Animal Health (NP 103) Annual Report for 2009

Introduction

The mission of the Animal Health National Program is to conduct basic and applied research on selected diseases of economic importance to the United States livestock and poultry industries. The goals of the research mission are to produce knowledge and technology to reduce economic losses from infectious, genetic, and metabolic diseases. Cyril G. Gay and Eileen L. Thacker, National Program Leaders (NPL), Animal Health, are currently managing the program.

The Animal Health National Program started the new 5-year national program cycle in fiscal year (FY) 2007. The Animal Health National Program currently includes 46 core research projects supported by 104 scientists located at 10 research sites throughout the country. The ARS research budget for the Animal Health Program in FY 2009 was $65.3 million.

ARS scientists working in the Animal Health National Program again received several accolades this past year. Dr. Mary Pantin-Jackwood, Veterinary Medical Officer, Exotic and Emerging Avian Viral Diseases Research Unit, Southeast Poultry Research Laboratory, Athens, Georgia, received the Early Career Research Scientist award for her research on demonstrating the critical role of domestic ducks in the control of avian influenza viruses and the characterization and improvement of diagnostics of novel enteric viruses in poultry. Dr. Marcus Kehrli, Research Leader, Virus and Prion Diseases Research Unit, National Animal Disease Center, Ames, Iowa, received the American Dairy Science Association (ADSA) Fellow Award, which recognizes Dairy Foods Division and Production Division members that have rendered distinguished service to the dairy industry over 20 years or more.

Scientists within the National Animal Health Program were very active in their fields in FY 2009, with 189 articles published in peer-reviewed scientific journals. Also, scientists published many of the discoveries and findings in the popular press, including 12 articles in trade journals and book chapters. Technology transfer activities for the National Animal Health Program included 9 invention disclosures, 3 new Cooperative Research and Development Agreements, 52 active Specific Cooperative Agreements, and 112 Material Transfer Agreements.

The following section of the report summarizes high impact research results addressing objectives in the current National Program Action Plan.

Animal Health Research Highlights

Safety of Pork Products Demonstrated during 2009 Pandemic H1N1 Influenza A Virus Outbreak

Soon after the emergence of the pandemic H1N1 Influenza A virus in April 2009, ARS scientists began research using virus samples provided by the Centers for Disease Control and Prevention (CDC). The first step was to address the safety of pork by evaluating whether meat, blood, and tissue from pigs infected with the new 2009 pandemic A/H1N1 influenza virus would be free of infectious virus. To evaluate pig susceptibility to the virus and its effect on meat, scientists inoculated virus-free pigs with the H1N1 virus, observing them daily for clinical signs of disease and testing nasal swabs and fresh samples from lung, tonsil, inguinal lymph node, liver, spleen, kidney, skeletal muscle (ham), and colon contents for signs of the virus. Live 2009 A/H1N1 influenza virus was only detected in the respiratory tract of infected pigs and did not appear to spread and replicate in other tissues, indicating that meat of infected pigs is safe for human consumption.

Biotherapeutics Feed Supplements Developed for Poultry Health

USDA-ARS scientists have worked with industry to develop novel biotherapeutic antibodies as feed supplements to enhance the disease resistance of poultry flocks to gastrointestinal pathogens that impact food safety and production gains. Using applied advanced technology in avian immunology and genomics, scientists have identified novel molecules that have been shown to enhance host innate immunity, decrease early mortality, and reduce the use of antibiotics in poultry production. These innovations will reduce economic losses due to enteric diseases in poultry and will decrease the use of many antibiotics that are associated with human drug resistances. These novel dietary immunomodulation strategies to enhance poultry health have implications for human health, farm animal security, and production capabilities of poultry industries worldwide.

Novel Immunomodulatory Mechanism for Classical Swine Fever Virus

Classical Swine Fever Virus (CSFV) is a highly infectious foreign animal disease of pigs that results in high rates of mortality and morbidity and poses a significant threat to the U.S. national pork industry. Recent outbreaks in Western Europe have shown that there is a critical need for new countermeasures to control the disease and for effective vaccines that can provide rapid protection, stop the transmission of the virus, and differentiate infected pigs from vaccinated pigs. ARS scientists at the Plum Island Animal Disease Center in Greenpoint, New York, are conducting molecular virology studies in secure bio-containment facilities to understand the mechanisms of CSF viral pathogenesis, which is a vital step on the path to vaccine discovery. In these recent studies, scientists have predicted the amino acid sequence of the CSFV protein called NS4B and identified potential receptor molecules of the swine immune system. Changes within this receptor completely decreased the ability of CSFV to cause disease, reducing viral replication in the oronasal cavity and limiting spread from the inoculation site to

secondary target organs. These discoveries elucidating swine immune response will support the development of effective new vaccines against CSFV.

