REPORT OF THE COMMITTEE ON DIAGNOSTIC LABORATORY AND VETERINARY WORKFORCE DEVELOPMENT

Co-Chairs: Bob Frost, Lincoln, CA
Bennie I. Osburn, Davis, CA

J Lee Alley, AL; Gary A. Anderson, KS; Alex A. Ardans, CA; Joan M. Arnoldi, WI; Lawrence Barrett, NY; Thomas W. Bates, CA; Judith Bossé, CAN; Mike Chaddock, DC; Neville P. Clarke, TX; John R. Clifford, DC; Karen Conyngham, TX; Ron DeHaven, IL; Leslie A. Dierauf, WI; Brian R. Evans, CAN; Peter J. Fernandez, AE; J. Pat Fitch, MD; Frank D. Galey, WY; Tam Garland, DC; Pamela J. Hullinger, CA; Paul Kitching, CAN; Don P. Knowles, WA; Elizabeth A. Lautner, IA; Randall L. Levings, IA; Bret D. Marsh, IN; Barbara M. Martin, IA; Grant M. Maxie, CAN; Richard H. McCapes, CA; Terry F. McElwain, WA; Doris M. Miller, GA; Terry L. Nipp, DC; Donal T. O'Toole, WY; Gary D. Osweiler, IA; Kristy L. Pabilonia, CO; Lanny W. Pace, MS; Elizabeth J. Parker, DC; Barbara E. Powers, CO; Willie M. Reed, IN; Ralph C. Richardson, KS; Y.M. Saif, OH; Emi K. Saito, CO; A. David Scarfe, IL; Brian T. Smith, DC; Mark Spire, KS; Alfonso Torres, NY; Richard D. Willer, HI; William C. Wilson, WY.

The Committee met on October 27, 2008 at the Sheraton Greensboro Hotel, Greensboro, North Carolina, from 7:00 to 10:15 p.m. There were 22 members and 25 guests present. Co-Chairs Frost and Osburn briefly reviewed the Committee's accomplishments over the last few years which has evolved as a working committee that has produced resolutions promoting veterinary medical workforce and animal health laboratory needs.

Invited speaker Dr. H. Scott Hurd, Deputy Under Secretary of the Office of Food Safety, United states Department of Agriculture (USDA) was unable to attend due to family illness. Dr. Hurd who manages all meat and poultry inspection in United States, with over 10,000 employees, is responsible for insuring the protection of public health and food safety through policies and programs aimed to ensure that the nation's supply of meat, poultry and processed egg products are safe and wholesome. Dr. Hurd's presentation was to address the critical needs of the nation's specialized food system veterinarians and illustrate opportunities for graduating veterinarians in food safety and public health careers. Dr. Hurd's comments intended for presentation to the Committee are included at the end of this Report.

Mr. Brian Smith, Association of American Veterinary Medical Colleges, reviewed 2008 veterinary work force and related issues. The report in its entirety is at the end of this report.

Dr. Neville Clark, The Center for Foreign Animal and Zoonotic Disease Defense's (FAZD Center) reviewed the FAZD Center Top Products and need for renewed funding. Dr. Clark's report in its entirety is at the end of this report.

A brief discussion on the status and number of bio-medical research laboratories in the Hearing Report of the House Committee on Energy and Commerce, Subcommittee on Oversight and Investigations was held and a review paper in its entirety is included at the end of this report.

Dr. Paul Kitching, Animal Health Centre, British Columbia, Canada gave a report on the status and accomplishments of the North American Animal Health Laboratory Network. The integration of animal production systems across North America requires that the diagnostic laboratories supporting the movement of live animals between the United States, Mexico and Canada develop harmonized testing procedures, thereby avoiding border delays or other disputes which can result from discrepant test results. The initiative to harmonize the protocols used by testing laboratories involved in certifying exports and national surveillance programs has been supported by the three governments and encouraged by USAHA. Currently the focus has been on harmonizing tests for vesicular diseases, avian influenza and tuberculosis, with workshops being held in the participating national laboratories and the sharing of proficiency panels. Additional tests will be included in the future, reliant on adequate resource support. This collaborative work supports the Security and Prosperity Partnership (SPP) efforts which, among

other things, commit the three countries to work together to build a safer and more economically dynamic North America.

Dr. Larry Clark, Director, Wildlife Services, National Wildlife Research Center (NWSC), reviewed the planning progress of the Centers' Biosafety Level-3 (BL-3) Agriculture Wildlife Disease Research Laboratory. An action item was presented as a reaffirmation of previous resolutions passed in 2006 and 2007 in support of the NWSC Laboratory initiative.

Dr. Clark Tibbetts, Executive Vice-President, TessArae, LLC, presented a new microbial diagnostics paradigm. The platform is based upon highly multiplexed detection and identification of viruses and bacteria by direct and simultaneous sequencing of multiple pathogen genes. The methodology is capable of detection and differentiation of previously known and unknown emergent strains or deliberately altered variants of targeted pathogens. Dr. Tibbetts urged professionals and agencies to seek resources to support validation of emerging applications of multiplexed gene sequencing-based diagnostics.

A brief discussion reviewing senior scientist veterinary pay adjustments scale Title 42 resulted in an action item.

Dr. William Wilson, et.al., Arthropod-Borne Animal Disease Research Laboratory (ABADRL), United States Department of Agriculture (USDA), Agriculture Research Service (ARS), presented a review of a white paper on Readiness and Capacity of the United States for the Instruction of an Exotic Arthropod-Borne Viruses. The paper in its entirety is included at the end of this report.

