the additional security, maintaining quality and control of MSHMP data is assured.
This ongoing effort provides valuable data and reports back to SHIC and the industry. With enhanced capacity to help the pork industry respond to emerging pathogens MSHMP delivers timely data used by practitioners and producers to enhance herd health.

Analysis of MSHMP data
There were four 2020 MSHMP data analysis projects initiated in 2020 that help to inform producers and veterinarians about disease management:

a. PRRS continues to plague the swine industry with 20-30% of herds breaking annually. These outbreaks cost the swine industry and its producers an estimated $664 million every year.

   Pork producers continue efforts to increase biosecurity. However, there are still gaps in biosecurity measures when considering prevention of PRRS outbreaks. The industry needs the ability to better predict operation risk of a PRRS outbreak as well as to evaluate farm specific biosecurity.

   SHIC funded the development of a biosecurity screening tool to identify breeding herds' risk to PRRS outbreak using a short survey. The objective of this study was to measure and benchmark the relationship between key biosecurity aspects and PRRS outbreaks in breeding herds, while validating a short biosecurity screening survey.

   A total of 13 production systems were enrolled in the study (188 sow herds), representing 15 states. The best machine learning algorithm predicted PRRS outbreaks with an accuracy of 78.5%.

   The 44 biosecurity measures were ranked according to their contribution to the model prediction. The first four most important variables were devotion to breeding genetic replacements, number of swine premises within a three-mile radius, number of breeding females on the premises, and distance to the nearest public road. The probability that a herd had reported an outbreak were higher in farms that had raised breeding animals as genetic replacements. The higher the number of swine facilities within a three-mile radius and the closer the farm was to a public road, the more likely the facility would be expected to break with PRRS.

   The analysis offers a flexible, shortened approach to screen breeding herd's PRRS biosecurity vulnerability. This study highlights the value of using data to build upon our understanding of biosecurity risk in an operation.

b. SHIC funded two studies of MSHMP participants' data to apply machine-learning to predict PED outbreaks on sow farms. The researchers were able determine it is possible to predict the probability of an outbreak when considering animal movements and environmental conditions.

Another goal was to see if shared producer data could be used to develop critical tools for the prevention of disease spread and implementation of risk mitigation. Further, this work serves as a model for near real-time disease forecasting.
As a result, a predictive machine-learning model that estimates the probability of a PED break biweekly has been developed. The forecasting model uses data on pig movements, geolocations of farms, environmental, and weather factors to predict the probability that a sow farm will become infected two weeks in advance. The goal is farm-level forecasts for two weeks in the future that can be updated and delivered as new data emerges each week allowing ample time to mitigate the risk or minimize the impact. The platform may also be applied to other diseases, such as PRRS, although ongoing analysis suggests that PRRS breaks are more difficult to predict.

North Carolina's PED outbreak time-series from 2013 to 2020 (using MSHMP data) has also been analyzed. Approximately 50% had at least one recurrent outbreak, and the proportion of farms with more than two recurrent outbreaks varied from 2.3% to 5.9%. High-resolution maps to identify current and future PED risk in North Carolina have been developed. This project also analyzes the efficiency and likely success of possible biosecurity and mitigation steps that could be taken in advance of the outbreak. This has the potential to predict the near-future risk for PED outbreaks in North Carolina and make intervention recommendations to minimize costs and maximize treatment efficacy.

c. MSHMP has been adding capacity to capture PRRS sequencing data from cooperating veterinary diagnostic labs (VDLs). The sequence acquisition process was organized, and simplified, making sequence monitoring a reality. Next, the real-time monitoring component is being developed. This data is being used to develop analytic methods for understanding PRRSV, giving producers the opportunity to respond to emerging, highly virulent strains.

Working closely with participating VDLs, MSHMP staff was able to establish a methodology which increases PRRSV sequence update frequency. These frequent updates and virus classification into virus type, RFLP, and lineages has opened a great opportunity for the program from an added value standpoint. Maintaining an updated database has allowed MSHMP to quickly respond to sequence comparison requests from participants throughout the year during their outbreak investigations.

As expected, several clusters identified in the dataset contained sequences with high similarity which highlighted the fact that a sequence (e.g. virus) disseminated throughout a region in a specific period of time. However, there were other instances in which clusters found contained multiple sequences clearly highlighting the fact that regional diversity continues to pose a risk from a biosecurity and pathogen evolution standpoint.

2. Make industry swine health information available to help uncover, communicate, and mitigate regional and national risks to herd health

The World Organization for Animal Health (OIE)
The COVID-19 pandemic caused the annual general assembly meeting to be virtual with only the official country delegates participating. However, communication with the US delegate continues as does review and comment on relevant OIE issues and papers.

