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# Pseudorabies (Aujeszky's Disease) and Its Eradication

## A Review of the U.S. Experience

**Technical coordinators**

Lowell A. Anderson,[1] D.V.M., M.S.; Neal Black[2]; Thomas J. Hagerty,[3] D.V.M.; John P. Kluge,[4] D.V.M., Ph.D., Diplo. A.C.V.P.; and Paul L. Sundberg,[5] D.V.M., Ph.D., Diplo. A.C.V.P.M.,

[1]Lowell Anderson is Area Epidemiology Officer in the Veterinary Services branch of the U.S. Department of Agriculture's Animal and Plant Health Inspection Service in Des Moines, IA.

[2]Neal Black is the former president of the Livestock Conservation Institute and former editor of National Hog Farmer magazine.

[3]Thomas Hagerty is the former chair of the United States Animal Health Association's (USAHA) Pseudorabies Committee, former chair of the Program Standards Subcommittee of USAHA, past president of USAHA, and former Minnesota State Veterinarian.

[4]John Kluge is professor emeritus in the Department of Veterinary Pathology, College of Veterinary Medicine, Iowa State University, and is former chair of the Transmissible Diseases of Swine Committee of USAHA. He was also the first chair of USAHA's Pseudorabies Committee and wrote the chapter on pseudorabies in Diseases of Swine, published by the Iowa State University Press.

[5]Paul Sundberg is Vice President, Science and Technology, the National Pork Board, and a member of the Pseudorabies Control Board.



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# Foreword

This report has been written to serve as a history of the U.S. Aujeszky's Disease (Pseudorabies) Eradication Program and as a guide when future disease eradication programs are considered. The report provides an overview of the program and its history and is generally nontechnical, with specific sections written by subject matter experts. The information was compiled during 2007, three years after the last four States qualified for Stage V (Free) Status. This eradication effort was formally initiated in 1989.

The contents of this report include a variety of information that represents the viewpoints of individuals participating in the eradication effort. To introduce the challenge of pseudorabies (PRV), the report covers characteristics of the virus and the history of the disease in the United States, followed by the emergence of virulent strains in the 1970s that coincided with management changes in the swine industry. The report also discusses early attempts at PRV control, vaccines, and diagnostic tools, and then reviews various pilot projects, individual State experiences, and national debate on the pros and cons of eradication versus control. In addition, the report offers details on the evolution and acceptance of a national eradication program, including debate among industry and State/Federal officials, funding, testing protocols, cleanup plans, and the development of gene-deleted vaccines and their complementary tests. The ongoing threat of reintroduction from feral swine and emergency response plans are also included. Lastly, the technical coordinators have included a chapter on lessons learned from our various viewpoints on the eradication effort.

Although we specifically named a few individuals in the report for having contributed to this program, it is not our intent to omit the names of other individuals who also contributed significantly. The PRV eradication effort would not have been successful without the hard work and support of many, and we regret that we could not recognize all individual contributors by name. We dedicate this report to the many people who, in their own unique way, contributed to the completion of the eradication objective. We are also deeply grateful to our international colleagues who so generously shared their experiences to help us accomplish the goal of eradicating PRV from the domestic swine population in the United States.

**Acknowledgments**

Thirty-one authors (listed below) contributed information to this report. They were selected by the technical coordinators based on their areas of expertise and roles played throughout this eradication program. These roles included pork producers, members of pork producer advisory committees, executives with pork producer associations, officers of the American Association of Swine Veterinarians, current and former State Veterinarians, officers and committee leaders from the National Institute for Animal Agriculture, university extension veterinarians, officers and committee leaders from the United States Animal Health Association, researchers from universities and government agencies, and veterinarians from the Veterinary Services (VS) branch of the U.S. Department of Agriculture's (USDA) Animal and Plant Health Inspection Service (APHIS).

**Contributors**

Lowell A. Anderson, D.V.M., M.S.
Paul L. Anderson, D.V.M., M.S.
Joseph F. Annelli, D.V.M., M.S.
Mary Battrell, D.V.M., M.S.
George W. Beran, D.V.M., Ph.D., L.H.D.
Troy T. Bigelow, D.V.M.
Neal Black, Editor and Industry Leader

Philip E. Bradshaw, Pork Producer
Robert G. Ehlenfeldt, D.V.M.
John I. Enck, V.M.D.
David A. Espeseth, D.V.M., M.S.
Robert D. Glock, D.V.M., Ph.D., Diplo. A.C.V.P.
Thomas J. Hagerty, D.V.M.
Edwin C. Hahn, Ph.D.
Howard Hill, D.V.M., Ph.D.
Richard D. Hull, D.V.M.
John P. Kluge, D.V.M., Ph.D., Diplo. A.C.V.P.
John A. Korslund, D.V.M.
Willard J. Korsmeyer, Pork Producer
James W. Leafstedt, Pork Producer
Bret D. Marsh, D.V.M.
James D. McKean, D.V.M., M.S., J.D.
William L. Mengeling, D.V.M., Ph.D., Diplo. A.C.V.M.
R. R. Ormiston, D.V.M.
Kenneth B. Platt D.V.M., Ph.D., Diplo. A.C.V.M.
Mark A. Schoenbaum, D.V.M., Ph.D.
R. L. 'Rick' Sibbel, D.V.M.
Paul L. Sundberg, D.V.M., Ph.D., Diplo. A.C.V.P.M.
Mike Telford, Industry Leader
Max A. Van Buskirk, V.M.D.
Larry L. Williams, D.V.M.

The technical coordinators gratefully acknowledge the participation of the following individuals in the complex process of reviewing the text for technical accuracy.

**Reviewers**

Tom Burkgren, D.V.M., M.B.A., Executive Director of the American Association of Swine Veterinarians
Sam D. Holland, D.V.M., South Dakota State Veterinarian
Elizabeth A. Lautner, D.V.M., M.S., Director of the USDA–APHIS–VS' National Veterinary Services Laboratories and former Vice President of Science and Technology, National Pork Board
David G. Pyburn, D.V.M., USDA–APHIS–VS, Swine Health Programs
James E. Stocker, former Director of the National Pork Producers Council and National Pork Board, former board member of the National Institute for Animal Agriculture, past Director of the North Carolina Pork Producers Council
Jeffrey J. Zimmerman, D.V.M., Ph.D., Diplo. A.C.V.P.M., Associate Professor of Veterinary Diagnostic and Production Animal Medicine, Iowa State University

## Timeline and Milestones

The following information briefly summarizes the events, highlights, and milestones that took place during the development, implementation, and completion of the PRV Eradication Program. The reader will find additional information about these topics in the chapters that follow.

**1975—**First PRV meeting in Peoria, Illinois, a national symposium during the Livestock Conservation Institute's (LCI) annual meeting. Illinois began quarantining infected herds. The Iowa Purebred Swine Council helped to fund a study of PRV at Iowa State University's Veterinary Diagnostic Laboratory. Thirty PRV cases were disclosed in Iowa from January through May. Antiserum use began in Illinois' infected herds. The LCI PRV Committee formed. The committee approved a resolution supporting the "concept of eradication." Indiana became the first major hog-producing State to require testing for PRV. Sales began in some midwestern States of an inactivated vaccine that was not licensed by APHIS' Center for Veterinary Biologics (CVB).

**1977—**The preliminary draft of a three-stage eradication plan was announced. Survey of diagnostic labs that indicated 714 cases were confirmed in 1976. USAHA and the National Pork Producers Council (NPPC) supported eradication. The American Farm Bureau Federation (AFBF) called for study to determine the feasibility of eradication. Three national breed

association conferences were cancelled due to concerns about PRV. A Veterinary Services study group approved a resolution calling PRV an emergency. VS considered action on developing interstate movement regulations regarding the disease. VS convened a meeting in Ames, Iowa, to chart a course against the disease. At the conclusion of the meeting, Dr. Frank Mulhern, former APHIS Administrator, voiced the following:
"The industry is not giving up on eradication, some day, down the road, but not now. Instead, it is asking for the vaccine to provide immediate relief now."
Three endemic areas were identified: northwestern Iowa; Pike County, Illinois; and Carroll County, Indiana. A Federal license was granted for the first PRV vaccine, produced by Norden Laboratories in Lincoln, Nebraska. Negative tests were required for all animals at summer breed-type conferences. VS announced a PRV control program based on monitoring to determine disease incidence, restrictions on animal movements to reduce spread, and restricted use of vaccine in endemic areas. Entries at State fair swine shows decreased substantially due to PRV. APHIS proposed for comment Federal regulations requiring negative tests on breeding stock prior to movement. The regulatory proposal was revised in response to purebred breeders.

**1978—**A survey of State veterinarians revealed that 40 States had at least a basic PRV control program, involving quarantines and the reporting of cases. APHIS publishes second and third drafts of Federal rules for comment.

**1979—**APHIS issued the final draft of the Federal rule, effective in May. The pilot eradication effort in southwestern Michigan was approved. Purebred breeders called for uniform State movement regulations.

**1980—**The Michigan program confronted challenges resulting from controversy over indemnity payments. One of four alternatives—control until an eradication program could be put into effect—was approved by the LCI's PRV committee. The National Association of Swine Records called for changing movement regulations to allow interstate movement of vaccinated animals.

**1981—**The NPPC's Board of Directors asked VS to drop PRV regulations and allow States to regulate the disease. A joint national hearing (called by committees of the NPPC, LCI, and USAHA) illustrated the deep divisions in the industry. The LCI committee called for VS to set up pilot projects to determine whether eradication was feasible. Iowa State University researchers announced the development of a "subunit" vaccine that could be used to distinguish antibody response from vaccine versus field strains in pigs when tested.

**1982—**Two pamphlets were published by LCI, one on the elimination of PRV from a herd and the other covering the epidemiology of PRV. In a slaughter survey designed to determine PRV seroprevalence among swine in three major hog States, nearly 20 percent of herds and 10 percent of pigs tested positive for the disease.

**1983—**The NPPC called on APHIS to fund pilot projects or withdraw all Federal regulations. The NPPC also pledged $100,000 to support the projects, and APHIS agreed to provide $400,000 for projects. Pilot projects were launched in Iowa and Illinois and later in Wisconsin, Pennsylvania, and North Carolina.

**1984—**Illinois pioneered the feeder-pig certification rule, requiring negative tests of sow herds for movement of feeder pigs, effective February 15, 1985.

**1985—**National Pseudorabies Control Board established.

**1986—**The Peoria Illinois meeting was convened to discuss results from the pilot projects. The jury that heard analyses of the pilot projects voted for eradica-

tion and called for the task force to write a plan. The first gene-deleted vaccine was licensed. The latex agglutination test and PRV enzyme-linked immunosorbent assay (ELISA) test were licensed. Task force issued the "seventh draft" eradication plan and sought comments from industry. The USAHA PRV committee endorsed the eradication plan. The National Pseudorabies Control Board granted the first State status—Class B—to Wisconsin.

**1987—**The PRV eradication plan, written in 1986 and discussed over the winter of 1986 to 1987, was approved by the NPPC in March. A VS summary of the pilot projects indicated almost a 98 percent success rate in cleaning up herds. State veterinarians estimated the number of infected herds as follows: Iowa, 3,000; Illinois, 570; Indiana, 1,000; and, Minnesota, 1,000.

**1988—**CVB licensed a diagnostic test to differentiate antibody from gene-deleted vaccine. Surveys in slaughter plants indicated that PRV seroprevalence was less than 1 percent in 1974 and, by 1984, had risen to over 8 percent in market weight hogs and nearly 19 percent in breeding animals, some of which could be due to titers from vaccine. The disease was concentrated in areas with high hog populations. The USAHA PRV Committee approved a draft of the Program Standards at its annual meeting in Little Rock, Arkansas. VS published the draft and distributed it to State officials the following January.

**1989—**Regional meetings were conducted throughout the United States. The first feral pig meeting was convened in Orlando, Florida. The first summary of quarterly State reports showed infected herds per 1,000 herds by States as follows: Iowa, 65; Indiana, 53; Nebraska, 43; Minnesota, 28; Illinois, 25; North Carolina, 18; South Dakota, 14; Georgia, 11; and, Ohio, 10. The average of the 31 States reporting was 21 herds per 1,000. Indiana reported that all infected herds were on cleanup plans. Ohio reported that 90 percent of infected herds were on cleanup plans, and the average of the 31 States reporting was 36 percent. The NPPC and VS formed a large herd cleanup committee to coordinate research on cleaning up large herds. Program goals were approved:

By 1992, all States were to have reached Stage II or higher and at least 22 States would be in Stage IV or free.

By the end of 1995, all States but Iowa would have reached Stage III or higher, and 40 States would be in Stage IV or Free.

By the end of 1996, all States would be in Stage III or higher.

By the end of 1998, all States except Iowa would be in Stage IV or Free.

By the end of 2000, all States would be free of PRV. Idexx's HerdCheck® differential diagnostic test, which differentiates between field virus and vaccine antibodies, was being considered by VS for recognition as an official test.

**1990—**The Program Standards were amended to permit interstate movement of swine based on compliance with new herd vaccination and testing procedures. Twenty-eight States achieved status in the program. The number of States in the various stages were as follows: Stage III, 7; Stage II, 13; and, Stage I, 8. Split-State statuses were proposed by the LCI PRV Committee and approved by the USAHA PRV Committee. Differential vaccines were approved in an amendment to the Program Standards. Washington was the final State to form a PRV advisory committee. All other States had PRV committees. LCI published a new edition of *The Epidemiology of Pseudorabies: A Field Guide* (see Appendix I). Thirty-six States were

participating in the national PRV program, with 10 in Stage I, 19 in Stage II, and 7 in Stage III. A large herd cleanup study was initiated. LCI published a new edition of *Plans for Elimination of PRV from a Swine Herd* (see Appendix II). Mandatory herd testing was initiated in Nebraska.

