**Project/Activity Number:** NC229

**Project/Activity Title:** Detection and Control of Porcine Reproductive and Respiratory Syndrome Virus and Emerging Viral Diseases of Swine

**Period Covered:**12/05/2022 to 12/04/2023

**Date of Report:** 1/2/2023

**Annual Meeting Dates:** 11/30/2023 – 12/02/2023

# Brief Summary of Minutes of Annual Business Meeting

The 2023 NC229 Business Meeting was held on December 1st, 2023, **from 4:30 pm – 6:00 pm** in conjunction with the 2023 NAPRRS/NC229: International Conference of Swine Viral Diseases in the Intercontinental Hotel, Chicago, IL. The meeting was open to all NC229 members. Sixty people attended the Business Meeting. The agenda was as follows:

* NC229 Business Meeting Opening and Introduction, Dr. Pogranichniy, Kansas State University
* USDA-NIFA Update, Dr. Bjork, REE-NIFA.
* NC229 Performance Highlights in Year 2022, Pablo Pineyro-Pineiro, Iowa State University.
* Expanding the Toolbox: Viral Disease Diagnosis in Veterinary Diagnostic Laboratories, Dr. Burrough, Iowa State University.
* Swine as a Model for Biomedical Research: Influenza and Beyond. Dr. Richt, Kansas State University.
* Closing Remarks and Election of New Members

# Changes in the Consortium Organization and Governance

* Dr. Pogranichniy from Kansas State University completed a 2-year term as the Chair of NC229, and Dr. Pineyro from Iowa State University will become Chair of NC229 for a 2-year term, from 2024 and 2025.
* Dr. Vu from University Nebraska-Lincoln assumed the position of Vice-chair and Dr. Arruda from The Ohio State University assumed the Secretary position of the NC229 committee.
* Dr. Miller from Kansas State University was elected as the new Member at Large.

# Outputs

* Contributed 70 peer-reviewed articles to high-impact journals.
* Presented 85 abstracts or proceedings at national or international conferences.
* Shared insights through seven non-peer-reviewed publications in swine magazines.
* Distributed 12 monthly swine disease reports via the Swine Disease Reporting System to swine producers and veterinary practitioners.

# Outcomes

1. New assays and sampling matrices for rapid and reliable diagnosis of swine viral disease.
2. Advanced technologies to study swine disease etiology and virus evolution in the field.
3. Advanced knowledge on viral pathogenesis, host immune responses to virus infection, and factors associated with host resistance and resilience to virus infection.
4. Novel methods to reduce the impact of virus diseases on swine health and productivity.
5. Many critical reagents, including monoclonal antibodies, as well as diagnostic assay support to collaborating stations, other universities and industry for research and diagnostic applications.
6. Collaborative project among multiple VDLs, with the goal to aggregate swine diagnostic data and report in an intuitive format (web dashboards and monthly bulleting reports), describing dynamics of pathogen detection by PCR-based assays over time, specimen, age group, and geographical area.
7. Training a new generation of scientists specializing in swine virology

# Summary of last year research activity

# PRRSV

## Enhanced our understanding on PRRSV pathogenesis

* Identified functional immune and genomic controls of responses to PRRSV infections in neonatal pigs and fetuses.
* Assessed thyroid hormone metabolism during PRRSV infection
* Explored the complexity of highly polymorphic swine leukocyte antigen (SLA) class I and class II histocompatibility genes to aid in identifying viral peptides binding to SLA.
* Identified specific types of host cells, cellular, and cell surface markers in PBMCs and lymphoid tissues related to PRRSV persistence.

## PRRSV immunology

* Investigated mechanisms of immune protection and correlates of immunity, particularly in the area of neutralizing antibodies.
* Developed an *in silico* machine learning algorithm to predict antigenic cross-reactivity from genetic sequence data.

## Developed new vaccines and evaluated the efficacy of current vaccines.

* Evaluated the efficacy of a USDA-approved PRRS vaccine against a highly virulent strain originating from China.
* Developed a broadly protective PRRS vaccine using non-toxic enterotoxin and E. coli as an adjuvant-delivery system.
* Adopted a ferritin-based nanoparticle platform for developing vaccines against PRRSV.