Provide context and analysis to press information about swine health advancements

a. A paper with information on a new ASF vaccine from the Chinese Harbin Laboratory was published online on March 1, 2020. In the abstract of the paper, authors state, "The virulence, immunogenicity, safety, and protective efficacy evaluation in specific-pathogen-free pigs, commercial pigs, and pregnant sows indicated that one virus, namely HLJ/18-7GD, which has seven genes deleted, is fully attenuated in pigs, cannot convert to the virulent strain, and provides complete protection of pigs against lethal ASFV challenge."

   SHIC asked two US experts in ASF to review the paper and provide comments. One reviewer is currently with a US university and the other is outside of a university. Both have extensive research experience focused on exotic viral diseases of high consequence and the molecular mechanisms that underlie viral virulence. Both reviewers requested anonymity due to personal opinion shared as well as respect for professional relationships.

   "The Chinese ASF vaccine looks very promising for protecting against the currently circulating Georgia 2007 strain. This research group has gone much further than others with proposed ASF LAV vaccine candidates in evaluating aspects of vaccine safety and efficacy. This suggests to me they are preparing data necessary for licensing the vaccine in China. If licensed for use in China, we will be able to evaluate vaccine performance under ASF endemic field conditions. Success of the vaccine should significantly decrease ASF prevalence in China thus reducing the threat for others including the US," said one of SHIC's reviewers. Also, pointed out by the second reviewer, "there is no information about commercialization of a potential vaccine – a hurdle still to overcome – however there is expectation that a vaccine in China can be commercialized relatively quickly".

   Both reviewers offered that they assume the data presented in the manuscript are accurate and reproducible. Interpretation of their technical comments gives cautious optimism of vaccine progress, under the conditions shown in the paper, but "there were still some technical issues that are not addressed that could support some skepticism."

   - "There is no full-length sequence, so it is uncertain if the deletions are correct as designed or if there are other mutations.
   - Viremia data is missing from most of the recombinant viruses made.
   - The sequence of virus recovered from failed vaccines (that were virulent) is not presented.
   - There are some inconsistencies without the experimental data to confirm the hypothesis. For example, one dose of 10^5 TCID50 seems to have the same results as two

doses of 10^5 TCID50. The hypothesis is that adding a booster dose, immunity will last longer, however this is not tested."

Regarding the possibility of a carrier status, post-vaccination, one reviewer said, "The data show very low to undetectable levels of viral DNA (not infectious virus) in tissues 21 days post-vaccination which is still a rather early time post-infection. ASFV persistent/latent infection in pigs (viral DNA present with no infectivity) appears to be the usual infection outcome. Vaccine transmission among animals will likely not be an issue due to the relatively poor replication of the virus in the animal."

b. There was significant press attention paid to an influenza study published in the *Proceedings of the National Academy of Sciences*. The study said a Eurasian avian-like H1N1 swine influenza virus with 2009 pandemic genes can facilitate human infection. Veterinarians and animal health experts from USDA, SHIC, NPB, NPPC, AASV, and U.S. universities reviewed the study published in the *Proceedings of the National Academy of Sciences*, and agree the study has scientific rigor. However, it does not contain important context essential for complete understanding of the present situation overseas nor the potential threat to the U.S. swine herd and consumers.

   The group encouraged caution when interpreting this study. Eurasian avian-lineage (EA) H1N1 is not a new strain of influenza in pigs and the G4 genotype, based on the whole genome constellation, has been detected since at least 2016, frequently in Chinese pigs. Since 2008, the U.S. Centers for Disease Control and Prevention and the USDA have had a joint influenza working group to share information from pigs and people. By collaborating and sharing scientific information on influenza strains, significant efforts have been made to protect both human and swine health. The surveillance in pigs is made possible through pork producer participation and payment for the initial diagnostics.

   Finally, it was the opinion of the experts who reviewed this paper that if this virus were in the U.S. pig population, it would be detected by the diagnostic tests available at U.S. veterinary diagnostic labs and USDA surveillance. EA H1N1 strains, including G4, have not been found in human or swine surveillance mechanisms in the USA.

Feral Swine Disease Management

This year, USDA estimates there are 6 million feral swine in the US creating issues for traditional livestock production, natural resources, and other species. To address these ongoing issues, including domestic and foreign disease surveillance priorities of feral swine, USDA convened a technical working group consisting of state and federal animal health officials, university wildlife experts, and swine industry representatives, including Dr. Paul Sundberg, SHIC, Dr. Harry Snelson, AASV, Dr. Dave Pyburn and Dr. Patrick Webb, NPB, Dr. Liz Wagstrom, NPPC and Bobby Acord, a consultant with NPPC. The published review and recommendations report was a collaborative effort between USDA and the other groups for the purpose of addressing the feral swine threat to domestic swine health.