The following ten Resolutions were passed unanimously and forwarded to the Committee on Nominations and Resolutions:

- Support for High-Containment Biosafety Laboratories
- Veterinary Medicine Loan Repayment Program (PL 108-161)
- Increasing the Veterinary Workforce by Expanding Veterinary Medical School Capacity
- Support for Section 1433 Formula Funds for Animal Health and Research
- Support for Food Animal Residue Avoidance Databank (FARAD)
- Support for Regional Centers of Excellence in Food Systems Veterinary Medicine
- Increased Funding for Expanded Research for the Department of Homeland Security National Center for Foreign Animal and Zoonotic Disease Defense (FAZD) Center
- Funding for Wildlife Services, National Wildlife Research Center's New Biosafety Level-3 Agriculture (BSL-3 AG) Wildlife Disease Research Laboratory
- Veterinary Diagnostic Laboratory Readiness for Arthropod-Borne Diseases
- Review of Compensation for Research and Diagnostic Veterinarians

The meeting was adjourned at 10:15 pm.

Food System Veterinarians of the 21st century

H. Scott Hurd,
Deputy Under Secretary of the Office of Food Safety
USDA

Thank you for the opportunity to address your Committee.

As the nation's largest employer of veterinarians, the work this Committee does in veterinary workforce development is important to the Food Safety and Inspection Service (FSIS), and so I am especially pleased to share these thoughts with you.

I would like to focus on the food system veterinarians of the 21st century: why we need them, the skills they need, and opportunities in FSIS for this "food system veterinarian" of the future.

As you know, veterinarians have long played a role in protecting public health. The first meat inspection act of 1890 in this country, enacted to reduce the risk of trichinosis from affecting United States (U.S.) pork exports, required veterinary inspection of live animals for export and inspection of cured meat for both export and interstate commerce.

Sixteen years later, the Meat Inspection Act of 1906, a watershed event in the history of food safety and public health in the U.S., started a system of continuous veterinary inspection in slaughterhouses. Today, there is still a need for veterinarians in the food system. As we move forward, we're looking for veterinarians who *specialize* in the food system.

FSIS does more than inspect meat. Modern animal processing systems require millions of dollars in investments; the modern veterinarian must understand how to work in these complex systems.

As FSIS moves to an advanced food safety, risk-based inspection system, we have found ourselves with a critical shortage of some of the skills we need most. We need veterinarians who have skills in areas such as epidemiology, data analysis, Hazard Analysis and Critical Control Points (HACCP) and modern microbiology.

Further, as we continue to expand the role of veterinarians in the food system, my colleagues at FSIS also emphasize other less technical areas that the veterinarian of the future needs.

First, we need them to have a public health mindset or frame of reference. At FSIS, our bottom line is protecting public health. The food system veterinarian uses their knowledge and expertise toward this important goal.

They must be able to work effectively in teams. We need people who are skilled in supervising, motivating, and leading teams—such as a group of in-plant inspectors. Project management skills are also important skills for food safety specialists. As I will address, our veterinarians will be involved in a wide range of activities that require this skill.

These veterinarians also need certain soft skills, including interpersonal skills to assist their teams and plant management in finding optimal solutions to complex problems. Obviously, communication skills are also vital.

So far I have focused on what skills the food system veterinarian of the future needs. But veterinarians, by training, already bring a broad range of knowledge and skills to the food safety table and have several critical skills in ensuring the safety of foods of animal origin. What we have to do is take these skills and apply them in the context of a high speed, modern slaughter system.

Going forward, we need to *train* and *equip* veterinarians to specialize in food safety, understand and embrace the complexity of the modern food system, and make public health their priority.

The FSIS veterinarian of the future is no longer just a technical concentration. We are transitioning our veterinarians into public health professionals who oversee the effectiveness of farm-to-table food safety systems. At FSIS, we call this food system veterinarian of the future the public health veterinarian (PHV).

Our veterinarians' roles have been expanded to include public health assurance responsibilities such as verifying HACCP system and intervention processes when conducting food safety assessments, identifying and evaluating conditions affecting the growth of microorganisms, analyzing data to determine indicators of pathogen reduction before and after control points, participating in recalls of adulterated product, directing ante-mortem and post-mortem inspection and overseeing humane handling and slaughter.

They are engaged in opportunities in the field, in international public health assessment and policy, or in scientific public health and policy. They undertake activities that are outside of the box of how we think

about the typical, ‘hard hat’ slaughter veterinarian, but there are critical ways veterinarians are involved in ensuring public health through food safety.

I am always excited about the opportunity to get the word out about the opportunities that FSIS has for veterinarians. I mentioned earlier that we are the largest employer of veterinarians in the country, so you can see that we have worked hard to attract some of the brightest minds in the veterinary field to food safety.

Some of the things we do to get and keep great veterinarians in the door are offer recruitment bonuses, Student Loan Repayment, and continuing education, as well as establish partnerships with institutions and organizations, such as the Public Health Service Commissioned Corps and the University of California, Davis, where Committee Co-Chair, Bob Frost, and I had the chance to meet.

The ‘food system veterinarian of the 21st century’ I have been talking about has already shown up to work at FSIS, and we are still looking and actively recruiting for more.

Thanks to the work of veterinarians in public service, today far fewer people are getting sick from food they eat than was they were more than a century ago when veterinarians first began inspecting meat and poultry for human food.

We believe that PHVs will continue to play a key role in the food system. There is still a correlation between good animal health and good public health. The food system veterinarian of the 21st century understands this correlation and embraces the complexity of the modern food system.