**1991—**All but four States were participating in the program. North Carolina was the first State to adopt split-State status. The International Symposium on PRV Eradication was conducted in St. Paul, Minnesota. Seventy percent of sows and nearly three-fourths of infected herds contained in States with Stage II status or higher were in the herd cleanup phases of the program. APHIS assembled a Feral Swine Technical Group. State program status as of July was as follows: Stage I, 12 States; Stage II, 20 States; Stage III, 13 States; Split-State stages II/III, 1 State; Stage IV, 3 States; and, no status, 1 State. All States were participating in the program by August. The USAHA PRV Committee recommended revisions to the Program Standards. VS presented an annual report indicating that 15 States had no PRV infection, 4 States had only 1 known infected herd, and 7 other States had less than 5 infected herds.

**1992—**Dr. Arnold Taft of Illinois became VS' PRV program manager. Maine became the first PRV-Free State. LCI joined with the technical advisory group and recommended that sales of PRV vaccines that do not contain gI(gE) deletion be discontinued by July 1, 1993, and their usage be discontinued by January 1, 1994. State status as of July 15 was as follows: Stage I, 9 States; Stage II, 15 States; Split-State stages II/II status, 3 States; Stage III, 14 States; Stage IV, 8 States; Free, 1 State. Utah and New Mexico became the second and third PRV-Free States.

**1993—**Alaska was granted Free status. The total number of PRV-infected herds in the country as of July 30 was 6,854.

**1994—**North Dakota became the 12th Free State, joining Alaska, Connecticut, Idaho, Maine, Mississippi, Montana, New Mexico, New York, Oregon, Utah, and Wyoming. States in other stages at the end of the year: Stage I, 1 State; Stage II, 9 States; Stage III, 25 States; Stage II/III, 2 States; and, Stage IV, 10 States. The total number of infected herds in the country was 5,342.

**1995—**The PRV-infected herd count in the United States dropped to 4,789.

**1996—**Maryland became the 19th Free State. Other State statuses as of June 30 included: Stage IV, 7 States; Stage III, 17 States; and, Stage II, 8 States. South Dakota, the first large hog-producing State, reached Stage IV.

**1997—**Iowa achieved split-State Stage II/III status. Thirty-two States were in Stage IV or Free. Tennessee became the 25th State, in addition to Puerto Rico, in Stage V/Free. Other State rankings included: Stage IV, 5 States; Stage III/IV, 2 States; Stage III, 12 States; and, Stage II/III, 5 States. The number of known infected herds in the United States was 2,077.

**1998—**Alabama joined the list of Free States. The number of States in various stages included: Stage V, 27 States; Stage IV, 5 States; Stage III/IV, 3 States; Stage II, 11 States; and, Stage II/III, 4 States.

**1999—**The Accelerated Pseudorabies Eradication Program (APEP), which involved depopulating infected herds with Commodity Credit Corporation funds, began. The number of PRV-infected herds in the United States was reduced to just over 200 at the end of the year. The number of infected herds jumped to 462 early in 2000, mainly due to a surge in outbreaks in Iowa.

**2001—**North Carolina, Ohio, and California achieved Free status. As of February 28, only Massachusetts, South Dakota, and Illinois remained in Stage IV; Indiana, Minnesota, Nebraska, New Jersey, and Tennessee in Stage III/IV; Florida, Louisiana, and Texas in Stage III; and, Iowa in Stage II/III. Only 12 known infected herds remained in the United States—9 in Iowa and 3 in Nebraska as of September 30. At the end of the year, four States remained in Stage IV; three States in Stage III/IV; three States in Stage III (all because of feral pig infection); and, one State (Iowa) in Stage II/III.

**2002—**There were no known cases of PRV in the country, with the exception of an infected herd in Pennsylvania that was depopulated in June. Nebraska and South Dakota achieved Free status, and Iowa reached Stage IV.

**2003—**All States were Free, except for Iowa, Pennsylvania, and Texas. Those three States were in Stage IV.

**2004—**All States achieved Free status.

**2005—**At its annual meeting in April, the National Institute for Animal Agriculture (NIAA)—the new name for LCI—celebrated PRV eradication.

# Contents

# Chapter 1: The Changing Swine Industry

Production of swine and the relationship of changing animal husbandry practices from the 1950s through the 1980s had a bearing on the stage being set for PRV affecting swine in a more severe manner than in the past. The losses and movement restrictions that ensued eventually led the industry to consider eradication.

In the United States, swine production practices remained stable between about 1920 and 1960. But after that, the industry began to change. The science of genetics was brought to bear on improving the "meat-type hog." Production practices changed. Transportation improved, and swine movement began to be a factor in the spread of swine diseases.

During the 1950s, production practices ranged from farrowing in outdoor A-frame style structures during summer months to using heated buildings. In the northern climates, farrowing was done in spring and fall to avoid temperature extremes. Muddy lots were being replaced with concrete (see fig. 1.1). At most facilities, manure removal was labor intensive. Many sows farrowed in pens. Wooden panels and heat lamps placed in the corner of the pen were used to protect and warm the pigs. Piglets nursed the sow for 8 weeks or more. Feeding balanced rations and adding protein were becoming more common.

Swine movement in the 1950s was to markets (including livestock auction markets), to other farms through private treaty sales, and to exhibition. The latter two movements required certification by veterinary inspection containing vaccine information about hog cholera and erysipelas.

During the 1960s, swine producers began to use larger, more modern farrowing facilities (see fig. 1.2), gestation barns for sows, and finishing floors for mar-

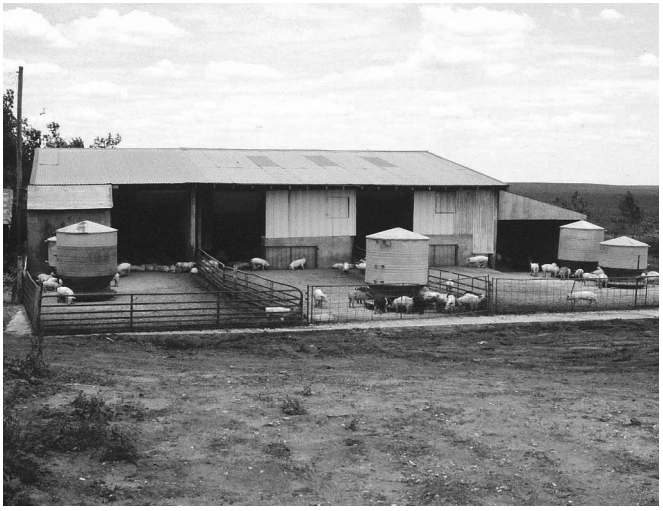


Figure 1.1. Muddy lots were being replaced with concrete. *(APHIS photo by Lowell Anderson)*

Figure 1.2. Modern farrowing facilities. *(Photo by George W. Beran, R Allen Packer Heritage Room)*

ket swine. The use of slotted-floor, total-confinement swine production also began. In the Eastern United States, outdoor facilities for finishing large numbers of feeder pigs purchased from multiple sources were created to satisfy demand by processing plants seeking supplies from closer locations. Hogs confined to indoor environments were leaner, and the terminology applied to swine ready for market changed from "fat hogs" to "market hogs" or "butcher swine." The trend toward larger herds grown in more-confined spaces set the stage for changes in swine disease issues.

The Hog Cholera Eradication Program created more attention among producers about exposure to disease. However, concern about commingling animals originating from multiple sources was minimal. Taking swine to an exhibition and back home again was common. Isolation and biosecurity were concepts known by some but not commonly practiced.

The average herd was 25 to 100 sows, with most farms in the Midwest operating as farrow-to-finish while feeder-pig production grew rapidly in North Carolina and other Southeastern States. A large number of seedstock producers were in business to provide new and improved genetic material to the farmer–producer.

Changes in pig type and consumer preference affected the swine industry. During the 1970s, advances in genetics helped to decrease back fat, increase muscle, and improve feed efficiency. Boar test stations gathered hogs from many different sources to compare these traits and were popular places for seedstock purchases. Likewise, exhibition at fairs and national breed shows helped to advertise and market these improvements. However, these trends toward commingling facilitated the mixing of swine and perhaps the mixing of diseases among them. All of these practices were important in terms of commerce and influenced the changes regarding the popularity of pork among consumers.

Figure 1.3 Transporting swine between farms and to markets. *(APHIS photo by Lowell Anderson)*

The concept of isolation, closed herds, and biosecurity began to take shape in the late 1960s to early 1970s with the idea of Specific Pathogen Free (SPF) swine. Delivering pigs by caesarean section kept them free of specific diseases. It was later shown that they were not able to avoid PRV if exposed. However, the concept of biosecurity was established.

Although sales of SPF breeding stock were good, the concept was not considered cost effective for the average producer. Most swine producers continued to add boars and sometimes gilts to their herds on a regular basis from a variety of sources and without isolation procedures.

The 1970s continued to be a time of great change in the swine industry. The size of production units continued to increase. For the first time, producers began to combine farrowing efforts in corporate and cooperative ventures, taking the offspring to their farms for finishing. Breeding cooperatives enlarged, and individual farms and seedstock producers became larger. A thriving seedstock industry began to diminish purchases of boars from the neighbor and encourage purchasing males and females from companies

located at greater distances. Better travel conditions and hog trailers facilitated long-distance travel of both breeding stock and feeder pigs (see fig. 1.3).

The number of confinement facilities increased. Larger finishing floors accommodating higher numbers of pigs, such as the "Cargill unit," were common. Geographic areas with access to feed, transportation, and markets saw increases in the number of swine units, and concentration of swine populations began.

The mid-1970s brought the first reports of a "new," more severe form of the disease in swine called pseudorabies, also known as Aujeszky's disease.

Swine producers greeted this new disease threat in a variety of ways. The first response was apathy. Most producers thought it a temporary, short-lived phenomenon and believed that it would not create issues in their neighborhoods. The second response could be characterized as resignation. It seemed since nothing could be done about PRV, it would become just another disease to deal with. The third response was fear. As diagnostic testing became available, potential buyers avoided purchasing infected feeders or breeding stock. This changed everything for producers of breeding stock and feeder pigs. Loss of livelihood became a real possibility.

The late 1970s saw PRV begin to change the industry. Testing of breeding stock and clinical outbreaks of the disease demonstrated the increased incidence of PRV.

Producers were skeptical of how to control this new disease. The reliability of the diagnostic test was a concern. Initially, there was discussion over the interpretation of dilutions of the serum virus neutralization test. In some herds, pigs tested positive with low titers but had no signs of clinical disease. Faced with disease in their herds, owners had to decide to either wait for herd immunity to naturally control disease or attempt to test and remove infected animals from the herd. Several factors affected this decision. A number of States began to require health certification by a licensed, accredited veterinarian before pigs could move in interstate commerce. Other States began to impose quarantines and to restrict movement of pigs originating from herds testing positive for PRV. Producers could either live with infected herds or clean them up.

The 1980s continued the trend toward increased concentration of swine populations, and several new practices were begun to solve specific disease problems. Closed herds with shower-in-and-out procedures were tried. All-in, all-out production practices for buildings and sites began. Weaning pigs at an earlier age seemed to control diseases spread from breeding stock to offspring. Three-site (farrowing, nursery, finishing) production also addressed some disease issues. Controlling PRV through vaccination came to be routinely considered.

The development of an effective vaccine that prevented losses from abortions and piglet deaths solved many problems but created a few more. Depending on the situation, some producers changed their attitudes toward PRV. Commercial farrow-to-finish operators continued, as before, to live with PRV and accept losses. Seedstock and feeder pigs were not permitted to move interstate, if vaccinated. However, intrastate movement of vaccinated pigs was allowed in some States. Thus, for a seedstock producer, there was the dilemma of whether or not to vaccinate. There was no uniform, nationally-managed surveillance program. Some States had no evidence of the presence of PRV; others were quarantining any herd testing positive. To sell hogs for any purpose other than slaughter, owners had to eliminate the PRV virus from the herd.
Cost of the disease, vaccine expense, market restrictions, and even loss of markets drove the industry to consider eradication. Producers with PRV prob-

lems came to view the idea of eradication differently than producers whose swine were not affected by the disease. In general, producers not affected by movement restrictions and quarantine requirements quickly supported the idea of eradication. Owners of PRV-infected herds struggled to find tools to control the disease. In 1978, the industry had completed a successful campaign to eradicate hog cholera. The individuals who worked on that campaign were ready to embark on PRV eradication before tools were available to do the job.

# Chapter 2—Emergence of the Virus

## Coexistence, 1813–1960s

The first detailed account of the presence of what later was to be known as PRV in the United States was written in a notebook by a Dr. Hildreth, a physician living in Marietta, Ohio. He wrote in September 1813 about a case of "mad itch" in one of his client's cows. The description included the cow's rubbing its head, twitching its neck muscles, scratching, and mutilating itself. The cow died in agony 12 to 14 hours from the onset of clinical signs (see fig. 2.1).

Figure 2.1. A heifer exhibiting Mad Itch and central nervous signs caused by PRV. *(Photo by George W. Beran, R Allen Packer Heritage Room)*

Other stories describing similar clinical signs and outcomes appeared in farming and livestock magazines and journals throughout the last half of the 1800s. Some early articles described a common practice of raising hogs with cattle. Both species were eating common feedstuffs, such as cornstalks. The macerated, saliva-dampened cornstalks were blamed for transmitting the disease to cattle. This was the first indication that swine may have had some connection with the occurrence of PRV in cattle. At the turn of the century, science determined that swine were the reservoir host and the source of the disease affecting cattle.

To consider the record of emergence of PRV, turn to the early 1900s in Europe and note the first recognition of the disease in animals other than swine. In 1902, Aladar Aujeszky, a Hungarian, investigated a fatal disease affecting a bull, a cat, and a dog (see fig. 2.2).

Figure 2.2. A bust of Aladar Aujeszky in Budapest, Hungary. *(Photo by George W. Beran, R Allen Packer Heritage Room)*

He learned much about the cause of PRV infection by experimentally injecting rabbits, guinea pigs, and mice, and discerned that it was transmitted by direct contact or inhaling airborne infectious material. From his studies came the name "Aujeszky's disease," by which PRV is known internationally. "Mad itch" was the term then applied to the disease in cattle. It manifested by scratching and self-induced mutilation at the site where the agent had entered through penetrated skin or had contacted mucous membranes.