The National Feral Swine Damage Management Program (NFSP) was created in 2014 with the mission of managing feral swine disease damage. Per the published report, about 3,000 samples from feral swine are tested each year for antibodies against classical swine fever (CSF), swine brucellosis (SB), and pseudorabies (PRV). A targeted surveillance program prioritizes counties based on existing feral swine populations, domestic pork production, landfills, and other disease-driven factors.

Swine health webinars to "keep pace with industry chatter"
SHIC offered a series of webinars in 2020 with the intent to respond to "industry chatter" about current swine health issues. The American Association of Swine Veterinarians is a co-sponsor of the webinars which are conducted by Iowa State University Swine Medicine Education Center. Webinars included:

- Hemorrhagic tracheitis syndrome – 336 registered/234 unique views
    - Hemorrhagic tracheitis syndrome has been progressing east to west across Canada for a period of years and has now reached the US. During a SHIC webinar a case overview was provided by veterinary practitioners. Their presentation included their experiences with management, strategies, and interventions. Sampling guidelines was also addressed and a scientific design to test management options was presented.
- Coccidiosis management strategies – 333 registered/201 unique views
    - The August edition of the Swine Disease Reporting System reported a large jump in the number of coccidiosis cases coming into the Iowa State University Veterinary Diagnostic Lab during July. With limited therapeutic options, management strategies become even more important and SHIC offered a webinar on coccidiosis.
- Lameness and arthritis – 232 registered/146 unique views
    - Veterinary diagnostic labs at Iowa State University and the University of Minnesota both reported an increase in submissions related to swine lameness during September. This industry chatter prompted a webinar that included a discussion on what makes a good and complete investigation of lameness.
- Porcine astrovirus type 3 – 292 registered/149 unique views
    - During a SHIC-sponsored webinar practitioners and diagnosticians discussed porcine astrovirus type 3 (PoAstV3) which has been causing central nervous system disease for at least a decade. PoAstV3 was discovered in a 5,000-head sow farm where it was initially assumed to be untreated lameness. The case fatality rate was between 90% and 100% when the animals were displaying neurologic symptoms with no response to treatment. Fresh lung, liver, kidney, and spleen were submitted to a VDL with no significant findings reported. When fixed and fresh cerebrum were submitted, PoAstV3 was diagnosed. PoAstV3, spread by the fecal-oral route, has been associated with paresis, paralysis, knuckling, incoordination, and lateral recumbency in pigs at various production stages.

Continue to evolve and refine domestic swine disease monitoring and reporting
SHIC continues to support a domestic swine disease monitoring program, the "Swine Disease Reporting System". It is a veterinary diagnostic laboratory-based project resulting from the veterinary diagnostic lab data standardization project SHIC supported in 2016 and 2017.

The Swine Disease Reporting System is a collaborative project among multiple veterinary diagnostic labs (VDLs), to aggregate swine diagnostic data. Data included are from the Iowa State University VDL, South Dakota State University ADRDL, University of Minnesota VDL, and Kansas State University VDL. The Swine Disease Reporting System reports monthly dynamics of pathogen detection by VDL-performed assays over time, specimen, age group, and geographical area.

Beginning in June 2020, a new element was included in the report – specific state-by-state pathogen trends. With this, veterinarians and producers will know if incidence of PED, PRRS, *Mycoplasma hyopneumoniae*, or potentially other pathogens is moving up or down in states being analyzed. Identifying these trends is just the first step to further analysis of the data to understand the reasons for the trends and, thus, to help manage them.
Information for each state regarding the change from baseline, the number of total, positive submissions, and percent of positive results are recovered from the models and transferred to Microsoft Power BI for geographic visualization. The dashboards for state-by-state pathogen trending can be accessed on the SHIC website or by visiting Iowa State University's site for the Swine Disease Reporting System.

Surveillance and Discovery of Emerging Disease

1. Investigate newly identified agents associated with disease

Porcine sapovirus
A veterinary diagnostic lab received a case from a farm experiencing an ongoing problem with piglet diarrhea in the lactation phase for more than two years. PED, PDCoV, transmissible gastroenteritis virus (TGE), or rotavirus were not detected from small intestines using real-time RT-PCR assays. Additionally, there was no significant bacterial growth from the small intestines.

