**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:**11/30/2023 to 12/01/2024

**Date of Report:** 1/15/2025

**Annual Meeting Dates:** 12/07/2024 to 12/09/2024

# Brief Summary of Minutes of Annual Business Meeting

The 2023 NC229 Special Session was held on December 8th, 2024, **from 4:00 pm – 5:30 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. 49 people attended the Business Meeting. The agenda was as follows:

* NC229 Session Opening Remarks, Dr. Pineyro, Iowa State University
* NC229 Multi-state program summary and future perspective, Hiep Vu, University Nebraska-Lincoln.
* USDA-NIFA Research Opportunities for 2025, Michelle Colby, NIFA.
* NC229 Station Representative Updates
  + Hiep Vu (Nebraska)
  + Kim VanderWaal (Minnesota)
  + Federico Zuckermann (Illinois)
  + Alex Pasternak (Indiana)
  + Xiuqing Wang (South Dakota)
  + Jishu Shi (Kansas)

# Changes in the Consortium Organization and Governance

* Dr. Pineyro from Iowa State University is currently Chair of NC229 for a 2-year term, from 2024 and 2025.
* Dr. Vu from University Nebraska-Lincoln is currently Vice-chair and Dr. Arruda from The Ohio State University is the Secretary position of the NC229 committee. Dr. Miller from Kansas State University is Member at Large.

# Outputs

* Reports were received from 7 stations (IL, IN, KS, MN, ND, OH, SD), and also Canada (Montreal) and USDA.
* 31 principal leaders / contributors were reported along with the 7 station representatives, and 52 staff and students being trained from those institutions in the field of swine viruses
* Contributed 56 peer-reviewed articles to high-impact journals.
* Presented 71 abstracts or proceedings at national or international conferences.

# Outcomes

Objective 1: Etiology, pathogenesis, and virus-host interaction.

* Fetal Resistance to PRRSV: Researchers in Indiana have deepened the understanding of how porcine fetuses respond to PRRSV, focusing on factors like gestational age that influence resistance. Collaborative work between Indiana and North Carolina State University explored the spatial transcriptome of the porcine placenta to uncover mechanisms of vertical transmission.
* Advanced Models for Pathogen Studies: Porcine respiratory organoids were developed in South Dakota to mimic the pig respiratory epithelium, facilitating detailed host-pathogen interaction studies while reducing reliance on live animal models. These models provide critical tools for preclinical testing and vaccine development.
* Collaborative PRRSV Research: The USDA worked with Purdue University and Saskatoon researchers to study vertical viral transmission in pregnant gilts, identifying key tissues and genes related to fetal resistance, resilience, or susceptibility. Additional work with Ohio State University and Kingfisher Biotech characterized monoclonal antibodies targeting CXCL10, advancing therapeutic options.
* Microbiome and Viral Interactions: Illinois identified disruptions in mucosal microbial communities during PRRSV infection, correlating microbial diversity with disease markers. Their neonatal piglet model demonstrated how influenza A virus reshapes the nasal microbiome, linking microbial shifts to infection outcomes. These findings suggest microbiome-based mitigation strategies for swine diseases.

Objective 2: Epidemiological investigation of viral pathogens that affect swine population in the United States.

* Minnesota worked on whole genome analyses of clinical outbreaks identified immune escape mechanisms in natural populations, further enhancing understanding of viral dynamics.
* Diagnostic Advancements and ASF Preparation: The feasibility of portable point-of-care (POC) PCR systems for swine influenza diagnosis was demonstrated with a collaborative effort between Ohio and Minnesota, efforts that could significantly speed outbreak response. Ohio has also completed efforts on adoption of mucosal vaccine technologies in pigs.
* Multi-State PRRSV Surveillance: Ohio led the compilation and analysis of PRRSV-2 sequences from five states (Ohio, Indiana, Michigan, Pennsylvania, and West Virginia), collaborating with the OH state diagnostic labs and production systems. This work highlighted regional differences in viral transmission.

Objective 3. Immunology, vaccinology, and antiviral drugs

* ASF Vaccine Development: In Kansas, researchers developed two live attenuated ASF vaccines, proven safe and effective for pigs aged four weeks or older. Additionally, they collaborated to create 3D organotypic cultures for respiratory and intestinal mucosa, mimicking natural swine tissues and enhancing the study of respiratory pathogens like influenza A and SARS-CoV-2. Ohio completed initial ASF virus stocks for vaccine formulation testing, coordinating efforts with multiple institutions to improve biosecurity and preparedness.
* PRRS Vaccine Development: Research in Illinois revealed how high-frequency RNA recombination in PRRSV driving viral adaptability and vaccine resistance. Collaborations visualized recombination hotspots, guiding antiviral strategy development. Illinois also developed a double-mutant PRRSV-2 vaccine candidate that reduces co-infection severity, showcasing its potential as a solution for severe farm outbreaks. Also, a nonpathogenic PRRS strain (G16X) vaccine.
* Innovative Vaccine Strategies: In North Dakota, a suicidal PCV3 vaccine demonstrated safety and efficacy. Collaboration with Iowa State University advanced assays for Torque teno virus (TTSuV1), while partnerships with Biological Mimetics Inc. applied AI algorithms to design next-generation PCV2 vaccines.

# Summary of last year research activity

### **1. Porcine Reproductive and Respiratory Syndrome Virus (PRRSV)**

* Focus on virus-host interaction, molecular mechanisms, and persistence.
* Development of vaccines (e.g., G16X strain) and diagnostics.
* Genetic diversity and immune evasion studies (e.g., lineage-variant classification).

### **2. African Swine Fever Virus (ASFV)**

* Development of ASF vaccines (Kansas, Ohio, and South Dakota).
* Early detection methods (e.g., PCR in boars).
* Cross-species transmission studies.

### **3. Collaborative Diagnostics**

* Development of portable nano-sensors for ASFV, PRRSV, and influenza.
* Validation of monoclonal antibodies for diagnostic tools (e.g., CXCL10 expression).
* Studies on PCR optimization for field diagnostics.

### **4. Swine Influenza**

* Vaccine platform development using novel vectors (e.g., corn-based or mannose-chitosan-based vaccines).
* Host-virus interaction research (e.g., immune response to IAV in porcine organoids).

### **5. Emerging Pathogens**

* Studies on PCV3 (Porcine Circovirus 3) and Torque Teno Virus.
* Research into cross-species coronavirus transmission.

### **6. Genomic Studies**

* Use of bioinformatics tools for genomic classification.
* Research into structural changes in PRRSV (e.g., GP5-M heterodimer variations).
* Comparative transcriptomics for multiple swine pathogens.

### **7. Immunology and Vaccinology**

* Innovations in live attenuated and vector-based vaccines.
* Suicidal vaccines for PRRSV and PCV3.
* Epitope prediction using AI for vaccine safety and efficacy.

### **8. Disease Surveillance**

* Programs like the Morrison Swine Health Monitoring Project (Minnesota).
* National pathogen dashboards for swine diseases.

### **9. Host-Pathogen Interactions**

* Organoid models to mimic pig respiratory and intestinal tissues.
* Study of microbial shifts during infection and immune evasion mechanisms.

### **10. Multi-State Training and Outreach**

* Training students and professionals in diagnostic and research techniques.
* Conferences (e.g., Leman Swine Conference) and international workshops.
* Collaborative projects between universities, USDA, and industry.