Summary of Significant Accomplishment(s):

1. **Issue, problem or situation addressed by the project or committee:** Porcine reproductive and respiratory syndrome (PRRS) was first described in U.S. swine herds in 1987. Sixty percent of U.S. herds are estimated to be infected with the PRRS virus (PRRSV). According to the National Pork Board (NPB), PRRS is the most economically significant disease facing the industry. The $560 million that PRRS costs U.S. pork producers annually dwarfs annual losses to hog cholera ($363 million, adjusted to year 2004 dollars) and pseudorabies ($36 million, adjusted to year 2004 dollars) prior to their eradication.

The NC-229 Committee was formed in 1999 using a novel "consortium" approach to conduct stakeholder driven "Big Science" on the virology, immunology, epidemiology, diagnostics and control of PRRSV, combining NPB, industry and USDA funds. The complex pattern of PRRSV transmission between herds, the ability to establish a subpopulation of asymptomatic carrier animals, the ineffectiveness of vaccines and lack of economic diagnostic assays makes the prevention, control, and elimination of PRRS a daunting task that is best resolved through a multistate effort, for the first time targeted to just one virus. The objectives in the NC-229 multistate project (11 states, USDA-BARC, USDA-MARC, USDA-NADC and NPB) address stakeholders' needs to implement a program that rapidly and efficiently develops the technology necessary to control and eliminate the virus.

2. **The project or committee’s objectives:** The objectives and outcomes listed are from the second 5-year plan of work submitted by the NC-229 committee (2004-2009).

1. Implement a virtual laboratory infrastructure through the development and open distribution of resources, materials, protocols and data among participating researchers.
   i. **Outcome(s):** Funding from the USDA CAP grant, NRI, ARS, NPB and private sources created a community resource of laboratory tools.
   ii. PRRSV Sequence Database ([http://prrsv.ahc.umn.edu](http://prrsv.ahc.umn.edu)) was developed by NC-229 committee members with funding from NPB and SD. The site contains 5400 PRRSV ORF 5 nucleotide sequences accessible by the internet for data mining.
   iii. Virus isolate bank of PRRSV field isolates is maintained by University of Missouri for use in comparative studies of virulence, genetic relatedness, vaccinology, immunology and virology studies.
   iv. Basic reagents including PRRSV polypeptides encoding non-structural proteins and associated monoclonal antibodies are available to the group.
   vi. ARM-7 database was established from multi-institutional “Big Pig” project for each laboratory using “Big Pig” samples to deposit experimental results.

2. Achieve biosecurity within herds by preventing the spread of virus within a herd and facilitating its elimination from endemically infected herds.
   i. **Outcome(s):** Numerous studies have established that both antibody and cell-mediated immune response are essential for eliminating PRRSV from pigs. Cell-mediated immune mechanisms such as interferon-gamma and T-cell responses may be most critical for the elimination of this virus and the prevention of carrier animals. These results, along with lack of innate immunity, are crucial for developing new approaches for antiviral drugs and vaccines.
   ii. There are variations in host responses to elimination of PRRSV that may be linked to host genetics, indicating that select breeds of pigs may be better able to resist PRRSV infections.
   iii. An early host protein expressed during acute PRRSV infection has been identified as a potential biomarker that could be used for early diagnosis of this disease and thus facilitate better prevention strategies.
iv. “Big Pig” was a multi-disciplinary, multi-institutional project (KS, IA, SD, USDA-BARC, IDEXX, Inc) that monitored PRRSV infection in 165 pigs for 203 days. Thousands of clinical samples collected from these pigs were placed in storage for use by NC-229 and other scientists to study various aspects of the virology, immunology, and epidemiology of PRRSV. This is the first time the industry has coordinated a study in which several laboratories have used universal samples from a similar infected herd.

v. Established numerous infectious clones that enable the construction of mutant viruses in which the role/function of various viral proteins in PRRSV infection can be determined. Potentially vaccines can be produced that allow the differentiation of vaccinated from naturally infected animals, i.e. DIVA vaccines, a must for future elimination programs.