Next Generation Sequencing was applied to the fecal and intestinal tissue samples and a sapovirus, that appears to be a new variant of the virus, was detected. Although sapovirus has been reported in association with enteric disease in pigs, it is often in mixed infection with other pathogens. This appears to be the first detection of a porcine sapovirus single etiology in piglets with diarrhea in the United States. A real time RT-PCR to detect viral RNA in clinical samples and determine the viral load from intestine tissue and fecal samples and the ability to test for the virus directly in fixed tissues has now been developed to assist diagnosticians during other investigations.

2. Ensure detection of emerging disease to facilitate rapid response.

Improving swine disease surveillance
An effective surveillance system should provide data for production and/or business planning, document freedom from specific pathogens and provide for a rapid and effective response to emerging and/or foreign animal diseases. Current statistical methods for selecting sample size, i.e., how many pigs and which pigs to sample, worked well for traditional farms, but does not work for modern farms because of industry evolution since they were developed. Progress during 2020 investigated potential improvements that can be made toward a nationally coordinated swine health surveillance system to prepare, detect, and rapidly respond to emerging and foreign animal diseases.

Offer diagnostic fee support to help detect emerging diseases.
There continues to be incidents of high morbidity/high mortality where an etiology is either not identified or there is a strong supposition that the identified pathogen is not the likely cause of the outbreak. For these cases, SHIC offers diagnostic fee support when the initial, producer-funded diagnostics are unrewarding.

a. *Streptococcus equi subspecies zooepidemicus (S. zooepidemicus)*

The Iowa State University Veterinary Diagnostic Lab confirmed *S. zooepidemicus* in two potentially related, high mortality cases of sows for slaughter and feeder pigs in assembly yards in Ohio and Tennessee. *S. zooepidemicus* is commonly found in nature, particularly in horses, and has been recently found in dog kennels as well. There have also been recent, confirmed cases in swine in western Canada.

Prior to September and October 2019, no high mortality events due to *S. zooepidemicus* in swine had been reported in the US. In response to these high mortality events SHIC funded a project conducted by researchers from Iowa State University and the National Veterinary Services Laboratory for a genomic epidemiological analysis on the limited outbreak.

To genetically characterize *S. zooepidemicus* strains associated with high mortality and gain insights into the epidemiology of these highly unusual and unexpected outbreaks, researchers performed whole-genome sequencing on eight isolates from the Ohio and Tennessee outbreaks, another outbreak-unrelated swine isolate from Arizona, and 15 *S. zooepidemicus* isolates from other animal species. Three full-length complete genome sequences were further assembled, and genomic epidemiological and comparative genomic analyses were conducted. The study revealed eight isolates that were clustered together with a strain causing the outbreaks with high mortality.

Findings from this project provide significant and timely insights for a better understanding of the epidemiology and virulence of *S. zooepidemicus* isolates associated with highly unexpected and severe outbreaks that occurred very recently in the US swine population. In addition, identification of specific virulence genes and genomic islands may lead to the development of novel molecular diagnostic tools and provide the basis for future investigation of virulence mechanisms and control measures.

b. *Hemorrhagic tracheitis*

In 2020 SHIC continued further diagnostic work into understanding a hemorrhagic tracheitis syndrome that has been moving east to west across Canada and has now reached the US. From the clinical picture, it appears to be associated to a virus. Clinical signs typically include severe cough affecting a high percentage of animals that lasts 7-10 days, with low to moderate mortality.

Diagnostic investigations of tracheitis cases at both Iowa State University's veterinary diagnostic lab and the Animal Health Laboratory at the University of Guelph have been hampered by dependence on the submitter's tissue sampling and diagnostic test selection. Supported by SHIC, diagnosticians at these laboratories and the Ministère de l'Agriculture, des Pêcheries et de l'Alimentation Québec (MAPAQ), in Québec City have collaborated to develop a standardized diagnostic test plan for swine tracheitis cases.

Phase 1 of the project, "Development of a standardized protocol for diagnostic investigation and establishment of a tissue bank for future investigation of idiopathic tracheitis cases" allows thorough, consistent testing of these cases. Doing so enables exclusion of common respiratory pathogens as the cause of tracheitis in individual animals and herds, and establishes a tissue bank for future Next Generation Sequencing to identify novel or emerging pathogens in those cases with no confirmed etiologic diagnosis.

Responding to Emerging Disease

1. **Support a rapid, unified industry response to emerging disease outbreaks.**

National Swine Disease Council

In 2013, when pork producers faced an outbreak of PED, the US pork industry could only put emphasis on farm biosecurity. Today, the US pork industry has aligned its efforts to be better prepared to quickly respond to foreign animal and transboundary production disease by creating the National Swine Disease Council (NSDC). The council is made up of volunteer key industry leaders, the North American Meat Institute, and representatives from SHIC, NPB, NPPC, AASV. USDA, as well as state animal health officials, attend meetings and provide input. The NSDC focuses on providing recommendations, in collaboration with state and federal animal health officials and other industry stakeholders, to respond to emerging swine diseases that could potentially threaten herd health and negatively affect the US pork industry.