Improved Diagnostics Developed for New Newcastle Disease Viruses

Newcastle disease (ND) is a significant viral disease of poultry, with virulent strains being responsible for major diseases affecting many animal species over a wide area and extensive poultry mortality worldwide. Comprehensive and rapid tests to detect and differentiate virulent strains of NDV from the low virulence NDV strains are crucial for surveillance, diagnosis, and control of Newcastle disease, as the current nucleic acid-based (real time RT-PCR) tests often fail to identify new strains of NDV evolving worldwide. ARS scientists have developed a bioinformatics-based evaluation system focused on identifying viruses likely to escape detection under current U.S. testing technologies. This approach has resulted in the identification of virus genotypes circulating in Pakistan, China, Korea, Iran, Turkey, European countries, and the United States that would likely be missed using the current surveillance assays. As a result, scientists have developed four new RT-PCR based diagnostic assays to help American veterinarians accurately diagnose the presence or introduction of virulent strains of NDV.

Improved Foot and Mouth Disease Virus (FMDV) Vaccine Developed

ARS recently completed a proof-of concept study for the utility and efficacy of our recently developed Foot and Mouth Disease Virus (FMDV) vaccine candidate that can differentiate infected animals from vaccinated animals and demonstrated its ability to protect animals from disease as well as a commercially available FMDV vaccine does. Further, scientists demonstrated that the new vaccine does not cause disease or allow it to spread to contact animals. Scientists have also provided a companion test that enables differentiation between vaccinated cattle and those exposed to FMDV obtained in the wild.

Detection of Bovine Tuberculosis in Wildlife Enhanced

Traditional test and slaughter policies for bovine tumberculosis—a significant public health concern—have been effective in lowering the prevalence of disease, but the incidence of new cases has been increasing and eradication efforts have not been successful, due in large part to the persistence of *Mycobacterium bovis* infection in a wildlife reservoir of free-ranging white-tailed deer. In response to the need for new methods to detect infection in wildlife, ARS scientists evaluated the accuracy and feasibility of several blood-based assays for the detection of tuberculosis in white-tailed deer. Several tests were proved to be highly specific for the disease and were acceptable to policy makers. This research will allow the Michigan Department of Natural Resources to begin developing control and eradication strategies for tuberculosis in white-tailed deer and subsequently cattle in Michigan and other tuberculosis-infected states.

Identification of immune proteins associated with Johne's Disease

Johne's disease (Paratuberculosis) is a chronic, progressive intestinal disease of ruminants that is widespread in U.S. dairy herds and poses a significant economic problem for producers. Despite the presence of a voluntary control program for this

disease, the incidence continues to rise at a disturbing rate. ARS scientists have found that a novel immune protein, the cytokine osteopontin, was expressed differently in infected cattle compared to healthy cattle, illustrating differences in their immunity. This information will aid in the development of sensitive and specific diagnostic tools for early detection of infection as well as identification of vaccines and other preventive measures.

New Vaccine Strategies Developed for Controlling Bovine Babesiosis

Babesia bovis and *B. bigemina* are important causative agents of bovine babesiosis, known as Cattle Tick Fever (CTF), a significant problem in the southern United States until the 1940s, when the tick vectors were eradicated by intensive dipping of cattle with chemicals to kill the ticks (acaracides). However, the ticks that spread CTF are present in a buffer zone along the Rio Grande, in Mexico, and in U.S. territories, and have begun to spread, thus posing the threat of an outbreak of CTF in the border region. Increased tick resistance to current control chemicals, coupled with the lack of an effective vaccine, leave U.S. cattle highly vulnerable to the disease upon reintroduction. ARS has made critical progress in developing a long-acting anti-babesial and anti-tick vaccine by placing anti-tick genes into babesia organisms that are incapable of causing disease. This could lead to development of a vaccine potentially efficacious in preventing both tick infestation and CTF.

Resistance to Parasiticides Examined

By conservative estimates, gastrointestinal (GI) parasites cost the American cattle industry over $2 billion dollars per year in treatment costs and decreased productivity and growth, making GI worms, or nematodes, the most costly parasitic infection of American cattle. Although the drugs currently used to control cattle intestinal worms worldwide are generally efficacious and safe, global resistance by parasites to drugs is rapidly on the rise, current control programs may not be sustainable, and there is increasing concern over the presence of drug residues in food. In collaboration with APHIS and two University collaborators, ARS conducted a national survey of effectiveness of current chemical treatment practices used in cattle to control intestinal parasites, indicating that cattle intestinal parasites are becoming increasingly resistant to the most common drugs used to control them. Additional research is being conducted to investigate the genetic variation in the parasites resistant to treatment compared to non-resistant parasite populations, which will support future investigations into the use of population genetics to quantify parasite resistance and identify associated genetic markers.