3. Achieve biosecurity among herds by preventing viral spread between sites.
   i. Outcome(s): Developed new or improved methods for detection of types 1 (EU) and 2 (North American) PRRSV. Identified numerous new strains of PRRSV through sequencing.
   ii. Identified PRRSV membrane protein (ion channel protein) that has potential for conjugation with antiviral drugs, thus providing a novel target for delivery of antiviral drugs into infected cells for moderating the infectious process.
   iii. Identified certain risk factors that influence transmission of PRRSV between farms. A risk assessment program was developed for use by swine veterinarians.

4. Improve diagnostic assays and create on-farm monitoring systems.
   i. Outcome(s): Collaboration with industry to develop commercial PCR assay to detect PRRSV in semen and serum. This test provides a standard used by diagnostic laboratories and has found wide use for detection of PRRSV in boar studs. This is important for early and sensitive detection of PRRSV in boars to prevent use of contaminated semen.
   ii. Developing nanosensor technology for rapid, penside detection of PRRSV.
   iii. Use of ropes for stimulation of saliva production is a potential non-invasive process for collecting clinical samples for detection of PRRSV infected animals.
   iv. Non-structural protein (nsp2) identified as potential new antigen for a specific and sensitive differential ELISA test to differentiate detection of Type 1 and 2 PRRSV strains.

5. Develop and test PRRSV virus eradication protocols under various ecological settings.
   i. Outcome(s): Evaluation of various risk factors for introduction of PRRSV into herds indicated that fomites, insects and aerosols are most important.
   ii. There is a correlation between increased virulence of a PRRSV isolate and shedding/transmission by aerosols.
   iii. Equipping farms with air filtration systems reduces risk of area spread through aerosols.

6. Develop educational outreach tools for disseminating information through established outreach and extension networks to producers, veterinarians, educators and researchers. Includes the creation of information networks to ensure rapid and efficient communication of PRRS research results.
   i. Outcome(s): Publication of special issue of journal *Veterinary Immunology and Immunopathology* devoted exclusively to new information on PRRS immunology. 18 original and review articles contributed by NC-229 and other invited authors.
   ii. Organized first and only International PRRS Symposium in 2005 that is now an annual part of the NC-229 meeting ([www.prrssymposium.org](http://www.prrssymposium.org)).
   iii. NC-229 Committee, through CAP funding, sponsored PRRS workshops at the annual American Association for Swine Veterinarians (AASV) meeting for swine and Extension veterinarians.
   v. Quarterly newsletter implemented through CAP funding distributed to various stakeholders.
   vi. Feature articles in lay press through National Hog Farmer, The PigSite and ARS Netlink. PRRS website ([www.PRRS.org](http://www.PRRS.org)) is the major outlet for CAP information and progress and features links for stakeholders.

3. The impacts of the project or activity:
   a. Virtual laboratory has established community resources for NC-229 and other scientists that would not be available through an individual investigator project. Examples include, the sequence databank (receives several thousand hits annually); production of a swine oligonucleotide array with NC-1037 and NRSP-8; and various viral constructs, monoclonals and polypeptides.
   b. The “Big Pig” project has provided 20,000 clinical samples from a universal set of animals to various investigators within and outside of NC-229 for scientific studies. This is an example of true multistate collaboration in which investigators from all 11 states participated in this project.
   c. Development of infectious clones provide a research tool for determining the role of various viral proteins in
infection and are the most promising research tool for devising the next generation of vaccines to prevent PRRSV infections.

d. Epidemiological studies have provided information on viral transmission by insects, aerosols, and fomites and management tools to reduce the risk of introducing PRRSV into herds by these means.

e. The PRRSV website receives nearly 2,500 hits annually.

f. Established standard PCR assays for detection of PRRSV in infected boars. This test allows boar studs to identify boars and/or semen and remove these animals/semen from use. This reduces the risk of introducing PRRSV into herds through semen.