2. **Identify high risk events likely to be responsible for introducing emerging diseases onto farms.**

Rapid Response Program

The need to quickly identify, control, and eliminate a pathogen in an endemic, emerging, or transboundary production disease outbreak in the United States is crucial to protect the pork industry from suffering huge economic losses. In August 2016, SHIC funded development of the Rapid Response Program (RRP) to address this need, including recruitment and training of the Rapid Response Corps (RRC) Investigators who responds in the event of an outbreak. There were no active RRC investigations during 2020.

The RRC is a team of specifically-trained industry experts to analyze the patterns, causes, and pathways of health and disease conditions in affected herds. RRC members, distributed among six regions of the US, are trained, prepared and committed to moving within 24 hours of contact to conduct epidemiological investigations when a new transboundary or emerging disease outbreak occurs.

During 2020, SES Incorporated created and implemented an exercise to provide refresher training on the objectives, procedures, and implementation of the RRP for the RRC Investigators. The fall exercise for members of the RRC offered valuable continuing education, taking into consideration their geographically disparate locations. A series of virtual drills focused on the key phases of an RRC investigation: pre-investigation, investigation, and post-investigation (reporting). Due to the differences in production facilities and practices for the various phases of hog production, drills were developed for the primary production phases: sow farms, nurseries, finishers (including wean-finish and gilt replacement) and boar stud operations.

Overall, the RRC Investigators were well-versed in asking open-ended questions. Most of the open-ended questions expanded on the questions included on the RRP Investigation Form and Summary Report. All the RRC Investigators provided justification for their risk assessments in the refresher scenarios. In most cases, they did not use the terminology in the RRC Investigator training, using instead language based on their knowledge of the industry, past experiences, and the geographical area where they were located.
When asked for feedback on the drill, RRC Investigators identified the positive benefits of the SHIC RRC process refresher drill as a review of the training and of the investigation process. SHIC will be acting on the recommendations of the participants to continually improve the RRP, ensuring readiness in the event of a transboundary or newly emerging swine disease outbreak.

Communications

To broadly disseminate SHIC information to stakeholders, a variety of communications tools are employed including the SHIC website, e-newsletter, articles prepared for partners, news releases, interviews, social media, a new SHIC Talk podcast, and webinar series. SHIC also participates in industry events – virtually in 2020 – to provide access to information essential to protection of the US swine herd. Google Analytics of SHIC website traffic are used to measure impact of media efforts.

1. Activity on www.swinehealth.org
    - Top pages on SHIC website (January 1-December 15, 2020) with (number of visits):
        - Global Disease Monitoring Reports (5,878)
        - Chinese Swine Acute Diarrhea Syndrome Coronavirus (SADS-CoV) Spurs SHIC Response (3,559)
        - Seneca Valley Virus Summary (2,091)
        - Domestic Disease Monitoring Reports (1,613)
        - Research Results (1,338)
        - African Swine Fever (1,099)
        - About (944)
        - Fact Sheets (807)
    - Continuous WordPress and plugin updates completed
    - Website content updated
        - Posted press releases and articles
        - Posted monthly newsletters
        - Posted Research Results

2. Website impact
    - Over 26,800 individual sessions for the year (23,000 in 2019, a 13% increase).
        - 12.6% returning visitors
        - 87.4% new visitors
    - 19,569 separate users (23,289 in 2019, a 16% decrease)

- 46,058 total page views (57,104 in 2019, a 19% decrease)
- Average of 1.57 pages per session (1.74 in 2019, a 1% decrease)
- Average session duration of 1:24 (1:24 in 2019)
- 11,397 users were from the USA
- 1,027 were from Philippines
- 989 from Canada
- 448 from India
- 436 from United Kingdom
- 407 from Australia
- 271 from Germany
- 238 from Brazil
- 213 from Thailand
- 211 from South Korea

3. Press releases

   Five press releases were issued in 2020:
   - SHIC Receives Extension from National Pork Board and Reviews 2019 Results
   - Updated Feed Holding Time Calculations Inform Biosecurity Processes (Joint SHIC/NPB/NPPC release)
   - SHIC 2020 Plan of Work Emphasizes Actionable Steps to Protect US Herd
   - Jointly Funded Project Will Look for Gaps in US Pork Industry Biosecurity (Joint SHIC/NPB/NPPC release)
   - SHIC Convenes Group to Develop UVC Best Practices for Bio-Exclusion

Key media remain engaged by direct contact plus receive the SHIC e-newsletter and monitor social media posts. Several articles from the e-newsletter drove interviews and prompted follow-up by media. Pork Magazine conducts monthly interviews with the executive director based on e-newsletter contents, resulting in coverage in their print and online publications.