Although Aujeszky suspected the agent of the disease to be a virus, a German scientist named Schmiedhoffer first achieved passage through bacteria holding filters in 1910. A study that described experimentally transmitting the agent to swine was reported in 1914. U.S. researchers entered the picture in 1931, when, in Iowa, Shope isolated the virus from a cow and was able to cause paralytic disease in pigs inoculated subcutaneously with brain tissue. He demonstrated that virus was present in nasal secretions for several days. Shope learned much about the pathogenesis of the infection in swine. Acute clinical disease occurred

in baby pigs. All recovered swine, including older animals that experienced mild or inapparent infections, remained as carriers. Transmission among swine was recognized by aerosols or through milk, and from carrier swine to cattle by traumatic contact or, hypothetically, by rats as vectors. In 1933, Traub first propagated the virus in cell culture of rabbit brain and testicle.

In the United States, the name "pseudorabies" was given to the disease in cattle, due to similarities of the clinical manifestations to those of rabies.

The decade of the 1930s was mostly quiet on the PRV front in the United States. Reports came in more frequently from Asia, the United Kingdom, and South America about a highly fatal disease in young weaned pigs—clinical disease with abortions and stillborn pigs and some mortality in adult swine. By the end of the 1940s, PRV infection had been reported in pigs throughout the central and eastern countries of Europe. In the European reports, the disease primarily affected pigs from a few days to 1 month of age. Higher transmission and death rates occurred in younger animals. In older pigs, posterior leg incoordination, spasmodic muscular twitching, and convulsions were recorded. Among surviving pigs, all but those that exhibited the most severe symptoms demonstrated antibody titers.

In 1943, Ray, McNutt, and Packer in Iowa described two outbreaks in baby pigs, with mortality rates reaching 52 and 60 percent, respectively. Weaned pigs and sows in contact with or near the dying baby pigs remained clinically normal. A description of clinical disease in baby pigs included very rapid progression from normalcy to incoordination, progressive paralysis, prostration in less than an hour, and death ensuing within a few hours. In the U.S. experiences, PRV infections in older hogs were subclinical. Experimentally, adult swine were fatally infected following intracerebral inoculation.

Twenty-three lots of anti-hog-cholera serum produced in eastern Iowa, each representing approximately 125 hogs, were analyzed for antibody levels against PRV in guinea-pig neutralization test titrations. Of those 23 lots, 21 did have detectable PRV antibody titers, and all lots had antibodies against hog cholera virus.

In 1958, swine on a farm selling 1,400 pigs annually to a market in Missouri experienced acute central nervous system illness that included flaccid paralysis, coma, and a 38-percent mortality rate in 2 groups of new arrivals. Pseudorabies virus was recovered from brains of the affected pigs at necropsy. Experimentally, this virus reproduced a clinical disease indistinguishable from that of the encephalitic disease outbreak in the affected pigs. At least 20 pigs affected in the farm outbreak recovered, some additional pigs acted sluggish for a few days, and none of the other swine in the feedlots developed the clinical syndrome.

## History of Emergence of the Virulent Form of the Disease

In 1961 and 1962, Indiana herd owners began to report PRV outbreaks that were clinically and pathologically different from the occasional early outbreaks in this country. By the late 1960s, reports came from Illinois and other Midwestern States of acute clinical PRV outbreaks that were different, more like the outbreaks reported from Europe. Rapid intraherd spread and severe losses in suckling pigs, clinical illness with sequelae in grower pigs, reproductive disease in gilts and sows, and lesions observed at necropsy—particularly herpetic yellow-white foci of necrosis scattered through the spleen and liver—were described. This syndrome was different from the concept of PRV as an endemic, subclinical infection.

The more virulent form of PRV became an epidemic in the concentrated swine-raising areas of the United States during the early 1970s, and that experience

taught veterinarians a great deal about the epidemiology of PRV in swine. It was unclear whether this PRV represented an introduction of more virulent strains into the U.S. swine population, mutations and selection pressures taking place among the PRV strain(s) endemic in the United States, or that hog-raising systems were changing and affecting exposure and susceptibility of our swine. Differences among strains of the PRV virus were being recognized, both in pathogenesis and virulence. A general view prevailed that introduction of more-virulent strains into the country through importation of boar semen or by inadvertent human transport had occurred.

The first occurrence of the more-virulent, or "classical," PRV in Iowa was recognized in the northwestern part of the State in 1972–73. The next recognition was in Hardin County, in central Iowa, in 1973–74, followed in the same county by a second, very different episode in 1976–77. Spread of PRV in these two areas with high swine populations prior to widespread use of vaccines provided opportunities, however undesirable these opportunities were, to learn much about these now "classical" outbreaks. The areas were marked by no previous recognitions of clinical PRV, by only a few herds in which live or killed vaccines had been used, and by a large, highly susceptible swine population.

Every visit to a herd with PRV elicited the same, perfectly legitimate question: "Where did this come from?" Everyone, from producers through research scientists, was puzzled. Observant practitioners soon became painfully aware of so-called area spread, where the disease was observed to progress from farm to farm in an area of several square miles, more or less. Swine-industry and veterinary publications detailed the disease and its clinical characteristics. Pressures to control the disease were exerted through quarantine procedures and through concerns over liability for selling animals known or suspected of being infected with PRV. This overall situation created personal dilemmas where producers of feeder pigs or breeding stock had to choose whether they should call a veterinarian to confirm infection or wait until losses subsided and then continue sales. This seemed to be an easy choice until a young farm couple who were deeply in debt and needed income from sales of feeder pigs or breeding swine found themselves with this dilemma. These types of issues also led to the use of unlicensed vaccines.

# Chapter 3—Characteristics and Effects of the Virus

## The Virus

Pseudorabies virus, or PRV—the causative agent of Aujeszky's disease—is a double-stranded DNA, enveloped virus with icosahedral symmetry. It is classified as a member of the subfamily *Alphaherpesvirinae* within the family *Herpesviridae.* Characteristics of this subfamily include a wide host range, the ability to establish latent infections in sensory neurons, and a relatively short replication time and lysis of cells in culture. The virus can be propagated in a wide variety of cell lines, most commonly of kidney origin such as PK15, Vero, and MDBK cells derived from the pig, monkey, and bovine. The virus also replicates in chick embryo fibroblasts.

The virus appears spherical to slightly pleomorphic in negatively stained preparations, and varies in size from approximately 120 to 200 nanometers (nm) in diameter (see fig. 3.1). The viral genome has approximately 143 kilobasepairs (kbp). It is arranged linearly as a unique long (UL) and a unique short (US) sequence of nucleotides. The nucleocapsid (NC) measures approximately 100 to 110 nm in diameter and is composed of 162 capsomeres that include 12 pentons at the vertices of the capsid. With the exception of one penton, the capsomeres are composed of viral proteins, VP5 and VP26. The single penton is composed of multiple molecules of viral protein UL6 that form a hollow, cylindrical structure through which the virus genome is packaged during replication. The capsomeres are joined together by triplexes formed by one and two molecules of VP19c and VP23, respectively. Surrounding the NC is the tegument, which consists of at least 14 proteins including a transcription initiation factor, VP16 ($\alpha$TIF), and a protein *(vhs)* that facilitates the ability of the virus to take over the host cell machinery. The viral envelope is a lipid bilayer membrane derived from modified cell membranes. It contains at least 15

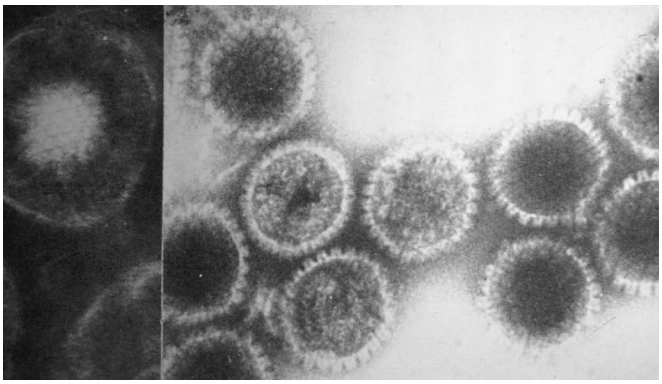


Figure 3.1. Electronmicrograph of Herpes virus.
*(Photo by George W. Beran, R Allen Packer Heritage Room)*

proteins, 11 of which are glycosylated. These proteins (with their currently accepted designations in parentheses) are gII (gB), gIII (gC), gp50 (gD), gI (gE), gX (gG), gH, gp63 (gI), gK, gL, gM, and gN and correspond to similar proteins of Herpes simplex virus 1 that affects humans. Of these, gB, gD, gH, and gL are essential for virus replication. Other glycoproteins such as gE, gI, the tegument protein US9, and the nonstructural protein thymidine kinase (TK) are nonessential, but their presence correlates with virulence. The proteins, gE, gI, and US9 are required for movement within the nervous system. TK is required for replication in nonmitotic cells, such as neurons. This information provided opportunity to genetically engineer a new vaccine strain that did not express gE or one or more nonessential proteins responsible for virulence. No longer expressing gE's superior antigenicity provided a means to introduce a marker to identify this attenuated strain. This finding proved to be invaluable for the PRV Eradication Program.

Pseudorabies viruses comprise a single serogroup. However, both vaccine and wild-type viruses can be differentiated into groups by using combinations of physical and biological markers (e.g., susceptibility to thermal and trypsin inactivation, efficiency of replication in alveolar macrophages, and virulence for mice, rabbits, chicks, and piglets). The use of such markers for epidemiologic, regulatory, and legal purposes is not

Figure 3.2. Raccoon found dead around a farm experiencing PRV infection in swine. *(Photo by George W. Beran, R Allen Packer Heritage Room)*

practical. Wild-type isolates and vaccine strains can be more definitely characterized by genomic differences as determined by restriction fragment length polymorphism (RFLP) alone or in combination with Southern blot hybridization using specifically designed DNA probes and reactivity to panels of monoclonal antibodies.

PRV is susceptible to inactivation by sodium hydroxide, bleach, iodine-based products, phenolic disinfectants, quaternary ammonium compounds, formaldehyde, and chlorhexadine. These disinfectants are not effective unless contaminated objects have been thoroughly cleaned before the disinfectants are applied. PRV is also susceptible to thermal inactivation.

## Replication

Attachment of PRV to susceptible cells is mediated primarily by gC and to a lesser extent by gB, both of which bind to heparan sulfate proteoglycans on the cell surface. Subsequently, gD binds to one of several cellular receptors represented by three different families of proteins. The critical role that these three glycoproteins play in infection makes them primary targets of the host's immune response. Subsequently, the NC gains entry into the cell by fusion of the viral envelope and the cytoplasmic membrane. This event is mediated by gB, gH, and gL. The NC moves along the cell microtubule network to the nucleus, where uncoating is completed and the viral genome is expressed. Assembly of the NC occurs in the nucleus. The tegument and the viral envelope are acquired as the NC moves from the nucleus to the Golgi apparatus. Enveloped virions are moved to the surface of the cell in vesicles and released. Infectious progeny virions can be detected about 8 to 10 hours after infection. PRV-infected cells generally survive for up to about 20 hours and can produce between 102 and 103 infectious virions.

## Host Range

The pig is the natural host of PRV. Feral swine are competent alternative hosts in certain environments; they will enter into transmission cycles through most of their range but may not perpetually maintain infection. Studies on the role of animals other then swine in the epidemiology of PRV were conducted through the 1970s and continued into the 1980s. All susceptible species were found to be aberrant hosts that did not independently maintain infection. On farms with infected swine and with cattle in direct contact or with cattle having access to exhaust fans from confinement swine units in cold weather, occasional bovine cases of mad itch in the former and encephalitic disease in the latter situations were all rapidly fatal. Sheep are highly susceptible to PRV by oral or inhalation exposure. Sheep in contact with infected swine actively shedding virus may act as inadvertent sentinels, experiencing rapidly fatal infections.

Cats are highly susceptible; dogs, raccoons, and skunks are moderately susceptible; and, rats and mice are moderately resistant to the infections (see fig. 3.2).

Exposure of these animals may be through scavenging PRV-infected swine carcasses, inhaling aerosolized virus, or ingesting contaminated feed or water. Incubation periods are typically less than 3 days. Clinical cases exhibit signs of encephalitis, with dogs also developing pruritis. Death ensues within 2 to 3 days.

Dogs may drag carcasses of infected swine from one production site to another, susceptible swine may eat carcasses of any of these animals, and rodents may unknowingly be milled in swine feed or transferred in bedding from an affected farm. Surveys of trapped wild animals in areas of infected swine have revealed no evidence for PRV infections to be maintained among raccoons, skunks, or opossums. Birds and insects have not been shown to enter transmission cycles, although houseflies experimentally fed PRV have retained viable virus in the gut with a half-life of 3 hours at ambient temperatures, and virus-contaminated flies have occasionally transmitted PRV through experimental corneal contact to swine.

Wildlife species, including mink, European brown bears, black bears, and a Florida panther, are susceptible to PRV. Humans and equine are not susceptible. The commonly accepted paradigm is that PRV is invariably fatal in susceptible species other than the natural host. However, naturally occurring PRV antibodies have been detected in raccoons and a 10-month-old black bear, suggesting that infection of these and possibly other species may not always be fatal.

## Transmission

PRV is transmitted most efficiently by direct contact between pigs. Infection by the aerosol route over short and long distances occurs, as does venereal transmission. PRV can also be transmitted by the oral route through ingestion of contaminated material (including water, milk from an infected sow, and other contaminated feedstuffs and contaminated carcasses).