g. Established a non-invasive method to collect saliva from pigs using ropes. This method may replace the invasive practice of collecting blood samples and provide a less stressful and more humane means to collect clinical samples from PRRSV infected pigs.

h. A risk assessment tool was developed to identify factors that place a herd at risk for reintroduction of the virus. This allows swine practitioners a method to identify these risks and implement management strategies to reduce reinfection of “clean” herds.

i. The North American PRRSV Eradication Task Force is now a working group that facilitates communication of PRRS control research results to producers and veterinarians with the ultimate goal of building producer confidence in management strategies and tools to eliminate PRRS.

j. Published a special edition of *Veterinary Immunology and Immunopathology* devoted to PRRS.

k. Have developed an International Symposium on PRRS as part of the NC-229 Annual Committee Meeting. This PRRS Symposium attracts numerous PRRS scientists worldwide. This conference attracted 190 participants in 2005 and over 200 in 2006 and 2007.

l. A search of Medline and CAB abstracts for papers published between 1998 and 2003 using only the MESH or CAB Thesaurus terms for PRRS or PRRSV recovered 613 unique references. Removal of 114 general or applied papers left 499 papers, including references from foreign research groups. Of these, 160 (32%) were written by members of NC-229 institutions.

m. The *PRRS Compendium* (ISBN 0-9722877-1-X), published in 2003 by the NPB, included chapters written by 12 authors from five NC-229 institutions. This is a comprehensive review of all the published scientific literature on PRRSV, including chapters on control and eradication.

n. The extent of links to extension: Information generated by this committee is presented by NC-229 participants at many swine meetings attended by Extension veterinarians and swine specialists. In August 2007 NC-229 investigators in collaboration with the NPB formed an Extension, Outreach, and Education Committee as part of the USDA CAP grant submission.

4. **Additional and relevant partnerships, associations or collaborations.**

a. The NC-229 Committee initiated the project "*Integrated control and elimination of PRRSV in the U.S.*" that was the first Coordinated Agricultural Project (CAP) funded by the USDA NRI program. This project was significant, not only in providing $4.2 million for a multistate committee, but the committee demonstrated superb leadership in bringing academia, NPB, AASV and numerous private industries together to support this coordinated effort towards elimination of PRRS. This collaboration with industry continues and has been expanded with the recent submission of a CAP2 PRRS project to the USDA-NRI for $4.8 million. The NC-229 Committee has provided continued leadership in keeping stakeholder groups involved and focused on this important goal of elimination PRRS from the swine industry in the U.S. Stakeholders support CAP projects with additional competitive funds and in-kind donations (animals, diagnostic tests).

b. The CAP projects are managed by a Project Director from the NC-229 group and an Advisory Committee composed of stakeholders from swine veterinary clinics, producers, biologics industries, and the NPB. The CAP project is leveraged by the $2 million PRRSV Initiative funded by the National Pork Board checkoff dollars.

   c. Members of the NC-229 committee have been leaders in organizing collaborative meetings with other disciplines that impact PRRS. The PRRS Host Genetics Consortium was formed in May 2007 with members of NC-229, NC 1037 and NRSP8 (swine genetics and swine genome), USDA ARS, members of the NPB Swine Health and Animal Science Committees, and commercial partners representing breeders, animal health, feed and diagnostic companies. This consortium has received $300,000 from NPB in 2007 and expects future USDA CAP grant funds to determine the role of host genetic resistance to PRRS. Animals and critical diagnostic reagents for the experiment will be donated by private companies.

   d. Leverage - Grants and contracts awarded to NC-229 participants for PRRSV research in years 2000 to 2007 total nearly $3.0 million from USDA-NRI, institutional grants (not Hatch or Formula), National Institutes of Health, the National and State Pork Producers Councils, and Private Industry, as well as the $4.2 million for PRRS CAP.