Thank you again for the opportunity to address your Committee. I hope that my perspective on the role veterinarians can play in the 21st century food system helps inform the discussion as you develop recommendations on veterinary workforce development.

Increasing the Veterinary Workforce

Brian Smith
Association of American Veterinary Medical Colleges

The United States Animal Health Association (USAHA) has historically passed resolutions supporting the concept of increasing capacity in veterinary schools by adopting a resolution in support of the Veterinary Public Health Workforce Expansion Act (HR1232, S. 746 in 110th Congress). That bill did not pass but was considered in the House of Representatives. A hearing was held in the House Energy and Commerce Subcommittee on Health in January 2008.

In 2007 and 2008, two new programs were signed in to law to address the lack of capacity within veterinary schools, the School of Veterinary Medicine Competitive Grant Program (authorized in the Department of Health and Human Services) and the Agricultural Biosecurity Grant Program (authorized in the Department of Agriculture). While these two new programs were inspired by past efforts to pass workforce expansion bills for academic veterinary medicine, they lack authorization language providing for more comprehensive construction in lieu of minor renovations and improvements. It has not been determined how effective these new grants will be at alleviating the shortage of veterinarians in the workforce and the lack of capacity at veterinary school.

Veterinary Medicine Loan Repayment

The Veterinary Medicine Loan Repayment Program (VMLRP) was created in 2003 by the National Veterinary Medical Service Act (NVMSA) and is a student loan repayment program for veterinarians who practice in underserved areas. This loan repayment program is to be administered by the United States Department of Agriculture (USDA). The Secretary of Agriculture can determine veterinary shortage areas in rural practice, urban practice, federal government agencies, and discipline areas. Recently highlighted awareness of bioterrorism and foreign animal disease threats to public health and food safety has heightened the urgency of a fully funded and implemented program. The VMLRP also creates a reserve corps of veterinarians available for mobilization in the event of an animal disease emergency or disaster.

NVMSA was enacted in December 2003 and has received modest appropriations beginning with the 2006 fiscal year. Until recently the regulations governing the VMLRP remained unwritten by USDA rendering the program non-functional. Language in the 2008 Farm Bill helped to expedite that process and USDA now reports it is on schedule to have the program running by March 2009. Congress also held a hearing in early 2008 to determine why VMLRP has been delayed for years. In the past, the Bush Administration has not included funding for NVMSA in the President's budget.

1433 Formula Funds

Section 1433 Formula Funds (Public Law 95-113) have been in existence since 1977 and provide an extremely valuable source of funds for fundamental research on diseases of food producing animals. These are important funds for most of the Veterinary Science Departments in the United States. In addition, some of the states with veterinary colleges have in the past provided some monies for faculty wishing to conduct food animal related research on local and emerging diseases; however these funds have been essentially eliminated in many of the states. As a result, college faculties are shifting to National Institutes of Health research which will not support research on agricultural animals, nor on food safety at the farm level. These funds have also supported training graduate students in most colleges and veterinary science departments. There are no other funds available at this time to provide this much needed support.

Historically, the President's budget has not requested any money for Section1433 Formula Funds but Congress has provided an average of about $4.3 million annually. There are indications that Congress may choose to cease funding the program if enough stakeholder support for the program is not conveyed to Congressional Appropriators.

Centers of Excellence

Part of the 2008 Farm Bill included the establishment of new regional centers of excellence in food systems veterinary medicine. A regional center of excellence shall be composed of one or more colleges

and universities (including land-grant institutions, schools of forestry, schools of veterinary medicine, or Land-Grant Institutions) to focus on species specific diseases.

The criteria for consideration to be a regional center of excellence shall include efforts to ensure coordination and cost-effectiveness, leverage available resources, implement teaching initiatives, increase the economic returns to rural communities, and improve teaching capacity and infrastructure at colleges and universities.

USDA has not reported how they intend to implement this new program, either as a new stand-alone grant or part of the larger reorganization of USDA's extramural research programs.

Food Animal Residue Avoidance Databank (FARAD)

FARAD, in existence since 1982, develops and maintains a unique food safety databank that provides veterinarians, livestock producers, and state and federal regulatory and extension specialists' information on avoiding both animal drug residue and environmental contaminates in meat, milk and eggs. FARAD's databank provides information regarding the time-course of drug and chemical depletion in the blood and tissues of animals following the routine use of drugs in animal agriculture, for the extra label use of drugs in animal agriculture, and during food contamination emergencies which might arise from exposure to environmental toxins, particularly pesticides, either accidentally or intentionally introduced into the food supply. Additionally, FARAD provides rapid response assistance, through both its telephone hotline and web access, for inquires concerning residue issues that affect food animal health and food product contamination; FARAD provides assistance in trade matters by maintaining databanks of foreign drug approvals; and finally, FARAD trains veterinary students and veterinary medical residents in the principles of residue avoidance.

The loss of an earmark for funding of FARAD in 2007 clearly demonstrates the dilemma that has existed throughout FARAD's existence. FARAD shut down all public access on September 30th 2008, and with remaining funds, will maintain the existing databank for an additional month. Without permanent multi-year funding ($2.5 million/yr for 3-5 years), FARAD will discontinue all activities by the start of 2009.