Transmission by these routes is facilitated by resistance of PRV to inactivation outside the host. PRV is most stable in cool, moist environments at pH 7.0 ±1.0. It rapidly loses infectivity upon drying or exposure to ultraviolet light. For example, infectivity was lost within 2 hours when a virus suspension was allowed to dry on glass at temperatures of 14 to 37 °C at relative humidity of 30 to 40 percent. In contrast, PRV retains infectivity in swine saliva and nasal washings for several days. Similarly, PRV can remain infective for several hours when aerosolized. The half-life of infectivity ranges from 36 to 44 minutes at 22 °C and 4 °C, respectively at a relative humidity of 55 percent. Under these conditions, infectious virus would still be present 24 hours after aerosolizing a 1-mL suspension of PRV containing 106 plaque-forming units. PRV also retains infectivity in swine slurry, which can be an important source of contamination. Infectivity in undiluted slurry can persist for at least 3 days at 15 °C at a pH of 6.5, and for at least 23 days at 4 to 15 °C at pH 6.8 when diluted with water for storage. The virus can also survive in well water for 7 days and in sewage lagoon water for 2 days.

Transmission of PRV between herds and among animals, other than by direct animal contact, is primarily by air, water, and contaminated fomites. Airborne movement of PRV has been attributed to short-distance transmission between production buildings and transportation vehicles. During major atmospheric events, virus may be moved several miles. Despite the rapid inactivation of PRV by sunlight or drying, or dispersal of virus suspensions, droplet nuclei may transport infectious doses over both time and distance. The virus is quite unstable at pH levels below 4.3 or above 9.7, or at temperatures that fluctuate above and below freezing. Experimentally, PRV suspended in porcine saliva survived less than 1 day on denim cloth or alfalfa hay and in pit effluent; 2 days on rubber, green grass, meat and bone meal, and sawdust bedding and in chlorinated water and anaerobic lagoon effluent; and, 3 to 7 days on plastic, steel, concrete, shelled corn, pelleted hog feed, straw bedding, and in well water at ambient temperature.

The incubation period is commonly 2 to 5 days, with nasal and oral excretion and, in adult swine, vaginal, preputial, and/or milk secretion coincident or just preceding any primary symptoms. Lifelong latent infec-

tion commonly follows clinical recovery or inapparent infection, with the virus remaining in trigeminal ganglia and tonsils. Recrudescence, or breaking out again after a temporary suppression by latently infected swine, follows stress of subsequent disease, farrowing, crowding, mingling with unfamiliar animals, or transport. Shedding in primary infection persists for 1 to 3 weeks and in recrudescence for 3 to 4 days. Long-term or recrudescent shedding is a common source of viral transmission into previously uninfected herds or portions of herds (see "Latency" in this chapter).

Typically, PRV enters into susceptible swine via the nasal mucosa (when they inhale the virus), or via tonsils or oral/digestive-tract mucosa (when they ingest the virus). Virus-contaminated semen may infect gilts and sows during breeding. Transmission of virus to embryos does not take place during early gestation, but fetuses may be infected in utero, with outcomes dependent on the stage of gestation.

Vaccinated swine resist higher doses of virus than unvaccinated swine exposed to the virus. Vaccinates are protected against clinical disease. If infected, they do not transmit the virus transplacentally, and they shed fewer virions and for less overall time than nonvaccinates. Infected, vaccinated swine still develop latent infections and still recrudesce, shedding virulent virus.

The epidemiology of PRV is changed by vaccination. Viral levels are lowered in air and on fomites in infected production units. Both intra- and interherd transmission is reduced, and total herd losses are greatly reduced in infected herds. Recognition of infected herds or individual animals by clinical histories is masked by vaccination, and case finding through serology becomes less certain.

## Latency

One of several concerns relative to a successful PRV Eradication Program was the known ability of PRV to establish latency in infected pigs—with the potential for subsequent virus reactivation and dissemination. It was clear that this issue would be particularly troubling if latent infections were common in clinically recovered pigs, and if such pigs eventually presented no easily discernable evidence of prior exposure, such as diagnostic levels of antibody. To circumvent this problem, the program was designed to minimize the impact latency might have on its success by simply considering that any pig that survived a known or suspected exposure to PRV was potentially a latently infected carrier. By taking this cautious approach, there was no definitive evidence that latency markedly impeded the program's progress. However, latency was never a forgotten issue, and its practical implications continued to be actively researched.

Several studies were performed to simulate latency and reactivation, but results may not have always paralleled the natural situation. For example, pigs were often exposed to a very high dose of virus to establish infection and latency or were subsequently treated with extremely high doses of corticosteroids to cause reactivation. Usually, both these scenarios prevailed. Moreover, the possibility of dissemination of reactivated virus was often assumed on the basis of detecting PRV from nasal or tonsil swabs collected from the pigs in question rather than by direct contact.

Other studies suggested that latency is a common, if not certain, consequence of infection in pigs with virulent field strains of PRV. The frequency of latency following exposure to avirulent or low-virulence strains, such as those that comprise modified-live-virus vaccines, is less clear. In such cases, it may be that reactivation to a level that can be detected either by virus isolation in vitro, or by transmission to susceptible pigs, is infrequent. Moreover, preexisting levels of circulating antibodies against PRV, whether actively or passively acquired, do not necessarily preclude the establishment of latency following exposure to virulent field virus. In fact, in at least one study in which

vaccinated pigs were subsequently challenged, both vaccine and virulent virus were later isolated following reactivation with corticosteroid treatments.

The time between administration of the stressor responsible for reactivation (usually high doses of corticosteroids) and the isolation of reactivated PRV from nasal swabs can be as short as a single day to as long as 11 days and possibly longer. Factors affecting these differences in time under controlled experimental conditions are unclear but may stem from host differences such as age, breed, and health status, as well as other variables such as virus virulence, the dose of virus administered to establish infection and latency, the dose of whatever is selected to cause reactivation, and the length of time that is allowed to elapse between acute infection and attempted reactivation. [As an aside, the shorter times detected experimentally may offer one explanation as to why dogs are sometimes fatally infected with PRV by encounters with feral swine pursued intermittently over an interval of a few days during hunting season.]

A single study in which pigs were vaccinated with attenuated PRV vaccine, later exposed to virulent PRV (challenged), and still later either treated with dexamethasone or again exposed to a large dose of virulent PRV serves to concisely illustrate many of the features of latency and reactivation of PRV in pigs. On the basis of virus shedding, pigs that had previously been vaccinated and challenged were relatively resistant to yet another exogenous exposure to virulent virus. In contrast, pigs that were initially treated the same (i.e., vaccinated and challenged) but that, instead of a second exposure to virulent PRV, were treated with dexamethasone, shed more virus for a longer time. A possible explanation is that stress (as mimicked in the study by treatment with dexamethasone) not only resulted in PRV reactivation but also adversely affected the ability of the pig's immune system to control this virus. Note also that following reactivation, a high concentration of virus was isolated from the nasal cavity (nasal mucosa)—a site that would likely predispose the pig to aerosol dissemination and area spread of the virus.

## Immunity

Well before the official beginning of the PRV Eradication Program in the United States, it had been established that immunity—whether actively acquired (through vaccination or natural exposure) or passively acquired (through ingestion of antibody in colostrum)—could provide protection for the pig from becoming infected or could reduce the severity of clinical signs. Moreover, preexisting antibody, likely in concert with cell-mediated immunity, was known to markedly reduce the magnitude and duration of virus replication (and thus, indirectly, shedding) following exposure or re-exposure to virulent virus.

Numerous studies had indicated that successful vaccination of young pigs was likely to provide adequate clinical protection for at least several months and typically until at least market age. Additional vaccinations were useful in maintaining, and even boosting, immunity in swine added to the breeding herd. The degree and duration of clinical protection provided by passively (colostrally) acquired immunity was more variable and was directly related to the amount of antibody ingested and absorbed by the neonatal pig. The amount of antibody ingested was, in turn, determined mainly by the antibody level of the pig's dam at the time of farrowing.

The positive aspect of passively acquired antibody is that it provides early protection for the otherwise highly susceptible young pig. As an adjunct to the eradication program this early, albeit transient, protection provides an opportunity to move young pigs to a virus-free environment (often referred to as offspring segregation) while they are relatively resistant to infection and unlikely to have already become virus carriers. The negative aspect is that passively acquired anti-

body interferes with the effectiveness of vaccination. Consequently, to help ensure successful vaccination of young pigs, it is important to determine (typically by serologic testing) when passively acquired antibody has waned.

Unfortunately, neither vaccine-induced, actively acquired immunity nor passively acquired immunity ensures the absence of virus replication following exposure to virulent virus. Continued replication of the virus predisposes the pig to latency with the potential for subsequent reactivation and shedding (see "Latency"). Vaccine-induced immunity also had the potential to complicate the detection of latently infected carriers. The most useful and reliable method for identifying past exposure to PRV, namely the detection of antibody in serum of the pig in question, could mean that the pig had been vaccinated or had recovered from infection with virulent virus, or both. In the latter two instances, the seropositive pig was a potential carrier and shedder of virulent PRV. Therefore, what was needed was a test that would recognize past exposure to virulent virus regardless of vaccination history.

Just such a test was developed and used during the program on the basis of an astute observation made in the late 1980s by J. T. Van Oirschot and his colleagues at the Institute for Animal Science and Health, Lelystad, the Netherlands. They noticed that a protein gel prepared from an attenuated vaccine strain of PRV was missing a band (protein) that was present in gels prepared from virulent strains of PRV. Van Oirschot's team immediately recognized the practical implication of their observation. If:

(1) All virulent strains coded for the protein in question, namely gE;

(2) All pigs infected with virulent PRV had an immune (humoral antibody) response to gE;

(3) Antibody for gE persisted in the serum of pigs exposed to virulent PRV long after exposure; and,

(4) An economical, reliable test could be developed to specifically identify serum antibody for gE, then there would always be a marker for exposure to virulent virus. The existence of such a marker can be counted on only if the vaccines used to induce immunity were restricted to those from which gE is absent.

Following the report of a naturally occurring "deletion-mutant" strain of PRV by Van Oirschot et al.—a strain that apparently had been altered genetically by repeated passage in vitro after its initial isolation from a pig—there was a flurry of activity in both commercial and public research laboratories to identify or create (by genetic engineering) additional deletion-mutant, attenuated strains and complementary diagnostic tests. Although the concept of a marker vaccine seemed simple enough, only nonessential viral proteins, i.e., proteins that did not have a necessary role in virus replication, were likely candidates for deletion. Also, the requirement that the selected protein(s) had to be highly antigenic, so as to stimulate a measurable and persistent antibody response, presented a challenge.

Despite such restrictions, several research groups were successful. However, with this success came the question of which genre of deletion-mutant vaccines and complementary tests would be the most reliable for use in the program. Vaccines with deletions of all or part of gE, gC, or gG (all of which are nonessential proteins) became the primary candidates. But clearly, unless the type of vaccine used were known for every vaccinated pig in question, testing would be complicated and results potentially misleading.

The choice was eventually made by a committee of the Livestock Conservation Institute joining with the technical advisory group, at least in part, on the basis

of a 1991 report of a study completed at the University of Nebraska. The investigators tested sera from feral swine so that there would be little or no chance of the swine having been vaccinated or in some other way exposed to vaccine virus. The sera were first examined by a highly sensitive latex agglutination test that provided a serologic answer as to whether the donor pig had been naturally exposed to virulent PRV. Aliquots of the same sera were next examined by ELISAs specific for gE, gC, or gG. Although the results of latex agglutination and ELISA did not correlate perfectly, there was a very close association between the results of latex agglutination and those of the gE and gC ELISAs. The association was somewhat less close for the results of latex agglutination and those of the gG ELISAs. Shortly thereafter, the members of these two committees decided that all attenuated vaccines used in the program would be compatible with the gE ELISA.

## Epidemiology

The following excerpts describe by example the clinical manifestations affecting animals when PRV is first introduced into a susceptible population. The first epidemic was a clinically devastating epidemic of what became the classical form of PRV. This epidemic spread over a 16-month period in three interrelated, geographically defined areas. There is strong epidemiologic evidence that the virus was introduced into each area through carrier swine.

In the first area, the disease started with a morbidity of 22 percent in the apparently susceptible portion of a mixed lot of feeder pigs. When the infection spread to resident pigs on another premises operated by the same owner, morbidity exceeded 93 percent. Apparently, the virus was introduced into the second area by sows brought in from an infected farm located in area number one. The virus was then inadvertently introduced into the third area by carrier boars.

Investigators from Iowa State University (ISU) followed the epidemiology of the spread of PRV within the area. Except for movement of pigs between premises of the same owners, there were no movements of swine among farms involved in the epidemic. In area number one, only 11 farm outbreaks were recorded among 75 farms that had swine. It was determined that one farm had PRV-infected pigs, but the disease was not recognized clinically. Strong evidence indicated that where serologically negative breeding animals were mingled with serologically positive convalescent sows or boars, clinical disease did not appear in the susceptible stock until times of stress by transport, farrowing, or lactation.

The same ISU investigators followed the role of dogs, cats, and wildlife in the epidemiology of these farm outbreaks. Dogs were the most commonly diagnosed as infected. They were present on 11 of the 12 farms with swine plus one nonfarm residence. PRV-infected dogs were reported on five farms with swine cases, on one farm with no swine cases, and on the single nonfarm residence. In all seven instances, the dogs involved had access to or had been observed eating carcasses of dead pigs or placentas of infected sows. All dog cases occurred at the same time as swine cases, and all were fatal. There was no evidence that dogs may have transmitted the virus to swine or to other dogs.

Cats were present on all farms involved, and investigators suspected that they had died from the disease on six farms. Two of three carcasses submitted for laboratory examination were confirmed to have PRV. One confirmed and one suspected case in cats occurred on these farms 1 to 3 weeks before the appearance of PRV in swine.

Farm operators reported suspected cases in seven skunks found dead in or near a hog pasture at the same time as the swine cases, and in six raccoons

found sick or dead in or near hog lots during the swine cases or, in one instance, 1 week before the appearance of PRV in the swine. The single raccoon carcass submitted for laboratory diagnosis was positive for PRV.

In swine, once the clinical disease appeared on a farm, it spread through the herd within 5 days to 4 weeks. Serological studies on such herds indicated that 100 percent of the animals were infected.