## Viral transmission and evolution

* Compared forecasting models to predict PRRSV-associated morality on nursery pigs under field conditions.Explored the temporal and spatial specificity of the porcine placenta to better understand mechanisms of vertical transmission.
* Investigated PRRSV variability at state, system, and farm levels and evaluated immune-potentiating candidates and commercially available MLV vaccines against contemporary PRRSV strains.Collaborated with pig production systems and swine veterinarians to detect, report, and characterize the emergence of the new PRRSV 1-4-4 L1C variant.
* Evaluated different sample matrices for PRRSV surveillance and compared the pathological effects of endemic PRRSV strains with the newly emerging 1-4-4 L1C variant.
* Evaluated the impact of cross-immunity on viral evolution within herds and the success of new introductions, including the frequency of PRRSV inter-lineage recombinations and ORF5-based lineage classification in the whole genome.
* Studied the association between PRRS elimination in sow herds and epidemiological factors while adopting a ferritin-based nanoparticle platform for developing PRRSV vaccines.

# Influenza

* Established a pregnant gilt model to assess vaccination effects on maternal immunity and fetal/neonatal development.
* Created a new non-viral vector platform for rapid development and updating of swine influenza virus vaccines.
* Developed multiple innovative nanoparticle platforms to boost the effectiveness of swine influenza virus vaccines.
* Explored the involvement of farm workers in introducing seasonal influenza viruses to swine farms.
* Investigated hand hygiene protocols at UMN to curb the transmission of influenza viruses between farm workers and pigs, and from pigs to humans.

# Porcine circovirus type

* Developed a PCV3 infectious clone and demonstrated that it was infective in pigs.
* Evaluated the synergistic effects of coinfection of PRRSV with PCV3.
* Developed an experimental, suicidal PCV3 modified live vaccine (MLV) and evaluated its efficacy in a weanling pig model.
* Developed an artificial intelligence driven algorithm (ANATOPE) to predict immunodominant epitopes in antigens and to particularly identify residues which can contribute to immunodominance.
* Studied the roles of PCV1 as a helper virus in supporting TTSuV1 infection.

# ****Senecavirus A****

* **Estimated the seroprevalence of Senecavirus A and assessed risk factors in the US swine industry.**
* **Characterized the population shedding dynamics through the use of processing fluids in breeding herds undergoing an outbreak.**
* **Assessed viral the transmissibility amongst piglets born during a Senecavirus A outbreak.**
* **Assessed roles of fomites in disseminating Senecavirus A.**
* **Assessed the seroconversion dynamics and the duration of antibodies to Senecavirus A in a breeding herd.**

# African swine fever virus

* Four institutions obtained permits to study African swine fever virus (ASFV).
* Conducted international research to identify suitable sample types and PCR protocols for early and reliable detection of ASFV in boars.
* Developed digital biosensor assays for swift ASFV infection detection.
* Evaluated various point-of-care platforms for ASFV detection under real-world field conditions.
* Created a risk-free, non-animal *in situ* (RISNA) surrogate assay to validate ASFV mitigation protocols.
* Investigated supply chain characteristics (vitamins and soybean products) for potential transmission of foreign viral animal diseases. Also explored blockchain technology for tracing imported ingredients.
* Continued collaboration with the swine industry to monitor the global spread of ASF through the Swine Disease Global Surveillance project.
* Collaborated internationally to evaluate multiple experimental ASF vaccines (DNA, subunit, modified live virus - MLV) and identified a safe and effective attenuated MLV ASF vaccine against the circulating ASFV in Asia.
* Discovered two distinct cell lines suitable for ASF viruses, a crucial advancement for large-scale production of MLV ASF vaccine.

# Other viruses

* Investigated the pathogenesis and clinical implications of low-prevalence respiratory pathogens like Porcine Parainfluenza Virus (PPIV), Porcine Respiratory Coronavirus (PRCV), and Astrovirus 4 (AstV4).
* Conducted research on a Classical Swine Fever (CSF) Differentiating Infected from Vaccinated Animals (DIVA) diagnostic assay. Collaborating with partners in Europe and Asia, we successfully validated an assay capable of differentiating pigs infected with wildtype CSF virus from those vaccinated with C-strain or C-strain E2 subunit vaccines.
* Collaborated with the Iowa State University station to develop new monoclonal antibodies against Porcine Circovirus-3 (PCV-3). Additionally, serological assays were created to assist in diagnosing and further researching this pathogen.