Hearing Report

Report on House of Representatives Committee on Energy and Commerce
Subcommittee on Oversight and Investigations
Chair: Bart Stupak (D-MI)

On May 22, 2008, the Subcommittee held the second hearing on the status and number of bio-medical research laboratories in the U.S. This hearing was entitled Germs, Viruses, and Secrets: Government Plans to Move Exotic Disease Research to the United States. The main topic of discussion was H.R. 1717 which would authorize the building of the Department of Homeland Security (DHS) National Bio and Agro Defense Facility (NBAF) which will be a Biosafety Level 4 (BSL-4) laboratory and would assume the research previously conducted at the Plum Island Animal Disease Center (PIADC) in addition to new zoonotic disease research. The bill would allow movement of NBAF to the mainland marking the first time in U.S. history that foot-and-mouth (FMD) research could be conducted there. Finalist sites for NBAF are Flora, Mississippi; Athens, Georgia; Manhattan, Kansas; Butner, North Carolina; San Antonio, Texas and a possibility exists that the facility could be rebuilt on Plum Island.

The hearing devoted much time to examining the potential threat to the U.S. livestock industry and national economy if foot-and-mouth disease (FMD) should escape a laboratory and be introduced into the surrounding environment. The Subcommittee reviewed the FMD outbreak in the United Kingdom in 2001 and the leak of FMD virus from the Pirbright laboratory in August 2007. They also recounted the 1978 accidental release of FMD from the PIADC. Virus did not escape the island and the World Organization for Animal Health (OIE) was persuaded not to issue an embargo of American meat products. A summary report from that incident cited the water barrier surrounding PIADC as being instrumental in containing the potential spread of FMD. Testimony also noted that Germany and Denmark both conduct FMD research on small islands, and that Canada conducts limited research with FMD at their national laboratory in Winnipeg which has had no virus escapes.

The Subcommittee also had concerns about the cost of NBAF and the future expenses of demolition, decontamination and environmental cleanup of PIADC if that site is abandoned.

The Government Accountability Office (GAO) issued an interim report at the hearing and GAO representatives testified that DHS had not performed the necessary steps to determine whether FMD

research can be safely performed on the mainland. GAO claimed that DHS neither conducted nor commissioned any study to determine whether FMD work can be done safely on the U.S. mainland, relying instead on a United States Department of Agriculture (USDA) study that simply addressed whether it was technically feasible to do so and disregarding the potential for human error. They also felt the DHS study was inaccurate in comparing other countries' FMD work experience with that of the United States. (Report # GAO-08-821T; summary and full text available from: http://www.gao.gov/products/GAO-08-821T).

DHS testified that while human error could never be fully avoided, the redundancies built into NBAF's design and use of the latest biosecurity and containment systems would effectively minimize any risks. Individual risk assessments are being conducted at each of the finalist sites to study the impact of a hypothetical FMD release and public comment will be received on those findings.

A panel of representatives from various livestock industries testified, describing the catastrophic effects that an FMD outbreak would have on the industry and the overall U.S. economy. They all felt that oversight for animal disease research should fall solely with USDA and that more study was necessary before a laboratory is located on the mainland. Concern was voiced for the ability of the U.S. government to assure consistent and adequate funding for NBAF, regardless of the location of the facility.

H.R. 1717 has not advanced past initial introduction (March 27, 2007), but the final version of the 2008 Farm Bill does contain a provision that would allow for FMD research to move to "…any facility that is a successor to the Plum Island Animal Disease Center and charged with researching high-consequence biological threats involving zoonotic and foreign animal diseases…" (HR 6124 EH; Title VII, Sec. 7524).

The Subcommittee has archived a copy of the webcast of the hearing along with witness list/prepared testimony: http://energycommerce.house.gov/cmte_mtgs/110-oi-hrg.052208.PlumIsland.shtml.

Government Accountability Office (GAO) Report

On October 16, 2008, the GAO released a report entitled "Biosafety Laboratories: Perimeter Security Assessment of the Nation's Five BSL-4 Laboratories". This report covered the current Centers for Disease Control and Prevention (CDC) laboratories, part of the United States Department of Health and Human Services, but would also apply to any BSL-4 laboratories planned by the United States Department of Agriculture. BSL-4 laboratories handle pathogens for which no cure or treatment exists. At present, CDC regulations do not mandate that specific perimeter security controls be present at all BSL-4 laboratories. The report found that current laboratory site security varies widely among the current five functioning laboratories. Only one laboratory had all recommended 15 security controls in place. Immediate action is needed to implement specific perimeter controls for all BSL-4 laboratories to act as a deterrent and to reduce the likelihood of unauthorized intrusion. The CDC should work with USDA to coordinate perimeter security requirements. Full text of GAO-08-1092 is available from: http://www.gao.gov/new.items/d081092.pdf.

Top Products from the National Center for Foreign Animal and Zoonotic Disease Defense

Neville P. Clarke
National Center for Foreign Animal and Zoonotic Disease Defense

1. Commercialization of Vaccine for Rift Valley Fever (MP-12): A major pharmaceutical company has approached the University of Texas Medical Branch (UTMB), a partner in the FAZD Center, to support the development of a commercial vaccine for Rift Valley fever using the MP-12 antigen which is also being considered for development of a human vaccine. The FAZD Center has supported the development of an animal vaccine at UTMB for three years. This is a major step towards successful technology transfer for a product that can either become part of the national veterinary stockpile or be commercialized for international use. If the decision to proceed is taken, the initial development cycle would require about one year.