The second epidemic was identified as involving three farms on which PRV was characterized by entirely subclinical infections. Epidemiologic evidence suggested that the virus was introduced through participation in exhibitions in August and early in September 1976. One serologically positive boar was recognized in October; it had been sold to a farm not in a PRV-infected area. The presence of the infection on the three study farms was monitored serologically by the investigators in Iowa.

The viral infections exhibited unique and similar characteristics on the three study farms:

(1) Infection by this strain was entirely subclinical. The swine involved were initially serologically negative and, though swine of all ages and in all stages of gestation, farrowing, and lactation were present on all three farms, no clinical or pathological evidence of infection was found.

(2) The spread of the strain through the herds was relatively slow.

(3) Serological titers in convalescent animals were relatively low, with an average serum virus neutralization titer of 1:12 in breeding stock.

(4) Serological titers decreased relatively rapidly, and some decayed below detectable levels. Among 118 animals tested in February and March, 68 titers remained constant, none increased, and 23 decreased, with 20 of those going from positive to negative.

(5) There was no evidence of transmission involving animals other than swine on the three farms.

(6) Finally, on one farm where serologically negative pigs were being moved to a separate premises following weaning, pigs of serologically positive dams were found to have lost their maternally acquired antibodies by 6 to 8 weeks of age.

A total of 194 weaned pigs transferred to the second premises remained serologically negative at 4 months of age. Ten of these that were brought into a laboratory isolation unit and subjected to physical and drug stressing for 5 days remained serologically and virologically negative through 2 weeks of monitoring.

Epidemiologic studies continued on individual farm outbreaks. Investigators evaluated the animal hosts, the variation in the herpes virus causing the infections, and the environment helping to add information about the epidemiology of PRV and reported:

(1) Slow transmission of the virus through dispersed outdoor herds led to low-exposure doses of environmentally attenuated virus with inapparent and incomplete herd infections.

(2) In large, concentrated swine populations in enclosed environments, infected swine excreted high levels of virus that moved rapidly along airflow patterns in the confinement units, changing the strain selection pressure to the more rapidly infecting and excreted viruses.

Figure 3.3. Suckling piglets dying from PRV.
*(Photo by George W. Beran, R Allen Packer Heritage Room)*

(3) The discontinuation of the use of anti-hog-cholera serum containing PRV antibodies no longer provided passive protection to young pigs.

(4) Rapid dispersal of virus strains occurred due to movement of nonclinical, infected swine with stress-induced shedding of virus. These swine came to be recognized as new sources of virus.

## Clinical Signs

The first clinical appearance of PRV in a herd was frequently rough-haired, listless neonatal pigs less than 3 weeks old that stopped sucking, developed central nervous system signs, and died within 24 to 36 hours, with litter mortality rates of 90 percent or higher (see fig. 3.3).

In other herds, PRV first appeared clinically in the breeding herd, with gestating sows and gilts aborting or farrowing stillborn or weak pigs that often died within a day or two. Respiratory disease, listlessness, and lack of appetite for 3 or more days often accompanied the reproductive failures or were the only clinical signs observed. In open breeding stock, observers noted failure to conceive, or in early gestation, resorption of fetuses and return to estrus. During the course of farm outbreaks, weaned pigs frequently went through clinical disease with listlessness, anorexia, rhinitis, dyspnea, and severe cough, with full recovery within 1 week. However, pigs that exhibited some neurological signs usually had other sequelae develop. In grower–finisher swine, observers often noted depression, anorexia, and mild to severe respiratory disease with weight loss, but with rapid recovery. In herds harboring clinically inapparent *Actinobacillus pleuropneumoniae* or *Pasteurella multocida* in older pigs or breeding stock, infection with PRV occasionally resulted in exacerbated or synergistic clinical pleuropneumonia or pasteurellosis.

## Pathology

At first, practitioners and diagnosticians noted that it was rare to find gross lesions in PRV-infected pigs. However, they soon discovered that some piglets had grossly visible lesions, so they learned to necropsy multiple piglets that had died to aid in making the diagnosis.

Grossly visible lesions in a few piglets may have included any one or all of the following lesion descriptions:

(1) Tonsillar inflammation that could be observed as fibrinous exudate or an erosive fibrinonecrotic lesion.

(2) Small (<1 mm), pale foci in liver and/or spleen. These small lesions tended to have slightly irregular or vague edges, not a crisp, well-demarcated appearance.

(3) Reddened foci were scattered on the pleura of the lungs.

Microscopic lesions included diffuse nonsuppurative encephalitis, which was consistently present and observed as perivascular cuffing and neuronal de-

generation. Inclusion bodies were generally sparse in the brain. There was often ganglioneuritis, prompting diagnosticians to harvest cranial nerve ganglia for histopathology and virus identification. Careful observation also disclosed small, necrotic foci in liver and spleen with a few degenerate cells. These were often accompanied by cells at the periphery that had a few intranuclear inclusion bodies of varying clarity. Some pathologists seemed to see this much easier than others. Focal to more generalized necrosis was observed in tonsils.

In addition to observing gross and microscopic lesions, a definitive diagnosis of PRV also depended on detection of the presence of the virus. One of the earliest diagnostic methods injected small amounts of tissue extract from affected piglets subcutaneously over the back near the dorsal midline of rabbits. This system was very sensitive, allowing only a few virus particles to lead to intense pruritus causing the rabbit to scratch the area. At this point, the rabbits were quickly euthanized.

Sensitive cell-culture systems soon became available for PRV isolation. More-rapid techniques (e.g., fluorescent antibody staining) evolved to speed the diagnostic process and accommodate the volume of submissions.

# Chapter 4—Early Attempts at Control

## Quarantines

Outbreaks of PRV causing extensive losses in Iowa, Indiana, and in two adjoining large herds in Illinois prompted formation in early 1975 of an Illinois task force and a call for a national symposium on the disease. The symposium was held prior to the annual meeting of the Livestock Conservation Institute (LCI, now National Institute for Animal Agriculture) in Peoria, Illnois, in the spring of 1975. It was reported at the symposium that 6,200 blood samples collected from Illinois packing plants yielded 139 positive results for PRV (2 percent), which were traced back to 43 herds. The symposium, attended by 150 to 200 pork producers, veterinarians, and regulatory officials, resulted in demands by producers that herds found to be infected with the disease be quarantined. Dr. Paul Doby, Illinois State Veterinarian, was joined by regulatory officials from other States who warned of problems with quarantines, especially with the lack of a method for lifting such quarantines.

The board of directors of the Illinois Pork Producers Association, meeting the next day, called for PRV quarantines, and Dr. Doby announced that a quarantine program would be started. The Illinois Pork group also called on LCI to form a standing committee on PRV. This idea was approved by the LCI board the next day.

## Antiserum Field Trials

**Illinois**

Several actions were taken by the Illinois Department of Agriculture and persons interested in the swine industry to address measures to combat the losses from this disease. One of these actions was proposed by the University of Illinois, College of Veterinary Medicine. The idea conceived that a hyperimmune antiserum collected from an infected herd, when given to piglets less than 2 days old, might protect them. The College developed a protocol for the project. If funded, Illinois officials would explore the possibility of developing a serum bank of hyperimmune PRV antiserum in an effort to provide some method of treatment aimed at reducing losses from this disease.

The study was financed ($25,000) by the Illinois Pork Producers Association, and a laboratory in Cary, Illinois, was contracted to harvest and process the serum. About 12 sows from 1 of the infected herds in the Beardstown, Illinois, area were used for the serum production.

The antiserum project culminated in the production of 50 L of hyperimmune PRV antiserum. Field trials were set up following this protocol: half the pigs in a litter would receive 5 mL of serum injected subcutaneously, and the remaining pigs would serve as controls. Illinois Department of Agriculture personnel spent considerable time working with owners of infected swine and quarantined premises, in distribution, administration, data collection, and tabulation of the antiserum trials. The study demonstrated nearly a 28-percent reduction in death losses; however, it proved not to be economically feasible.

**Iowa**

Because it could be used in the face of an outbreak, antiserum was considered a method of combating PRV. Field reports of the efficacy of antiserum were made more logical by the fact that pigs used as sources of hog cholera antiserum had usually been exposed to PRV, which was common in swine populations although in a nonclinical form.

Early attempts at antiserum production in one effort at ISU involved hyperimmunization of sows with three or four injections of live virus. The method then involved anesthetizing the sows during which time blood was drawn. Serum was harvested by simple clotting and centrifugation.

Studies at ISU were supported by a small grant from several producers whose facilities also served as test sites. Early attempts at immunizing newborn pigs in the face of an outbreak were marginally successful. Then, an experienced vaccine company representative suggested that injecting half a litter and leaving half the litter as controls might result in the controls experiencing virus replication and shedding, thus negating any protection afforded from antiserum in the vaccinated pigs. The advice was applied, and antiserum was soon demonstrated to be very protective if used in all pigs in a litter, or better yet, in several adjacent litters.

Antiserum proved to be an effective preventative that ultimately failed because of at least two factors: (1) Commercial companies questioned the economics of development and production and generally chose instead to focus on vaccine development, and (2) There was general concern about trying to license a product that might contain extraneous viruses, and no practical method of sterilization was identified.

# Chapter 5—Vaccines Diagnostics and Licensing

## History

In the early 1970s, using the tests available at the time, veterinary diagnosticians detected active PRV infection on the basis of gross and microscopic lesions, virus isolation, and the fluorescent antibody (FA) test on tissues.

As the disease spread, the need for biological control and diagnostic tests, both for antigen and antibody detection, became urgent. In particular, large numbers of serum samples needed to be tested rapidly for diagnostic, regulatory, and eradication purposes. The only serological test available was the serum virus neutralization (SVN) test, a test requiring a 3-day start-to-finish interval.

The first improvement in serological assays was the miniaturization of the SVN test using a 96-well plate, resulting in what became the gold standard, the microtitration SVN test. The test was considered to possess good sensitivity and specificity, plus it allowed for quantification of antibody using a twofold dilution scheme. However, the microtitration SVN test was still time and labor intensive. In particular, it required microscopic reading of individual reactions, which limited the number of samples that could be tested each day.

The next major improvement was the "screening" ELISA, licensed by IDEXX Laboratories Inc., Westbrook, Maine, in 1986 (HerdChek®; Anti-PRV). The ELISA soon replaced the SVN test for screening large quantities of serum samples for PRV antibodies. Using the ELISA significantly reduced the start-to-finish interval and increased laboratory throughput because it was not necessary to titrate serum samples, the reaction was rapid, and the results were read and interpreted by machine.

As PRV vaccines were developed and began to be used widely in the swine population, it became necessary to distinguish PRV-vaccinated swine from PRV-infected swine. The SVN and screening ELISA tests detected anti-PRV antibodies but could not differentiate antibodies produced by PRV vaccination from antibodies produced in response to PRV infection. Initially, diagnosticians and regulatory officials attempted to differentiate vaccinated from infected swine on the basis of SVN antibody titers on the assumption that infection with field virus produced a stronger humoral response than vaccination. Using that approach, antibody titers less than or equal to 1:16 were considered to be the result of vaccination and not infection. As in any biological system, the variation in the antibody response among individual pigs, especially in swine vaccinated multiple times, meant that many animals and herds were misidentified as infected or not infected. Although somewhat clinically useful, the method was unacceptable as the basis for regulatory decisions, such as interstate shipment of swine and other regulatory issues.

As PRV continued to spread through the U.S. swine population, the need for biological control became essential. Norden Laboratories (Lincoln, Nebraska) licensed the first conventional, commercial modified-live vaccine (MLV) and inactivated PRV vaccine in 1977. In general, MLV PRV vaccines became the most widely used because the immunological response and the resulting protection provided were better than those provided by the inactivated PRV vaccine.

The MLV PRV vaccines and the subsequent second-generation gene-deleted vaccines were quite effective in reducing or preventing clinical signs of PRV. Pseudorabies MLV-vaccinated swine subsequently infected with field-strain PRV had less viral invasion of tissues, and pregnant dams did not transmit the virus to their fetuses. Thus, the vaccine prevented abortions. PRV-vaccinated swine also shed at least a thousandfold

less virus when infected with field-strain PRV. This reduction in shedding was of paramount importance in the eradication of PRV. Some MLV PRV vaccines colonized the tissue primarily involved in latent infection (trigeminal ganglia), thus blocking the establishment of latency by a superinfecting challenge of field-strain PRV.

## Development of Vaccines and Diagnostics

Private-sector corporations developed and APHIS' CVB unit licensed several gene-deleted PRV vaccines for use in swine. The first such vaccine with a companion differential serological diagnostic test was licensed in 1988, a year before the PRV National Eradication Program began. The vaccine virus had a gX (gG) glycoprotein deletion and was manufactured by SyntroVet, Inc. (Lenexa, KS). This vaccine's companion ELISA serological diagnostic test was manufactured by IDEXX Laboratories (HerdChek®; Anti-PRV -gpX). Several producers commented that this vaccine, "Marker Blue," proved highly protective when administered to swine located in the swine-dense areas of North Carolina. One year later, the Upjohn Company (Kalamazoo, MI) licensed a gG-deleted vaccine (Tolvid®) with a companion differential diagnostic serology test. Both of these vaccines were highly efficacious, but the companion diagnostic tests lacked the desired sensitivity.

Table 5.1 identifies the various PRV vaccines, the companion differential diagnostic tests, their manufacturers, and the strain of PRV used.