4. Press release impact

Emails were sent to 250 ag news outlets for each press release. Farm broadcasters continued as a very important media outreach for SHIC with follow-up interviews requested after each press release was deployed. Delivery method of podcasts and online interviews continued to grow in frequency and will be more important than ever in 2021.

Individual emails are sent to the top five pork media editors as well as five farm broadcasters with each press release. Nearly 100% of the press releases were picked up by these national editors and farm broadcasters covering the US pork industry, many times resulting in one-on-one interviews with the executive director. Publications, radio networks and stations receiving personalized emails include:

- Pork Magazine and associated daily e-newsletter
- National Hog Farmer and associated daily e-newsletter (two editors)
- Feedstuffs and associated daily e-newsletter and weekly Food Animal Report
- Successful Farming and associated daily e-newsletter

- Brownfield Network
- Rural Radio Network
- WHO Radio – Des Moines, Iowa
- WMT Radio – Cedar Rapids, Iowa
- KWMT Radio – Fort Dodge, Iowa
- KGLO Radio – Mason City, Iowa

5. Event Interview Opportunities

Multiple media interviews were given throughout the year. Participation in the National Association of Farm Broadcasters annual meeting and its virtual Trade Talk resulted in nine interviews in a short period of time. Several interviews also resulted from participation in the AASV Annual Meeting as well as the South Dakota Pork Congress.

6. Articles Prepared for Partners (AASV)

As of December 16, 2020, 40 articles have been provided for the AASV weekly e-letter and other partners:

- SHIC Funding Brings Tools for Detection of SADS-CoV Closer to Completion
- SHIC Engages with Canadian Group for ASF Research Priorities
- SHIC 2020 Plan of Work Emphasizes Actionable Steps to Protect US Herd
- Updated Feed Holding Time Calculations Inform Biosecurity Processes
- SHIC Efforts Assess Tools for Feed Biosecurity Related to CSF and PRV
- SHIC Soliciting Proposals for ASF Research in Vietnam
- Call for Proposals: Identifying Gaps in US Pork Industry Biosecurity
- SHIC Study Looks at PCV3 Associations with Clinical Signs and Pathology
- SHIC-Funded Study Responds to Sapovirus Discovery with Diagnostic Tools
- SHIC-Funded Global Surveillance System Maintains Focus on Swine Health Risks
- SHIC Monitoring How ASF Biocontainment in China Is Changing Management
- SHIC ASF Vietnam Grant Funds Study of Oral Fluids for ASF Detection and Surveillance
- Time and Temp for Inactivation of ASF Virus Studied with SHIC Vietnam ASF Grant Funds
- SHIC Domestic Disease Report Expands to Include State-by-State Pathogen Trends
- SHIC Enable Test-and-Remove ASF Protocol Study in Vietnam
- SHIC Grant Funds Research into Potential Role of Rodents as ASF Vectors in Vietnam
- SHIC-Funded Genetic Characterization of *S. zooepidemicus* Provides Preparedness Tools
- SHIC-Funded MSHMP Project Grows in Scope and Capability
- Pig Flow Connections, Mycoplasma, Database Enhancements Now in SHIC-Funded MSHMP
- Report on Influenza Variant in Swine in China Lacks Context
- SHIC-Funded MSHMP Sequencing Project to Give Producers Edge in Responding to Emerging Virus Strains
- Hemorrhagic Tracheitis Standardized Submission to Help Find Etiology Support by SHIC
- SHIC Sponsored Research in Vietnam Looks at Risk of ASF Transmission via Boar Studs
- SHIC Issues a Call for Proposals for Improved Oral Fluids PCR Sensitivity
- SHIC Funds Evaluation of Staged Loading for Prevention of Virus Transfer