2. Model of Interstate Movement of Livestock: Most epidemiologic models assume disease is spread by direct or indirect contact at local levels and they do not take into account the long distance movement of animals across the country that occurs in commerce. The Department of Homeland Security (DHS) has provided special funding to the National Center for Food Protection and Defense (NCFPD) and the FAZD Center to acquire the data and to build a national transportation model that will be input to multiple epidemiologic modeling efforts. The initial effort will focus on beef, dairy, and swine, but the centers are planning follow up efforts for other commodities. This will provide for the first time a quantitative estimate of what is probably one of the most important factors in the spread of foreign animal or zoonotic disease through the interstate movement of large numbers of animals over long distances.

3. System to Alert Non-Commercial Livestock Owners of Disease Outbreaks: The County Animal Security and Health Network (CASHN) is designed to improve communication between the county agent and the backyard owner through a common element, the local feed store. A pilot program in six states found that a message of a disease outbreak can flow from the state veterinarian to the feed retailer in little more than 48 hours. The CASHN system could potentially take the message to an average of 795 non-commercial owners within a week of receipt, the pilot shows. Rapid dissemination is designed to improve response to a potentially catastrophic outbreak, such as the 2002-2003 outbreak of exotic Newcastle disease, which began with a smuggled bird, existed in backyard flocks for six months before detection, and eventually led to the destruction of more than 3.5 million birds and the suspension of exports to 34 nations from California, Nevada and Arizona.

4. Agreement to Enhance Data Collection on Incidences of Rift Valley Fever: A project between the FAZD Center and the Kenyan Ministry of Public Health will provide high resolution disease incidence data for the first time to improve modeling and vaccine trial development for Rift Valley fever. This project aligns directly to the DHS Chem/Bio Division's agrodefense portfolio.

5. Assessment of Impact of Foot-and-Mouth Disease (FMD) Outbreak in Feedlots: The impact of outbreaks of FMD into randomly selected feedlots has been assessed in a nine county area of the High Plains of Texas that contains a high concentration of large Concentrated Animal Feeding Operations (CAFO). The FAZD Center's economic researchers are evaluating the economic impacts of the various mitigation strategies that were simulated. Early detection is a very important facet in limiting the spread of FMD after introduction and the epidemiologic and economic impact. Vaccination as a means of containing the disease was effective only in selected scenarios. The early availability of vaccine was important in its efficacy.

6. Risk communications training on FAZD issues: The FAZD Center sponsored a two-day train-the-trainer workshop focused on how to handle risk communications during an outbreak of an animal disease that threatens the public health or the economy. Twenty-eight communicators participated in the workshop, representing Texas A and M University, Texas Tech University, Ohio State University, Iowa State University, Purdue University, Kansas State University, the University of Arizona and the University

of Georgia. The program is designed to give communicators the tools and training they need to provide instruction to communicators in their regions.

7. Recognition and Internships for FAZD Center scholars: Across the FAZD Center, approximately 100 students and post doctoral fellows are involved in research, education, and outreach activities. Many of them have earned honors, recognition and internships. Among them are:

- Noried M. DeJesus-Velazquez, a FAZD Center student participating in the 2007 DHS Minority Serving Institutions Summer Research Team Program, was chosen to make a presentation to the Department of Homeland Security (DHS), Science and Technology Directorate Under Secretary Jay M. Cohen. She also received honors for a poster presentation at the 2007 Annual Biomedical Research Conference for Minority Students.
- Texas A and M University graduate student Vinayak Brahmakshatriya won first place in the student poster contest held during the first DHS University Network Summit on Research and Education. He was among seven FAZD Center students who presented posters.
- Six graduate students completed fellowships with high level agencies and laboratories within the homeland security sector. Amy Pohl interned at U.S. Northern Command (NORTHCOM) in Colorado Springs to study education and research topics. Lindsay Holmstrom interned with Lawrence Livermore National Laboratory in California. Jennie Finks worked with USDA, Animal and Plant Health Inspection Service in Mexico and Central America. Melinda Hergert designed a public health program on rabies while working in South Africa. Amy Delgado worked with the Department of Environment, Food and Rural Affairs (DEFRA) in the United Kingdom. Heather Engleking interned with USDA, Food Safety and Inspection Service and Agricultural Research Service.

8. Genetic Marker Vaccines for Selected Zoonotic Diseases: There is a critical need for improved vaccines for zoonotic diseases of economic and public health applications, such as Rift Valley fever (RVF) and avian influenza (AI). In addition to safety, efficacy, and the ability to manufacture sufficient quantities of vaccine, FAZD Center investigators are using modern recombinant technologies to incorporate genetic markers into RVF and AI vaccines to make it possible to distinguish vaccinated livestock from infected livestock. In an outbreak, this property will prevent unnecessary slaughter of animals, and which causes further damage to the economy through trade restrictions while creating challenges to the capacity for carcass disposal.

9. Rapid Detection Tests: After an outbreak of foot-and-mouth disease (FMD) has been confirmed, the emergency response program to eradicate the disease involves sometimes massive culling of infected or exposed herds. The FAZD Center is developing rapid, accurate, inexpensive field tests that will distinguish between infected and uninfected animals at chute site within minutes. This will eliminate unnecessary loss of uninfected animals, saving hundreds of thousands of animals in large outbreaks. Prototypes are awaiting an opportunity for testing at Plum Island Animal Disease Center in 2008.

10. Anti-Viral Protection Against FMD: Standard vaccines for FMD require up to 10 days before becoming effective, creating an immunity gap during which livestock remain vulnerable to one of the most contagious of viral diseases. A new antiviral from the FAZD Center promotes “natural killer cells” that attack the FMD virus, providing protection within three days. Research in this area contributes to vaccine development at Plum Island Animal Disease Center (PIADC).