**Table 5.1–PRV vaccines and companion differential diagnostic**

| Vaccine | Manufacturer | Strain | Deletion | Differential test availability |
|---|---|---|---|---|
| Bio-Ceutic PRV® (MLV) | Boehringer Ingelheim | Bartha | gI | HerdChek® Anti-PRV-gI (IDEXX) |
| OmniMark™ (MLV) | Tech America Fermenta A.H. | Bucharest | TK-, gIII | Diasystems™ OmniMarkTM PRV (gIII) |
| PR-Vac® (MLV) | SmithKline Beecham Norden Laboratories | Bucharest | gI | ClinEase-PRV® |
| PR-Vac® (inactivated) | SmithKline Beecham Norden Laboratories | Bucharest | gI | ClinEase-PRV® |
| PRV /Marker® (MLV) | SyntroVet Inc | Iowa S-62 | TK-, gX | Anti-PRV-gX-Herd-Chek® (IDEXX) |
| PRV/Marker KV® (inactivated) | SyntroVet Inc | Iowa S-62 | gX | Anti-PRV-gX-Herd-Chek® (IDEXX) |
| PRV/Marker Gold™ (MLV) | SyntroVet Inc | | TK-, gX, gI | HerdChek® Anti-PRV-gX or Anti-PRV-gI (IDEXX) |
| Tolvid® (MLV) | The Upjohn Co | Rice | TK-, gX | Anti-PRV- gX-Tolvid Diagnostic® (AGDIA) |

See Glossary of Terms and Abbreviations: gI = gE, gIII = gC, gX = gG. MLV = modified live vaccine.

In 1990, SyntroVet and IDEXX again collaborated and marketed a new vaccine based on a virus with a gI (gE) glycoprotein deletion (SyntroVet PRV /Marker Gold®) and a companion differential ELISA diagnostic serology test (HerdChek®; Anti-PRV -gI). Like the first gene-deleted vaccine, Marker Gold demonstrated excellent efficacy in the field, and its companion differential serology test had markedly improved sensitivity and specificity.

Two other biologics companies developed gE-deleted vaccines. Norden Laboratories PR-Vac® had a natural gE deletion, and SmithKline Beecham, who purchased Norden Laboratories, developed and marketed Clin-Ease-PRV® in 1990, a companion differential diagnostic serology test. Boehringer Ingelheim's PRV vaccine, BioCeutic®, was licensed with the IDEXX HerdChek®; Anti-PRV -gI companion diagnostic test.

During the U.S. eradication program, PR-Vac and PRV/Marker Gold were the most widely used PRV vaccines and the IDEXX HerdChek Anti-PRV -gI ELISA became the "standard" differential serology test used to define swine and/or swine herds as PRV vaccinated or PRV infected. While the Tolvid vaccine was very efficacious, the lack of sensitivity of the companion gG differential serology test limited its use. In addition, its gG deletion was a disadvantage at a time when there was a strong movement to standardize the use of the gE-deleted technology. That is, the use of both gG- and gE-deleted vaccines in a population of swine would cause confusion, because swine vaccinated with a gG-deleted vaccine would have antibody against the gE glycoprotein and thus would incorrectly identify a herd as infected rather than vaccinated when tested with a gE serologic assay. And the reverse, gE-deleted vaccinated swine tested on a gG ELISA, would also result in an incorrect diagnosis. Thus, the standardization of a universal gene deletion for all PRV vaccines was imperative for the success of the PRV Eradication Program. Had a universally accepted consensus about which gene to delete from PRV vaccines not been reached by the industry, serological surveillance would have been impossible. The agreement to standardize gene-deleted vaccines to have at least the gene expressing gE deleted began in 1993.

Several other serological tests were also developed for the detection of PRV antibody. The particle concentration fluorescence immunoassay (PCFIA) and the automated latex agglutination (ALA) test were both used extensively in high-volume diagnostic laboratories. Like the ELISA, these two tests were automated, required only hours to run, and offered excellent sensitivity and specificity. The ALA continues to be used as a screening PRV antibody test in some laboratories. Biologics manufacturers developed other serological assays (e.g., complement-fixation, immunodiffusion, countercurrent immunoelectrophoresis, and indirect immunofluorescence), but all had limitations of sensitivity and/or long laboratory start-to-finish times or were difficult to perform.

On November 3, 2005, CVB licensed IDEXX Laboratories' new blocking, ELISA–PRV screening test based on the gII (gB) glycoprotein. This test has replaced the HerdChek Anti-PRV screening test and has a reported sensitivity and specificity of 99.5 percent.

The PRV Eradication Program owes a great deal of its success to the scientists and diagnosticians who developed the highly efficacious PRV vaccines and their companion differential serological tests. Without these technologies, the eradication program, as we know it, would not have existed.

## Field Applications of This Technology

Implementing the practical use of the differential test was a formidable teaching and mentoring activity for the veterinary profession practicing swine medicine. First, veterinarians had to learn the basic theory of why a differential test was possible. Second, producers had to be convinced this new testing concept was valid. Previous experience had suggested that most of the vaccines already in use were efficacious at preventing the clinical disease in vaccinated pigs.

There was intense competition among scientists and animal health companies to research, develop, and patent the differential vaccines. This competition allowed for more than one type of gene-deletion to be licensed and sold in the marketplace. The companies developing these vaccines had to collaborate with companies manufacturing animal diagnostic tests as few vaccine developers had the necessary business assets to produce both a licensed vaccine and the complementary diagnostic test.

Early on in PRV eradication, some veterinarians were using more than one type of PRV vaccine in the same herd. Additionally, there were vaccines for PRV that were either not differentiable or the complementary tests had not been developed. Herd owners using vaccines with different gene-deletions and having insufficient records found themselves unable to interpret test results correctly and therefore know the status of their herds.

Initially, the producers and veterinarians had expected test kits to be 100 percent sensitive and specific; however, experiences under field conditions demonstrated they were not. Furthermore, there was some variation in results among different kit serials, and some variation was due to nonspecific reactions obvious only after thousands of samples had been tested. Sorting out the many reasons for conflicting test results was, at times, difficult for diagnosticians, practicing veterinarians and regulatory officials. These variations proved problematic and provided a rationale for the refusal of a few producers and veterinarians to adopt this new technology fully in the beginning.

## Progress in Small Steps

Pioneers in understanding and applying this technology to successful herd cleanup plans were often criticized. They often owned the herds themselves and used their own herds to demonstrate the utility of the vaccines paired with the complementary diagnostic tests. There were many experiences of two steps forward and one step back in the learning process. Swine industry leaders convened forums and had discussions about the successes and the failures in the application of this technology. Complicating these discussions were the competing scientists and animal health companies, each espousing their technological advantages. Field cases were regularly reported and debated at these forums.

Reports of successes began to circulate within the swine industry, and even the critics began to take note of the progress being made. As testing technology evolved and the sensitivity and specificity of each test was improved, the ability to evaluate herd cleanup plans was enhanced. As use of these products in the field increased, they began to demonstrate which technologies had the best combination of both disease prevention (vaccine) and testing accuracy (diagnostics). These winning technologies were becoming the preferential choice in the swine industry.

**Case-by-Case Accomplishments**

There were many examples of individual herd cleanup accomplishments. It was common to document the steps needed to attain these accomplishments in a written plan called the herd-cleanup plan. The process can be better understood by working through an actual example with a PRV-infected herd:

**(1) Initial Contact—**The herd's attending veterinarian contacted the vaccine company's technical services (TS) veterinarian to come and collaborate on a herd that was not eliminating PRV in as progressive a manner as expected.

**(2) Field Visit—**The TS veterinarian and the attending veterinarian reviewed the results of blood tests and the brand names of PRV vaccines used in the herd.

**(3) Analysis—**The TS and attending veterinarians determined that two brands of PRV vaccines containing dissimilar gene-deletions had been used in the past 4 years, and some older animals in the herd probably had been given both brands of vaccines. Only one vaccine had been used in the last 2 years. The herd was also infected with PRV.

**(4) Farm Visit—**During a farm visit, the TS and attending veterinarians observed the animal husbandry practices in use. The vets also reviewed vaccination records and animal identification integrity.

**(5) Initial Plan of Action—**The herd managers identified all animals older than 2 years of age and sold them for slaughter after their next litter had been weaned.

**(6) Herd Revaccination—**The entire herd was assessed to ensure that all animals had been vaccinated in the last 90 days. Managers also sold animals without identification for slaughter.

**(7) Testing and Selecting Test-Negative Animals—**All animals under 2 years of age and older than 3 months were tested to determine the serological status of field virus infection. If an animal tested positive for field virus, it was sold for slaughter as soon as practical. Seropositive animals were not mated. Managers took aggressive steps to remove PRV-infected and older animals that had received two different brands of gene-deleted vaccines.

**(8) Segregation—**The TS and attending veterinarians recommended segregation of older animals from younger animals.

**(9) Selection and Use of the Same Vaccine Brand—**The TS and attending veterinarians advocated continued vaccination with vaccine products containing the same gene-deletion. These advisors also recommended vaccination for all animals every 90 days to maximize immunity and minimize shedding from infected animals.

**(10) Followup Plan—**Statistical sampling of younger animals was performed 90 days after this herd cleanup plan was adopted. This interim analysis was suggested by these advisors to better evaluate transmission of virus to younger susceptible, vaccinated animals. It was also used to demonstrate to the herd owner that progress was being made.

**(11) Evaluation—**If the statistical sample tested negative to antibodies from field virus, then the herd cleanup plan was not changed. If any sample was seropositive, then the advisors performed a reevaluation of the herd cleanup plan to discover the weaknesses and adjust the plan accordingly.

**(12) Assess the Area—**The TS and attending veterinarians evaluated swine herd-density within the area to determine the risk for exposure to PRV from neighboring swine herds. Area regulatory officials were also included in the decisionmaking process and assisted in the area risk assessments.

**(13) Completion—**Usually within 2 years of initiation of the herd cleanup plan, PRV had been eliminated from the herd.

Each herd had its own set of individual challenges. Sometimes, management practices had to be assessed and changed multiple times. Employees also had to be educated and mentored regarding implementation of the steps included in each herd cleanup plan. The motivation to succeed varied among herd owners. The successful veterinary advisor understood all these varying challenges.

On occasion, unexpected issues cropped up. Finding that a disgruntled employee had dumped the vaccine into the manure pit was just one of many eye-opening events that management had to explore in the evaluation and oversight process. Analyzing tap water and discovering high concentrations of chlorine established the reason that washing syringes with that water inactivated the modified live vaccine (MLV) component of the vaccine. These discoveries taught everyone the importance of looking at all the details.

Furthermore, occasionally testing identified a herd having just one animal with a positive test result, also called a singleton reactor. Sometimes when that animal was sacrificed and tissues were analyzed, no PRV was present. Unexpected findings like these occurred rarely but served as a reminder that biological variation among animals needs to be considered as well.

## Licensing Gene-deleted Vaccines/Diagnostic Test Kits

PRV vaccines and diagnostic test kits are veterinary biological products regulated in the United States under the Virus–Serum–Toxin Act of 1913, as amended in 1985. This act makes it unlawful to sell worthless, contaminated, dangerous, or harmful veterinary biologics or to ship veterinary biologics in or from the United States unless these items are prepared in a licensed establishment in compliance with USDA regulations. Prior to marketing these products in this country, firms must obtain a U.S. Veterinary Biologics Establishment License for their production facility and a U.S. Veterinary Biological Product License for each product they produce.

### General Licensing Requirements for Vaccines

For a licensed veterinary biologics establishment to obtain a veterinary biological product license for an MLV PRV vaccine, the firm must file an application for a veterinary biological product license with APHIS' Center for Veterinary Biologics (CVB) unit. Product applications must be supported by an outline of production and supporting data. The outline of production is the detailed protocol for manufacturing and testing the product.

Data must be provided to support the purity, safety, potency, and efficacy of product produced in accordance with the outline of production. The use of a Master Seed as the source of all seed for production assists in maintaining uniformity of production. Final product must not be more than five serial passages from the Master Seed. CVB personnel ensure that the Master Seed, Master Cell Stock, primary cells, ingredients of animal origin, and final product are tested according to standard test procedures. Product im-

munogenicity must be demonstrated by statistically valid (usually 20 vaccinates and 5 controls) host-animal vaccination and challenge studies. The vaccination must be conducted using the minimum level of antigen in the youngest age animals indicated in the outline of production with product produced at the highest passage level from the Master Seed that is permitted for production. The precise challenge method and the criteria for determining protection vary with the immunizing agent. The efficacy of each label indication must be established. CVB personnel also require potency testing on each serial of product prior to release.

Safety testing includes a combination of studies. Typically, the product is evaluated at a 10X dose in the host animal. Live products must be characterized to determine if they have the ability to shed from the host and transmit to contact animals. Back-passage studies are required to provide information on genetic stability and on what can be expected when the vaccine is put into animals in the field.

Once laboratory characterization studies are completed, field tests provide additional safety data. Field safety studies are designed to detect unexpected reactions that may not have been observed during the development of the product. The tests are done on the host animal, at a variety of geographic locations, using large numbers of susceptible animals. The test animals should represent all the ages and husbandry practices for which the product is indicated.

Licensees are required to produce three consecutive satisfactory serials of final product in their licensed establishment in accordance with the approved Outline of Production. Licensees forward samples of Master Seed, Master Cell Stock, and these serials to the CVB Laboratory for prelicense testing to confirm the firm's test result.

Upon satisfactory completion of all requirements, including review and acceptance of labels and circulars, CVB issues a U.S. Veterinary Biological Product License.

**Additional Requirements for Gene-Altered Vaccines**

It is the position of CVB that recombinant-derived, MLV vaccines do not differ significantly from conventionally derived products. Thus, CVB considered existing statutes and regulations applicable to the new gene-altered PRV vaccines, and they were required to meet the same standards of purity, safety, potency, and efficacy for licensure as described above for conventional products. However, the National Environmental Policy Act (NEPA) also required applicants for licensure of these new live gene-altered vaccines to conduct studies to evaluate any potential effects these products may have on the human environment prior to their release from containment. Required investigations included studies to characterize the recombinant microorganism's biochemistry, to evaluate its genetic stability (both in vitro and in vivo), to examine it for any changes in its tissue tropism or virulence in the host, to assess its potential to shed from the host and spread to target and nontarget host species, to evaluate its ability to persist in the environment, and to examine its potential to undergo recombination with similar field strains of the microorganism. CVB personnel use the data from these studies to conduct a risk analysis and to prepare an environmental assessment, in accordance with NEPA, prior to release of the product for field testing or licensure. NEPA procedures also require public notification, through the *Federal Register,* of any recombinant microorganism release action to be taken by CVB.