- SHIC Rapid Response Program Stays Current with Upcoming Exercise for Corps Members and Web-based Tools
- SHIC, Collaborating with CFIA, Funds Development of PCR to Detect and Differentiate Chinese PRV
- SHIC, AASV, NPB, and NPPC Engaged in Feral Swine Disease Management Effort
- SHIC/AASV Webinar Addresses Coccidiosis Management Following Rise in Diagnoses
- SHIC Adds New Sapovirus and PRV PCRs to Diagnostic Capabilities
- SHIC/AASV Webinar on October 13 to Address Uptick in Lameness
- SHIC/AASV Webinar Gives Specifics on Lameness Experiences, Management, and Diagnosis
- SHIC Convenes Working Group to Review UVC Best Practices for Bio-Exclusion on the Farm
- SHIC Funding Enables Investigation of PPV2 in Respiratory and Reproductive Diseases
- Farm-Level Outbreak Forecasting Expands to New Regions through SHIC-Funded Project
- SHIC-Funded Global Swine Disease Monitoring Report Delivers Near Real-Time Disease Info
- African Swine Fever Project in Vietnam Progresses Despite COVID-19 Pandemic
- SHIC Sponsored Astrovirus Type 3 Webinar Set for December 10
- SHIC's Rapid Response Corps Drill Ensures Preparedness
- SHIC/AASV Astrovirus Type 3 Webinar Provides Insight on Management and Diagnostics

Additionally, organizations like the US Animal Health Association (USAHA) are using SHIC information gleaned from media and the e-newsletter to share with their audiences. With USAHA, this means distribution to state animal health officials as well as key federal animal health officials.

7. SHIC Talk Podcast

In 2020, SHIC Talk was developed and launched. The podcast is hosted by Barb Determan and features guests on "industry chatter" topics as well as comments by SHIC's executive director. Four episodes have been produced so far with the fifth in production. SHIC Talk is available on the SHIC website as well as Apple Podcasts, Google Podcasts, Spotify, Pandora, Amazon Music/Audible, TuneIn/Alexa, and iHeart Radio.

2020 Episodes (as of December 15, 2020)

- ASF Test-and-Remove Protocol for Disease Management in China with Dr. Joe Connor
- Coccidiosis Diagnosis and Management (webinar follow-up) with Drs. Jeremy Pittman and Kent Schwartz
- SHIC Rapid Response Program with Drs. Derald Holtkamp and Tara Donovan
- ASF Research in Vietnam Update with Drs. Paul Sundberg, Liz Wagstrom, and Dave Pyburn

8. SHIC e-newsletters
A monthly SHIC e-newsletter publication schedule continued in 2020. The distribution list has just under 3,000 subscribers and is consistently updated.

The following chart details SHIC e-newsletter acceptance and impact.

Edition	Date Sent	# Sent	Opens	Opens %	Unsubs	Clicks*	Click %
January 2020 newsletter	1/10/2020	3171	925	31.9%	4	368	27.8%
February 2020 newsletter	2/6/2020	3195	829	28.4%	1	258	25.3%
March 2020 newsletter	3/5/2020	3194	831	28.1%	5	243	23.8%
Tracheitis Webinar eblast 1	3/27/2020	3007	873	29.5%	0	170	15.7%
Tracheitis Webinar eblast 2	4/1/2020	3007	829	27.0%	0	117	10.8%
April 2020 newsletter	4/8/2020	3013	974	31.4%	1	318	27.9%
May 2020 newsletter	5/6/2020	3021	975	33.2%	1	293	23.3%
June 2020 newsletter	6/3/2020	3019	878	30.1%	3	204	18.7%
July 2020 newsletter	7/9/2020	3036	873	30.0%	3	267	24.1%
August 2020 newsletter	8/6/2020	3042	857	29.5%	4	150	13.8%
Coccidiosis Webinar eblast	8/28/2020	2972	759	26.1%	0	154	15.7%
September 2020 newsletter	9/2/2020	2982	836	28.9%	0	207	15.7%
October 2020 newsletter	10/7/2020	2983	820	28.1%	3	215	19.6%
Lameness Webinar eblast	10/16/2020	2979	740	25.5%	3	70	8.1%
November 2020 newsletter	11/4/2020	2991	793	27.3%	3	126	11.9%
December 2020 newsletter	12/3/2020	2994	753	25.8%	4	217	17.8%
Astrovirus Webinar eblast	12/7/2020	2988	725	25.0%	2	116	12.6%
Averages			**839**	**28.6%**		**205**	**18.4%**
Benchmarks**				**10.0%**			**9.0%**

* Clicks = following a link from the newsletter to the SHIC website.