11. Avian Flu Training for Early Responders: In the event of an outbreak of highly pathogenic avian influenza H5N1, a lack of training among early responders will lead to delayed detection and ineffective reactions. The FAZD Center’s Avian Influenza School trains the trainers and provides training modules for use by extension agents, veterinarians, researchers and farmers – for prevention, intervention and recovery from outbreaks. Sessions have been held in Texas, California and Minnesota, and in Africa, and are in demand in the developing world.

12. Risk Assessment Models for Rift Valley fever (RVF): RVF is a zoonotic disease that is recognized as a candidate for intentional or unintentional introduction into the U.S. from the Horn of Africa, where an outbreak in animals and humans is underway. Using emerging FAZD Center models,

estimates of the impact of introduction of RVF are being made for the biennial White House Biothreat Assessment. A workshop of subject matter experts met April 23-24, 2007, to develop critical estimates of responses to the disease in the U.S. providing critical inputs to the application of the FAZD model for the threat assessment.

13. Integrated Platforms for Unknown or Attenuated Disease Agent Characterization: Pathogens encountered in the future may differ substantially and in unknown ways from those identified and characterized today, either by natural or intentional attenuation. To address this gap, the FAZD Center is developing with its partners a suite of universal, unbiased, and massively parallel micro- and nano-analytical devices that can collect, compare, and archive genetic biosignature information to effectively categorize and contribute to the development of strategies for outbreaks of unknown etiology. This suite of technologies includes the Integrated Biomarker Specific Biosignature (IBSB), Multiple Select Agent Specific (MSAS), and Universal Biosignature Detection Array (UBDA) platform technologies.

14. Integrated System to Support Threat Assessment: Strategic planning and emergency response interventions require a broad perspective to include economic, epidemiologic, and environmental consequences of options. The FAZD Center modeling approach is providing this linkage for planning, training, emergency response and recovery.

15. Pathomics Discovery Platform – Elucidating the Molecular Mechanisms of Infectious Disease Processes: The ability to examine the molecular intricacies of infectious agent-host processes is critical to the development of new protection, detection, and therapeutic strategies. The FAZD Center has worked with multiple partners including several national laboratories to develop a suite of molecular analytical tools that has provided valuable and often unanticipated insight into select agent disease pathways, and is now being employed for the study of other important agents including avian influenza.

16. Stakeholder Workshops on Mass Animal Mortality: If a pandemic or a catastrophe resulted in the death of U.S. livestock in large numbers, current environmental policy and regulations would severely hamper carcass disposal. FAZD Center workshops in California and Texas brought together major stakeholders from the livestock industry: industry representatives, policymakers, scientists and regulators. They examined policy and suggested changes to improve response and recovery, and established working relationships.

17. Protection Against Highly Pathogenic Avian Influenza H5N1 Transmission in Live Bird Markets: Daily interaction between humans and birds in live markets in major U.S. cites offer ample opportunity for transmission to humans and the possible mutation to human-to-human transmission. FAZD Center has studied these interactions and has defined the potential for transmission. Preventive measures have been approved and adopted.

Readiness and Capacity of the U.S. for the Introduction of Exotic Arthropod-Borne Viruses

William C. Wilson*, Kristine E. Bennett, James O. Mecham, Myrna M. Miller,
Will K. Reeves and Barbara S. Drolet
Arthropod-Borne Animal Diseases Research Laboratory
Agricultural Research Service

Arthropod-borne animal viruses (arboviruses) cause significant economic losses to the United States (U.S.) and world agriculture. This paper will discuss the current and potential impact of these viruses, as well as the readiness and capacity of U.S. diagnostic laboratories and veterinary workforce to deal with these re-emerging insect transmitted viruses affecting livestock and wildlife. The U.S. veterinary community needs to be more prepared for both endemic and exotic viruses including: bluetongue virus (BTV), epizootic hemorrhagic disease virus (EHDV), African horse sickness virus (AHS), Akabane, vesicular stomatitis virus (VSV), West Nile virus (WNV), the equine encephalitis viruses and Rift Valley fever virus (RVFV). The current readiness for endemic arboviruses is fairly high, but we are extremely limited in our capacity to detect and respond to an introduction of exotic viruses, which reflects the difficulties in investigating these unique pathogens. An integrated approach is needed, involving multiple scientific disciplines such as veterinary medicine, virology, entomology, pathology, immunology, wildlife biology, and epidemiology. Although there are many institutions in the U.S. with expertise in these disciplines, there are limited locations that have an integrated research team addressing veterinary arboviruses. In addition, there is limited workforce with veterinary arbovirus research experience and a lack of large animal high biocontainment facilities with the capabilities of performing insect-transmission studies.