In the case of the first gene-altered vaccine with two gene-deletions in the PRV genome, NEPA requirements had to be addressed before the firm was permitted to conduct field studies. To establish the safety

**Table 5.2–First gene-altered PRV vaccines licensed**

| Manufacturer | Gene deletions | Natural mutation | Date licensed |
|---|---|---|---|
| Boehringer Ingelheim | | gI-, g63- | 04/04/84 |
| Norden | | gI- | 04/09/84 |
| Diamond Scientific | gX-, tk- | | 12/03/87 |
| Syntrovet | gX-, tk- | | 03/29/88 |
| Fermenta | gIII-, tk- | | 02/21/89 |
| Syntrovet | gX, gI, tk- | | 1990 |

See Glossary of Terms and Abbreviations: gI = gE, gIII = gC, gX = gG, g63 = gI

of this vaccine to the human environment, the firm conducted studies demonstrating:

(1) The live gene-altered PRV vaccine virus was avirulent and yet fully capable of eliciting an immune response that protected pigs from PRV, but was not able to elicit antibodies to gG thus allowing serological differentiation between infected pigs and vaccinates;

(2) Transmission of the vaccine virus derived from recombinant DNA techniques could not be demonstrated on nasal swabs taken from either vaccinated pigs or from sentinel animals;

(3) Vaccination by the recombinant vaccine would reduce replication and shedding of field strain virus. Therefore, the vaccine would reduce the dissemination of virulent virus into the environment;

(4) The tk gene deletion was a stable characteristic of the vaccine virus with the probability of reversion being essentially zero;

(5) Field strains of PRV are found widely distributed in nature, and it does not contain an oncogene, or cancer-causing substance. Because the recombinant derived virus did not contain any new genetic information, there was no likelihood of it being oncogenic;

(6) Field strains of PRV are not pathogenic to humans. Since the recombinant-derived vaccine differed from field strain PRV by only two gene deletions, it was also considered nonpathogenic to humans; and,

(7) The Master Seed Virus prepared and characterized by the firm producing this vaccine had the same biologic properties as the parent strain. Data filed with CVB established the correlation between the two virus stocks that were utilized to prepare vaccine for experimental use. Based on the foregoing, CVB determined that the field testing of the recombinant-derived live-virus vaccine would have no significant environmental impact on the human environment.

In addition to general safety, field studies also included an evaluation of the effect of this vaccine on the semen quality of boars, the reproductive performance of sows and gilts, and the infection rate and performance of naturally exposed feeder pigs. When field studies were complete, and data demonstrated satisfactory safety, a second notice was published in the *Federal Register* with an environmental assessment considering the field study results announcing the licensure of this product. This process was repeated for licensure of the subsequent recombinant derived PRV vaccines that were licensed (see table 5.2). Vaccines developed by selection of naturally mutated viruses were licensed as conventional vaccines.

**General Licensing Requirements for Diagnostics**
Licensing diagnostic products requires the same application, supporting materials, and procedure as previously described for licensing conventional vaccines with the exception that supporting data must pertain to different issues. In the case of diagnostic products, data must support the sensitivity; specificity; ruggedness, repeatability, and suitability; and, predictive values of the product. Data for this purpose are developed by comparing the new diagnostic test against the current gold standard by the testing of well-characterized reference samples (from at least 20 animals) from negative (uninfected animals), strongly positive animals, weakly positive animals, samples generating assay values just above and just below the cutoff value, animals with reactivity to closely related (potentially cross-reactive) antigens and/or vaccinated animals, and animals reactive for only one, or a subset of antigens for kits that detect reactivity to more than one antigen.

**Approval of PRV Diagnostic Tests**
With the publication of regulations governing the interstate movement of swine designed to prevent the spread of PRV, approved PRV diagnostic tests were established that could only be conducted in approved laboratories. Therefore, licensing of a PRV diagnostic test by CVB did not automatically provide authority for the use of the test in official testing for the interstate movement of swine. In addition to licensure, PRV diagnostic tests also needed to be recommended for approval by the APHIS' National Veterinary Services Laboratories (NVSL) staff and approved by the agency's National Center for Animal Health Programs (NCAHP). APHIS is the same Federal agency responsible for publishing the Pseudorabies Eradication State–Federal–Industry Program Standards.

The approval process for PRV diagnostic tests was designed to provide an opportunity for potential users of the test to gain experience with the product and to allow cooperators the opportunity to determine with a greater degree of confidence that the product would perform according to label claims and would yield consistent and reproducible results in different laboratories under varied and prescribed field conditions. The manufacturer established field studies for this purpose and reported results to the American Associations of Veterinary Laboratory Diagnosticians (AAVLD), USAHA, and NVSL. The manufacturer provided test kits to at least three approved laboratories in different parts of the United States for testing reference and field samples in comparison with the gold standard. The NVSL and AAVLD, in collaboration with the NCAHP and CVB, reviewed the data from these laboratories relative to the efficacy of the product's potential use in the PRV Eradication Program. If found to be satisfactory for this purpose, the test was recommended to be approved and NCAHP prepared a *Federal Register* notice to inform interested persons that the product was approved for use in approved laboratories for official testing in the PRV Eradication Program.

In the case of the differential PRV tests, the approval process also required that the test be able to distinguish vaccinated swine from field-strain-infected swine. Furthermore, the test was to be (1) used only for herds immunized with the corresponding official gene-altered vaccine, (2) used for diagnosing a herd and not individual swine, and (3) conducted in a laboratory approved by NVSL.

The first differential PRV test was licensed on August 1, 1988, and became an “approved differential PRV test” for use in the program on May 9, 1990. By mid-1990, five differential PRV test kits had been licensed and two had been approved (see table 5.3).

**Table 5.3–Differential PRV tests licensed by mid-1990**

| Manufacturer | Date licensed |
|---|---|
| IDEXX | 08/01/88 |
| Agdia | 11/22/89 |
| Fermenta | 06/18/90 |
| Norden | 06/04/90 |
| IDEXX | 05/22/90 |

# Chapter 6—Planning for Eradication

## Committees

**Livestock Conservation Institute/National Institute for Animal Agriculture**

The role of the LCI/NIAA (LCI) PRV Committee was to secure industry consensus on actions regarding the disease. The committee was organized in 1975 and chaired by Dr. Al Leman of the University of Illinois. The first meeting took place in 1976. During this meeting, the committee approved resolutions calling for standard methods of diagnosis, a test and elimination program for seedstock producers, and if the disease continued to spread, a mandatory testing program.

At the 1977 meeting, the committee discussed information about successful field trials with the first PRV vaccine, which was produced by Norden Laboratories and licensed later that year. The committee also discussed rules for use of the vaccine. Other issues discussed at the meeting included the establishment of uniform quarantine regulations and interstate movement requirements.

During the 1978 meeting, the LCI PRV Committee called for the AAVLD to form a committee to develop standardized diagnostic protocols. There was also a discussion on the role of wildlife in PRV transmission.

In 1979, the committee called for action to develop a method to certify feeder-pig production herds as low risk for PRV by sampling a portion of animals representing the sow herd. Additionally, committee members heard at the meeting that the Norden vaccine could stop the epidemic spread of the disease.

LCI's 1981 meeting turned out to be one of its most significant. At that time, the PRV committee approved a proposal for pilot projects designed to determine whether PRV could be eradicated from an area, and whether that area could continue to be maintained free of the disease. This action was intended to answer the controversy in the industry between the eradication advocates and those endorsing vaccination as a solution.

The next year, the LCI PRV Committee's members heard descriptions of proposals for pilot projects in Illinois, Iowa, North Carolina, Pennsylvania, and Wisconsin and adopted a resolution endorsing them. Also at the 1982 meeting, the committee recommended implementation of a program to sample feeder-pig production herds and approved the concept of controlling the disease until an eradication program could be initiated. In 1983, the LCI's committee encouraged the licensing of a new, rapid field diagnostic test.

In 1984, the committee called for USDA-APHIS-VS to develop criteria for PRV-free areas and States, along with standards for maintaining such status. The LCI PRV Committee also called for discussion of the pilot project results. Specifically, the committee asked that a jury of seven industry organization representatives hear the results. After this took place, the jury's recommendation—which set the course of action against PRV for the next decade or more—stated:

> "We recommend that the goal of the industry be PRV eradication. This would be accomplished by a voluntary program of individual herd cleanup for a period of time, followed by a mandatory program based on surveillance to disclose all infected herds."

This recommendation was based on the conviction that: (1) the technical knowledge is available to eradicate PRV from the U.S. commercial swine population; (2) eradication is attainable, given the commitment and leadership of pork producers; and (3) eradication is in the best interest of the swine industry.

The jury called for an industry-wide information and education program on PRV. The jury assigned responsibility to the NPPC, the AFBF, and their State affiliates to assume leadership in obtaining a determination by

Congress that it is public policy to eradicate PRV, securing the necessary funding for PRV eradication, and forming State advisory committees.

In addition, the jury called on LCI to develop an industry-wide task force to outline a PRV eradication program that would be available for consideration by industry groups during the winter of 1986-1987. The LCI-appointed task force included advisors from the USAHA, the AAVLD, VS, and USDA's Agricultural Research Service (ARS). Hilman Schroeder, a Wisconsin pork producer and member of the jury representing the NPPC, served as the chairman.

Key elements of this eradication program included:

(1) The program would be voluntary in its initial stages, offering support to owners of infected herds in eliminating the virus by providing technical assistance, advice, and testing.

(2) New technology for testing swine serums was to be made available to accredited veterinarians to ensure widespread on-farm use of these tests in cleaning up infected herds.

(3) Indemnities, if part of this eradication program, should be minimal. A referendum of producers would be conducted if alternative sources of funding for indemnities were to be part of the program.

(4) Before implementing the mandatory phase of the program in any State, there would need to be sufficient support from the food animal industry in the State to enact the necessary legislation for that part of the program.

(5) If producers indicated that they were committed to continuing the program after the voluntary phase, the mandatory phase would include surveillance to disclose all infected herds; depending on the availability of new technology, surveillance would be conducted either by slaughter testing, first-point testing, or down-the-road herd testing. Such a surveillance program was expected to involve testing of culled breeding stock and would require an effective identification system.

(6) The program was to be flexible—carried out on a State-by-State basis—for areas within States and for individual herds to allow for differing conditions and situations. Both in the voluntary and mandatory phases of the program, State officials and herd owners were to develop individual herd plans for each infected herd based on the particular needs and situation affecting that herd. Individual States would take part in the program on the basis of cooperative arrangements with APHIS-VS.

(7) The program's preliminary goal was for eradication plans to be in effect in all States by January 1, 1989.

**The Seventh Draft Eradication Plan**

The plan written by the task force in 1986 was widely known as the "Seventh Draft PRV Eradication Plan" (see Appendix V). The plan was distributed widely throughout the industry and discussed by pork producer groups and others during the winter of 1986 to 1987. The delegates to the annual meeting of the NPPC in March 1987 approved the plan by an overwhelming majority. It was also endorsed by the AFBF, the American Association of Swine Practitioners, LCI, many State pork producer groups, and others.

The plan provided for flexibility and called for the establishment of State committees made up of producers and other segments of the industry. These committees were to determine PRV eradication activities and monitor the program's advancement from stage-to-stage in individual States.

The first stage of the program was preparation. During this stage, the State committees were formed. The committees then measured the prevalence of PRV in

the State, developed plans for future PRV eradication activities, and determined what changes were needed in State laws or regulations to implement these plans.

The second stage focused on disease control. At this time, States implemented surveillance programs to detect infected herds, quarantine such herds, and if the States thought it prudent, begin a voluntary herd cleanup program.

The third stage was the start of mandatory herd cleanup. At the beginning of this stage, the States required owners of infected herds to develop and implement individual plans to eliminate the infection from their herds. During the second part of this stage, if only a few infected herds remained in a State, animal health officials could require depopulation of those herds, with indemnity payment if funds were available.

The fourth stage of the program was for States that had completed the herd cleanup phase and had no known infected herds, but continued to conduct PRV surveillance.

The final stage was PRV-free status.

**Pseudorabies Control Board**

The Pseudorabies Control Board was a subcommittee established as a result of action by the LCI PRV Committee. The subcommittee's assignment in 1984 was to develop criteria for establishing what actions a State or area would have to take to be declared free of PRV. The subcommittee realized the technology and capabilities were not available to recognize a State as free of PRV. Instead, it recommended a two-class status—Class A for States/areas that demonstrated low prevalence of PRV, and Class B for States/areas that were conducting a surveillance program to detect and quarantine infected herds. The subcommittee also suggested that, given the length of time required to write and implement a Federal program and regulations, its recommendations should be given to industry and States to implement.

These subcommittee recommendations were approved by LCI, USAHA, and the NPPC in October 1985. Each of the three organizations agreed to appoint two representatives to review information and determine if a State or area qualified for the class for which it applied. Thus, the National Pseudorabies Control Board (Board) was established. On January 1, 1986, Wisconsin became the first State to which the Board granted Class B status.

The Board soon gained status among producers and State officials when a number of States, led by Illinois, passed legislation requiring that feeder pigs originate from herds in which a sample of sows test negative for PRV annually. These States concluded that surveillance programs meeting Board standards provided as much protection as could be expected with the technology available at the time. The States then accepted the classification granted by the Board for movement of pigs. Only five States would not recognize the classification given by the Board; however, most of these States later accepted the classifications.

As standards for the PRV Eradication Program were being developed in the late 1980s, the Board continued to review States for classification using the established standards. The three organizations (LCI, USAHA, and the NPPC) and VS wanted to keep industry and States involved in granting class-free status under the program's standards. The Board was then asked to advise VS on this issue. In response, the Board established a one-page checklist to accompany the State or area's application, along with other supporting documentation. The Board would then review these applications and present their recommendations to VS. The Board met in person twice each year at the

LCI meeting in the spring and at the USAHA meeting in the fall. Between the two meetings, Board members received applications by mail and reported their votes to the secretary of the Board, usually by phone. The checklist, which contained information the Board reviewed to determine a State's stage, was changed and updated when necessary. See Appendix IX for a sample of one of the early designs of the checklist, as well as a sample of another checklist adopted for use in 2005.