** Benchmarks are industry standard averages per Constant Contact (email distribution platform).

Appendix A

SWINE VIRAL DISEASE MATRIX	September 2018			
Representative virus affecting swine	Production impact	Domestic/Foreign market impacts	Likelihood of introduction into the U.S. or emergence of a domestic disease	Numerical Average
Foot and mouth disease virus	9	9	9	9.0
African swine fever virus	9	9	7	8.3
Classical swine fever virus	9	9	5	7.7
Pseudorabies virus*	8	8	5	7.0
Influenza A virus	4	8	8	6.7
Nipah virus*	8	9	2	6.3
Ebola-Restin*	8	9	2	6.3
Porcine epidemic diarrhea virus	6	4	7	5.7
PRRS virus (Chinese high path)*	6	5	5	5.3
PRRS virus	6	3	6	5.0
Porcine teschovirus (Teschen/PTV1)*	5	5	5	5.0
Japanese enchephalitis virus*	5	5	4	4.7
Getah virus*	5	5	4	4.7
Transmissible gastroenteritis virus	5	4	4	4.3
Menangle virus*	4	4	4	4.0
Porcine sapelovirus*	5	1	6	4.0
Porcine circovirus	4	2	5	3.7
Circovirus 3*	4	2	5	3.7
Porcine rotavirus	4	1	5	3.3
Swine vesicular disease virus	4	3	2	3.0
Vesicular exanthema of swine virus*	3	4	2	3.0
Porcine rubulavirus*	5	2	2	3.0
Seneca Valley virus*	3	3	3	3.0
Porcine parvovirus	3	1	5	3.0
Porcine deltacoronavirus	3	2	3	2.7
Porcine parainfluenza 1 virus*	3	2	3	2.7
Atypical swine pestivirus*	3	2	3	2.7
Influenza C virus*	2	2	2	2.0
Porcine respiratory coronavirus*	2	2	2	2.0
Hemagglutinating encephalomyelitis virus*	2	2	2	2.0
Encephalomyocarditis virus*	3	1	2	2.0
Hepatitis E virus*	1	3	1	1.7
Porcine adenovirus*	2	1	2	1.7
Porcine kobuvirus*	2	1	2	1.7
Orthoreovirus*	2	1	1	1.3
Sendai virus*	1	1	2	1.3
Porcine cytomegalovirus*	2	1	1	1.3
Porcine sapovirus*	1	1	1	1.0
Vesicular stomatitis virus*	1	1	1	1.0
Chikungunya virus*	1	1	1	1.0
Rabies virus	1	1	1	1.0
Porcine bocavirus*	1	1	1	1.0
Porcine astrovirus*	1	1	1	1.0
Swine pox virus*	1	1	1	1.0
Porcine torovirus*	1	1	1	1.0
Swine papillomavirus*	1	1	1	1.0
***** ***Fact Sheet found on www.swinehealth.org***				

Appendix B

SWINE BACTERIAL DISEASE MATRIX			August 2018
Total score = Potential Public Health Impact + Need for more efficacious intervention tools + Diagnostic Tools + Impact on pig health, welfare, production sustainability + Market impact			
	Average Total Score		**Average Total Score**
Streptococcus suis	28.3	*Clostridium perfringens*	12.6
Salmonella enterica	22.2	*Mycoplasma suis*	12.2
Mycoplasma hyopneumoniae	21.8	*Bacillus anthracis*	12.2
Escherichia coli	21.7	*Listeria monocytogenes*	10.8
Haemophilus parasuis	21.1	*Trueperella abortisuis*	10.5
Mycoplasma hyorhinis	19.1	*Yersinia enterocolitica*	10.2
Brachyspira hyodysenteriae	17.4	*Staphylococcus hyicus*	10.0
Actinobacillus pleuropneumoniae	16.1	*Mycobacterium spp.*	9.6
Actinobacillus suis	15.9	*Burkholderia pseudomallei*	9.4
Brucella suis	15.7	*Yersinia pseudotuberculosis*	8.8
Mycoplasma hyosynoviae	15.2	*Coxiella burnetii*	8.0
Brachyspira hampsonii	15.0	*Actinobaculum suis*	7.8
Staphylococcus aureus including LA-MRSA	14.8	*Chlamydophila psittaci*	7.6
Pasteurella multocida	14.5	*Chlamydophila pecorum*	7.2
Campylobacter coli	14.1	*Clostridium botulinum*	7.0
Leptospira spp.	13.8	*Streptococcus porcinus*	7.0
Campylobacter jejuni	13.6	*Clostridium chauvoei*	6.0
Erysipelothrix rhysiopathiae	13.6	*Clostridium novyi*	6.0
Clostridium difficile	13.5	*Treponema pedis*	6.0
Enterococcus spp. including VRE	13.5	*Clostridium septicum*	5.6
Bordetella bronchiseptica	13.1	*Staphylococcus dysgalactiae* subsp.	5.5
Brachyspira pilosicoli	13.0	*Rhodococcus equi*	5.3
Lawsonia intracellularis	13.0		