Among these arboviruses are those that are transmitted by biting midges in the genus *Culicoides*, including BTV and EHDV and VSV [23]. These viruses infect cattle, sheep, goats and/or wild ungulates causing sub-acute to lethal disease. BTV has the greatest economic impact to the U.S. livestock industry (estimated at $120 million annually), with losses attributed to effects on animal health and productivity. Losses worldwide attributed to BTV have been estimated at $3 billion annually. Although there is a fairly good understanding of the epidemiology of domestic strains of BTV, there is little to no information on how competent the primary U.S. vector, *Culicoides sonorensis,* or any other *Culicoides* species are for exotic BTV serotypes. Especially concerning is the economic and unique disease impact BTV-8 has had on Europe[18] and the fact that there have been multiple isolations of exotic BTV serotypes in the U.S. over the past 3 years.[6] There is only one commercial vaccine available nation-wide at that is specific to BTV type 10. There is limited to no cross protection between serotypes. The related orbivirus, EHDV, is of considerable interest to the captive cervid industry and the recent isolation of an exotic serotype (Type 6) has raised concerns in the livestock industry as well. EHDV-7 has been associated with clinical disease in Israeli cattle.[25] A number of assays are available for diagnosis of U.S. endemic strains including; virus isolation, virus neutralization, competitive inhibition and antigen capture enzyme linked immunosorbent assays (ELISAs) and reverse transcriptase-polymerase chain reaction (RT-PCR) genome amplification for domestic BTV and EHDV. Additionally, real-time RT-PCR assays are available to detect exotic BTV[20] and EHDV[24] serotypes. A multiplex assay has also been developed to detect BTV and EHDV and distinguish between the two viruses in a single closed tube.[21] Reagents for immunological-based detection and serotyping of exotic BTV and EHDV are limited to a few laboratories. There is no commercial EHDV vaccine available nation-wide. *Culicoides*-transmitted exotic arboviruses include African horse sickness (AHS) virus,[1] which is lethal to horses, and Akabane[26] which is teratogenic in cattle. There are tools available to diagnose AHS,[8,9,13] however; due to high biocontainment restrictions, performing these assays in the U.S. is limited to the USDA, Animal and Plant Health Inspection Service (APHIS), Veterinary Services (VS), Foreign Animal Diseases Laboratory (FADL) on Plum Island, New York. Currently, USDA-ARS does not have any internally funded research on AHS or Akabane.

Central and South America are enzootic for VSV which periodically invades the U.S., presumably on or in insect vectors, to cause epizootics in cattle and horses. *Culicoides*, black flies and sand flies transmit VSV.[2,14] Insects are believed to play an essential role in transmission of the virus from natural reservoirs to domestic livestock. Once initial infection has occurred, direct contact transmission is believed to be the major route of transmission. The clinical severity of VSV and its similarity to foot-and-mouth clinical disease results in quarantines, sale barn closures, and restrictions on the movement of livestock and animal products.[11] As with BTV there are a number of standard diagnostic tools available for detection of

VSV[17] including a recently developed real-time RT-PCR for detection and distinguishing VSV Indiana and VSV New Jersey.[16,22]

Endemic/epidemic viruses, including Western, Eastern and Venezuelan Equine encephalitis viruses that also cause disease in birds, humans and horses.[3] A majority of the current research on the equine encephalitis viruses (Alphaviruses) is conducted by laboratories whose primary interests are in human health using standard diagnostic tools where available.[3] There is a commercial vaccine for Eastern equine encephalitis (EEE)[5] and candidate vaccines for Venezuelan equine encephalitis (VEE) and Western equine encephalitis (WEE).[19]

The introduction of WNV into the U.S. in 1999 exemplifies how readily exotic arboviruses can establish themselves in new ecosystems and significantly impact an unprepared nation.[10] It is well known now that WNV is a mosquito-transmitted pathogen of birds, humans and horses. Unfortunately, gaps in understanding other endemic mosquito-transmitted viruses, such as Saint Louis encephalitis virus, complicated early detection of the WNV introduction. WNV spread in birds and mosquitoes across the country resulting in highly publicized impact on the nation. The economic impact on North Dakota alone in 2002 was estimated at $1.9 million.[15] Guidelines for detection of WNV came out fairly quickly[4] and a number of improvements have been made.[7,12] There are now at least three commercial WNV vaccines for horses. The rapid, uncontrolled spread of WNV and our inability to distinguish it from related endemic viruses, exemplifies our lack of readiness for introduction of exotic arboviral diseases.

Recent outbreaks of RVF have raised concerns of the potential impact of introduction of this virus into the U.S. The introduction of this arbovirus would have devastating effects on the U.S. livestock industry. When these outbreaks occurred in Africa, no USDA staff was vaccinated, nor had any experience working with this virus. The USDA-ARS and USDA-APHIS are working together to address the lack of diagnostic reagents and validated test. Seven USDA staff members have been vaccinated with the very expensive investigational vaccine to work safely with this virus. The USDA-ARS has developed a new research program to address countermeasures for RVF. This work is hampered by the absence of high biocontainment research facilities certified to work with this virus. Research on large animals infected with RVFV currently is being conducted outside of the U.S.

The development of validated diagnostics and effective control strategies and the formulation of reasonable animal regulatory statutes to reduce the economic impact on U.S. livestock require understanding the molecular biology, epidemiology and pathogenesis of these arboviruses. The following bullets are current needs in the U.S. to address these issues:

Readiness/capacity:

- Training and awareness/education for all National Animal Health Laboratory Network (NAHLN) laboratories and veterinarians as to clinical presentations of various arthropod-borne diseases;
- Clear guidelines/requirements for reporting by livestock owners and veterinarians;
- Sensitive/specific diagnostic assays, multiplex assays, standardized serum (sample) panels and testing protocols for validation;
- Information on susceptible vector and host species to exotic arthropod-borne pathogens;
- Better Integrated Pest Management;
- Better surveillance and modeling of both animals and insects;
- Information on potential wildlife reservoirs for arthropod-borne pathogens;
- Vaccine discovery, non-biased evaluation, and commercial development; and
- High biological containment laboratories and large animal isolation facilities to evaluate new diagnostics and vaccines.

The economic impact resulting from a lack of readiness and capacity could further damage the current U.S. economy. Although it is impossible to predict what will be the next arboviral introduction to the U.S., many of the scientific tools and infrastructure outlined here would be applicable to other pathogens not currently targeted.

