

Animal Protection

Porcine Reproductive and Respiratory Syndrome (PRRS): Mechanisms of disease and methods for the detection, protection, and elimination of the PRRS virus (NC-229)

Impact Nugget: NC-229 provides leadership towards the goal of controlling and eliminating PRRS by providing producers with: 1) a quantitative understanding of the economic impact of the disease, 2) an understanding of pathogenesis and its consequences, 3) rapid, molecular-based diagnostic tests and novel vaccine approaches, and 4) a wide array of scientific and educational tools for the prevention of disease.

Issue: Swine producers in the U.S. and throughout the world continue to suffer economic losses from PRRS. A recent analysis by NC-229 established that U.S. producers lose \$560 million annually (Neumann et al., 2005). By comparison, prior to eradication, annual losses to classical swine fever (hog cholera) and pseudorabies viruses were estimated at \$364.09 million (Wise, 1981) and \$36.27 million (Hallam et al., 1987), respectively (adjusted to Year 2004 dollars). Thus, as the most costly disease in the swine industry, the economic impact of PRRS is especially critical during narrow profit margin periods. Most economically-stressed producers attribute part of their plight to the severe impact of PRRS on reproductive, nursery, and grow-finish stages of production.

Resolution:

- Research led by the founders of NC-229 was responsible for the discovery of PRRSV and the creation of the first (and still best) immunological reagents for the detection of viral antigens. The same group developed the first polymerase chain reaction (PCR) methods for the detection of virus. Diagnostic methods continue to evolve with the development of high throughput methods for the quantification of viral RNA in serum and tissue samples.
- NC-229 researchers have provided swine producers an accurate economic assessment of how PRRSV impacts all stages of swine production. This impact includes damage from the initial viral infection and the characterization of how PRRS contributes to the etiology of other important economically important syndromes, including Porcine Respiratory Disease Complex (PRDC) and Post-Weaning and Mortality Syndrome (PWMS).
- Studies of viral pathogenesis have characterized the interaction of PRRSV with the immune system, including mechanisms of how the virus subverts the host immune response, becomes persistent, promotes infection by other pathogens and avoids elimination by vaccination. At the molecular level, NC-229 researchers have created several infectious clones of the virus, a tool to probe the mechanism of virus replication and pathogenesis. Potential outcomes of work in this area include the development of novel vaccines that incorporate vaccine specific antigenic markers and allow for the differentiation of vaccinated and naturally infected swine.
- The unique problems created by this new virus have led to the implementation of new approaches to the study of swine diseases, including the organization of multi-institutional and multi-disciplinary research teams that attack specific disease areas. These collaborative activities resulted in the successful funding of the \$4.5 million USDA PRRS CAP grant. NC-229 researchers implement the goals of the CAP program and are responsible for directing the research funding. NC-229 researchers have gone beyond USDA support by leveraging funding from other sources, including \$2 million from the National Pork Board and private industry.
- Outreach activities, e.g., the annual International PRRS Symposium and PRRS Compendium, both organized by NC-229 members, have provided links between basic research, applied research, and swine production.

Impact: The mechanism by which NC-229 members participate in PRRS research represents a new paradigm in animal disease research that focuses several resources and disciplines on a given problem, making the sum of the parts greater than the whole; NC-229 is highly collaborative, cross-disciplinary, and interactive.

Diagnostics

- Developed by NC-229 researchers, high throughput quantitative PCR, used by several laboratories, is the new gold standard for detection of virus in clinical samples.
- NC-229 investigators discovered new strains of PRRSV in the U.S. (“European like viruses”) and develop new diagnostic tests to detect these emerging strains.

Pathogenesis and immunity

- An understanding of viral evolution and genetic heterogeneity of PRRSV isolates has provided a logical explanation for the inability of vaccines to provide sterilizing immunity.
- Studies on PRRSV immunology, including the development of pig-specific ELISPOT and other cytokine assays, have led to an improved understanding of the porcine response to PRRSV infection.
- Research on how PRRS subverts host immunity and a better understanding of PRRSV biology has led directly to the potential for the development of novel control strategies, such as immunotherapeutic and antiviral drugs.
- The creation of infectious PRRSV clones by NC-229 researchers has provided the potential for an understanding of the genetic basis of virulence and the development of marker vaccines.

Prevention and control

- NC-229 researchers have demonstrated that diagnostic tests in combination with effective biosecurity protocols can result in the elimination of PRRSV from herds. This work provides the basis for projects that target regional elimination of the virus.
- Basic research on how PRRSV subverts the immune system creates the potential for a new generation of safe and effective vaccines that are based on a rational design. This includes the testing of several novel vaccine approaches.
- The analysis of virus replication in pigs and demonstration of homologous immune protection has led to the wide spread use of planned inoculation as a means to control PRRS in the field.
- Research on the various means of how PRRSV can enter a herd has led to the development and implementation of on-farm educational tools for improved herd biosecurity.

Research Needs for Future Impacts: Due to the increased calls for PRRSV elimination, NC-229 would like to see more emphasis on the application of basic research in field settings. This includes funding for projects involving the cooperation of producers in studies of large swine populations under production situations. In addition, funding is needed to improve translation of basic research findings concerning cellular and molecular pathogenesis into improved diagnostics, vaccines and management practices.

Cooperators: CTS, IL, IA, KS, MN, MO, NE, NC, SD, VA, University of Guelph, National Pork Board, USDA-ARS, USDA-NADC, USDA-BARC

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