References:

1 Burrage TG, Laegreid WW: 1994, African Horsesickness - Pathogenesis and Immunity. Comparative Immunology Microbiology and Infectious Diseases 17:275-285.

2 Drolet BS, Campbell CL, Stuart MA, Wilson WC: 2005, Vector competence of Culicoides sonorensis (Diptera: Ceratopogonidae) for vesicular stomatitis virus. J Med Entomol 42:409-418.

3 Griffin DE: 2007, Alphaviruses. *In*: Fields Virology, eds. Knipe DMHowley PM, 5 ed., pp. 1023-1067. Lippincott Williams & Wilkins, New York, NY.
4 Gubler DJ, Campbell GL, Nasci R, et al.: 2000, West Nile virus in the United States: guidelines for detection, prevention, and control. Viral Immunol 13:469-475.
5 Holmes MA, Townsend HG, Kohler AK, et al.: 2006, Immune responses to commercial equine vaccines against equine herpesvirus-1, equine influenza virus, eastern equine encephalomyelitis, and tetanus. Vet Immunol Immunopathol 111:67-80.
6 Johnson DJ, Mertens PPC, Maan S, Ostlund E: 2007, Exotic bluetongue viruses identified from ruminants in the south-eastern U.S. from 1999-2006. . *In*: Amer. Assoc. Vet. Lab. Diagn. Reno, NV
7 Kleiboeker SB, Loiacono CM, Rottinghaus A, et al.: 2004, Diagnosis of West Nile virus infection in horses. J Vet Diagn Invest 16:2-10.
8 Koekemoer JJ: 2008, Serotype-specific detection of African horsesickness virus by real-time PCR and the influence of genetic variations. J Virol Methods.
9 Laegreid WW: 1994, Diagnosis of African Horsesickness. Comparative Immunology Microbiology and Infectious Diseases 17:297-303.
10 Lanciotti RS, Roehrig JT, Deubel V, et al.: 1999, Origin of the West Nile virus responsible for an outbreak of encephalitis in the northeastern United States. Science 286:2333-2337.
11 Letchworth GJ, Rodriguez LL, Del cbarrera J: 1999, Vesicular stomatitis. Vet J 157:239-260.
12 Long MT, Jeter W, Hernandez J, et al.: 2006, Diagnostic performance of the equine IgM capture ELISA for serodiagnosis of West Nile virus infection. J Vet Intern Med 20:608-613.
13 Maree S, Paweska JT: 2005, Preparation of recombinant African horse sickness virus VP7 antigen via a simple method and validation of a VP7-based indirect ELISA for the detection of group-specific IgG antibodies in horse sera. J Virol Methods 125:55-65.
14 Mead DG, Howerth EW, Murphy MD, et al.: 2004, Black fly involvement in the epidemic transmission of vesicular stomatitis New Jersey virus (Rhabdoviridae: Vesiculovirus). Vector Borne Zoonotic Dis 4:351-359.
15 Ndiva Mongoh M, Hearne R, Dyer NW, Khaitsa ML: 2008, The economic impact of West Nile virus infection in horses in the North Dakota equine industry in 2002. Trop Anim Health Prod 40:69-76.
16 Rodriguez LL, Pauszek S, Smoliga GR, Wilson WC: 2008, Real-Time RT-PCR for Vesicular Stomatitis Viruses New Jersey and Indiana-1 strains: a phylogenetic approach to a highly variable RNA virus. J Clin Micro Submitted.
17 Rodriguez-Sanchez B, Sanchez-Vizcaino JM, Uttenthal A, et al.: 2008, Improved diagnosis for nine viral diseases considered as notifiable by the world organization for animal health. Transbound Emerg Dis 55:215-225.
18 Saegerman C, Berkvens D, Mellor PS: 2008, Bluetongue epidemiology in the European Union. Emerg Infect Dis 14:539-544.
19 Schoepp RJ, Smith JF, Parker MD: 2002, Recombinant chimeric western and eastern equine encephalitis viruses as potential vaccine candidates. Virology 302:299-309.
20 Toussaint JF, Sailleau C, Breard E, et al.: 2006, Bluetongue virus detection by two real-time RT-qPCRs targeting two different genomic segments. J Virol Methods.
21 Wilson WC, Hindson BJ, O'Hearn ES, et al.: 2008, Development of a Multiplex Bluetongue and Epizootic Hemorrhagic Disease Real-Time RT-PCR serogroup detection and differentiation. J Clin Micro In Preparation.
22 Wilson WC, Letchworth GJ, Jimenez C, et al.: 2008, Field evaluation of a multiplex real-time RT-PCR For vesicular stomatitis virus. J Vet Diagn Invest Submitted.
23 Wilson WC, Mecham JO, Schmidtmann ET, et al.: 2008, Current status of bluetongue virus in the Americas. *In*: Bluetongue, eds. Mellor P, Baylis MMertens P, p. In Press. Elsevier, Oxford, England.
24 Wilson WC, O'Hearn ES, Tellegren-Roth C, et al.: 2008, Detection of all eight serotypes of epizootic hemorrhagic disease virus (EHDV) by real-time RT-PCR. J Vet Diag Investig Submitted.
25 Yadin H, Brenner J, Bumbrov V, et al.: 2008, Epizootic haemorrhagic disease virus type 7 infection in cattle in Israel. Vet Rec 162:53-56.
26 Yamakawa M, Yanase T, Kato T, Tsuda T: 2006, Chronological and geographical variations in the small RNA segment of the teratogenic Akabane virus. Virus Res 121:84-92.