On rare occasions, the Board would contact States directly about a concern or clarification regarding their programs. When the Board met in person, State veterinarians or their designees would hand deliver applications and answer questions. The PRV National Coordinator from VS contacted the States regarding questions about these applications, received recommendations presented by the Board, and approved the designation of a State's PRV stage/status.

The Board was very careful to evaluate only whether the area or State was in compliance with the Program Standards for the stage described on the application. At times, however, the Board did make suggestions for changes and updates to the Program Standards. The Board continued to review all applications until it voted to recess at the USAHA meeting in October 2006. The Board decided not to disband until the Secretary of Agriculture declared the United States free of PRV and surveillance programs for the disease were better established.

**National Pork Producers**

In August 1976, the NPPC directed its PRV Oversight Committee to gather information on the economic losses resulting from PRV and obtain research funding to study the disease.

In 1983, the NPPC sponsored and partially funded the Pilot Projects. The Pilot Projects were a rather natural progression using science and implementing a studied approach to solving industry problems. Utilizing a Technical Advisory Committee with professional and producer members, the industry set out to determine the rudiments of successful PRV control and eradication plans.

Four years later, NPPC officials presented a plan for a 10-year PRV Eradication Program. This plan eventually received support from the U.S. Congress, when it authorized the Secretary of Agriculture to establish such a program and appropriated $20 million annually for 10 years to fund the program.

In 1988, the NPPC outlined and adopted the 10-year goals. Funding increased moderately in 1988 and 1989. The NPPC actively endorsed and demonstrated producer consensus for furthering the success of the PRV Eradication Program in March of 1990. By May of that year, the organization had approved a reorganized committee structure to accommodate the larger and more intense eradication effort. The committee assumed responsibility for all aspects of the total national program, and all of the individuals with designated roles would be members of the 16-member committee. From this committee, one member from each of the four VS regions was appointed to the budget subcommittee.

With those changes in place, the successful continuation of the PRV Eradication Program was largely a matter of allowing the established system to work, as the States, VS, and industry groups addressed ongoing budget and funding issues.

**United States Animal Health Association**

USAHA had a longstanding committee to address diseases of swine, such as Hog Cholera. By the late 1970s, there was enough concern about what was then known as "Aujesky's Disease" that USAHA made a decision to establish a subcommittee to address this "new" disease. This eventually became USAHA's

PRV committee. A great deal of discussion ensued within the organization over appropriate terminology, but eventually USAHA members accepted the term "pseudorabies."

By the end of the 1970s, the leadership of USAHA was involved in discussions with VS, the NPPC, and LCI over the appropriate course of action for this swine health problem. The members of USAHA—the PRV committee in particular—were as divided as the swine industry was about what course of action to take. A very effective vaccine for use in swine had been developed, and some members felt that the disease should be controlled through a vaccination program. Others believed that, while vaccine controlled the disease in swine, it did not stop the transmission of the virus to other swine or to other animals. The vaccine was lethal if given to almost any other species. This debate raged into the 1980s, with a central question—is it better to control or to eradicate the virus? Because PRV is caused by a Herpes virus, many people felt it would be impossible to eradicate the disease.

Upon the urging of other stakeholders, USAHA leadership established the PRV committee to address the various aspects of the debate, gather information on these issues, and facilitate the general discussion. During a PRV committee meeting on October 27, 1987, the chair announced the appointment of an ad hoc committee to review the proposed Uniform Methods and Rules (UM&R) for PRV. In the past, UM&Rs had been developed by committees and published by APHIS for other diseases (i.e., brucellosis and tuberculosis). Members of the main PRV committee had been working on such a proposal for that disease

Following the ad hoc committee's report on the proposal and much discussion within USAHA, the chair referred the proposal to a new group within the PRV committee. This group became the Program Standards subcommittee and was charged with developing the methods and rules to contain PRV.

The USAHA PRV Committee became the annual forum to review and discuss the steps being taken in the eradication program and develop recommendations for VS. The committee agenda was similar from year to year. A VS representative presented a national report on the progress of the program. The States were then invited to report on the progress they were making through the various steps in the national program, beginning with the development of a State advisory committee. There was also an industry report, presented by the NPPC.

During the meeting in May 1981, USAHA approved a recommendation to establish pilot projects to determine if PRV eradication was feasible. Finding the appropriate method to release quarantines became a major issue for State veterinarians, as well as for the industry. This discussion demanded a great deal of effort by the committee and became a major point in the development of the Program Standards.

The USAHA Program Standards subcommittee met twice each year, in the spring at the LCI annual meeting and in the fall at the USAHA annual meeting. Ideas were presented and discussed by committee members and other interested individuals at LCI, and amendments were proposed to the Program Standards (see Appendixes III and IV).

These proposed changes were debated again at the USAHA PRV Committee meeting and, if agreed upon, were presented to the entire body of USAHA for approval. The PRV Committee also received recommendations from the PRV Control Board regarding State PRV status. The committee supported its determinations on the status of each State's progress and recommended those statuses to VS.

Over the years, the use of vaccine in the eradication program became a very controversial issue discussed at these committee meetings. While effective vaccines were available, and were being used in most of the

major swine-producing States, there was no method to differentiate between antibodies produced from exposure to field strain virus or vaccine strains. This was a serious impediment to the progress of the program and debated at length both in the Program Standards subcommittee and in the full PRV Committee. Until vaccines and their complementary, differentiating diagnostic tests were developed, it appeared that the PRV Eradication Program would "stall out." As these vaccines and the diagnostic kits initially became available in the late 1980s and early 1990s, the committee recommended to VS and State veterinarians to approve their use. The products improved over time, and regulatory officials became more comfortable after utilizing these tools in eradication efforts. Vaccine then became a useful tool in the control of PRV, particularly in the major swine-producing States with the most infected herds.

In 1990, the PRV Committee made a decision to appoint two subcommittees of technical experts. One was to review the PRV vaccines being produced, and the other was to review the diagnostic tests under development. These subcommittees were to report back to the full PRV Committee annually on the evaluation of the products and recommendations for their use. The information was valuable to the Program Standards subcommittee during deliberations.

Addressing PRV and other diseases in commercial and breeding swine herds of all sizes had held the committee's attention through the 1980s. However, by 1993, USAHA established a feral swine advisory committee. This committee was charged with reviewing the information that was available regarding not only PRV in feral swine, but also swine brucellosis (see Chapter 11).

Funding for the National PRV Eradication Program was another major topic of discussion in every PRV meeting. Since the program was to be a cooperative State-Federal-industry program, it was expected that each entity would be responsible for some part of the funding. The industry assumed the lead role in securing Federal funding for the program. At the same time, the industry within each State, along with the State regulatory official, were responsible for obtaining State funding. The USAHA was very supportive of these efforts and encouraged the State veterinarians and industry to work closely with VS in presenting the need for and efficacy of those funds.

Throughout the 1990s, the industry became increasingly more encouraged about the progress of PRV eradication efforts. During that time, over 6,000 swine herds were infected in the United States, more funding became available for surveillance, and the number of quarantines continued to decline as more infected herds were cleaned up. It then became very important to bring all stakeholders to the table to garner the support needed to continue moving forward with eradication.

The Board reported at the October 1996 PRV Committee meeting that 80 percent of swine herds and 65 percent of breeding swine in the United States were in stages III, IV, or V. However, the Board stated that two areas of concern needed to be addressed in the State reports: (1) States must address the feral swine issue, and (2) the States applying for stage IV status must have had no new cases of PRV in the past 12 months.

The Program Standards and the PRV committees were revising the standards annually to reflect the progress in the eradication program, clarify what needed to be accomplished, and develop more stringent standards to keep progress moving forward. Once adopted by the USAHA, these measures had the force of the entire industry behind them to provide VS with a clear view of what the next steps for the program should be.

VS reported at the PRV Committee meeting in October 1999 on the success of the Accelerated Pseudorabies Eradication Program (APEP) (see "APEP," Chap-

ter 8). At the following year's meeting, the Program Standards committee recommended that no further changes be made to the standards at that time. This committee was reviewing proposed changes to Part 85 of the *Code of Federal Regulations* (CFR) that would commit much of the Program Standards to the CFR. It is important to note that, at the time, USAHA was reluctant to incorporate the Program Standards into the CFR; USAHA leadership was concerned that doing so would lessen the flexibility of the program. The swine industry and USAHA were convinced that the PRV program continued to make progress due to its flexibility and strong producer and industry support. Eventually, standards dealing with the interstate movement of swine, official tests, and herd statuses were adopted and published in the CFR.

At the November 2001 meeting of the PRV committee, VS reported that, as of October 2000, there were only 434 quarantined swine herds in the United States. By 2001, the number of quarantined herds had been reduced to 12; these herds were in Iowa and Nebraska. The following year, VS reported that the last PRV quarantine in the country (in Iowa) was released on July 12, 2002. This was the first time the United States had no known PRV-infected commercial or breeding swine herds. From that point forward, the Program Standards required that any swine herd found to be infected with PRV had to be disposed of within 15 days. Federal money was available for depopulation, and USAHA strongly encouraged all States to follow this procedure.

**State/Producer Pseudorabies Advisory Committees**

As State-specific control/eradication programs were implemented within the PRV Eradication Program, PRV advisory committees were formed in many States to provide industry and producer guidance on policy and implementation strategies. In some States, these advisory committees were legislatively mandated, with requirements for reporting either directly to the legislature or the State Veterinarian's office. In other States, these committees were formed under the auspices of the State department of animal health and directly advised those offices. Some of these committees represented the redeployment of State educational or PRV action committees formed in the mid-1980s, as awareness about the presence of PRV rose. But in all cases, the advisory committees served as a forum for industry members, producers, and regulatory officials to discuss PRV eradication activities, program status, and potential outcomes, or to answer questions about program implementation activities. The activity levels and impacts of these committees depended on formative mandates or the desired level of involvement from the State department of animal health.

The composition of the advisory committee and scope of its work varied depending on a number of factors—such as individual State needs, legislative or departmental prerogatives, and former or existing animal health regulations or animal disease prevention or eradication objectives. In a few cases, the committee's composition was mandated by legislative requirements. In most cases, committee membership was under the guidance of the State animal health authority, in cooperation with State pork producer groups, and represented a broad array of interested parties or industry segments within their States. Generally, appointments to the committee included representatives from pork producer organizations, livestock markets and other ancillary industries, State and Federal animal health regulatory agencies, university or State diagnostic laboratories, university research and extension personnel, and practicing veterinarians. In cases where these groups were not legislatively mandated to be included in active committee membership, their representatives were given ad hoc or advisory—but not voting—status in committee activities.

Depending on formative mandates, the scope of advisory committee work ranged from actively formulating programmatic policy and managing resultant State regulatory mechanisms to acting as a sound-

ing board for producers, with advisory functions and minimal programmatic control. The scope of work for each committee reflected individual State needs and political environments, existing regulatory structures, and animal disease control authorities. Each functioned within its political and regulatory environment to strengthen producer and ancillary industry support; identify and discuss new science technologies and field experiences; improve eradication efforts or industry acceptance; influence modifications to legislation or budgetary levels; receive and evaluate complaints about program implementation; and, provide regulatory officials with on-the-ground intelligence as the State eradication steps were implemented. In exceptional cases, the advisory committees or their representatives counseled individual producers or markets to encourage participation or compliance with State eradication efforts.

State advisory committees were critical to the success of State PRV eradication efforts. They identified a focused group of responsive individuals who understood local activities, needs, resources, and perhaps limitations within the context of the national eradication effort. Without substantial voluntary regulatory compliance and political support from the State pork-producing industries, implementing program policy would have been difficult—or even impossible—in many situations. State advisory committees enabled such support to build, which led to successful eradication programs at the State level.

## Program Standards

After approval of the national eradication plan in early 1987, USAHA requested that APHIS develop proposed program standards for the effort. The Program Standards provided a roadmap to PRV eradication, giving States a specific outline of the requirements for progressing through the five-stage program. Pertinent State and Federal laws and regulations were promulgated to facilitate the requirements of the Program Standards; APHIS then approved, printed, and distributed these standards. Each year, the USAHA PRV Committee reviewed the Program Standards. In October 1987, USAHA recommended amendments to the standards. By January/February of the following year, APHIS incorporated these recommendations into a new edition of the Program Standards and widely distributed the revised document (see Appendixes III and IV).

The Program Standards specified the following five-stage program:

**Stage I – Preparation**
This is the initial stage in which the State develops basic procedures to control and eradicate PRV. To qualify for this stage, the State must have completed the following steps:

(1) A State PRV Advisory committee is functioning;

(2) Reliable procedures for determining prevalence are in place;

(3) State and/or industry representatives have or are actively seeking legal authority to conduct diagnosis and eradication;

(4) A system for distributing program literature is functioning;

(5) Applicable Federal regulations are enforced; and,

(6) A State progress report will be produced monthly.

**Stage II – Control**
In this stage, a State continues to cooperate within program guidelines. The goals of this stage are to identify infected herds and begin herd cleanup. Steps for this stage include:

(1) Stage I standards are implemented;

(2) A surveillance program including circle testing around all newly identified infected herds is implemented;

(3) Authority to require herd cleanup plans on all known infected herds exists;

(4) Swine movements entering the State are controlled;

(5) Intrastate movements are appropriately controlled; and,

(6) Transmission of PRV from wild or feral swine is controlled.

**Stage III – Mandatory Herd Cleanup**
In this stage, the cleanup of infected herds becomes mandatory. Required steps include:

(1) Stage II standards are implemented;

(2) Specific epidemiologic procedures are in use;

(3) Surveillance procedures are in effect, including slaughter, market, and on-farm blood collection;

(4) Vaccination may be permitted; and,

(5) Regulations to prevent virus transmission from wild or feral swine are implemented.

**Stage IV – Surveillance**
In this stage, the State has been successful in controlling PRV and their efforts now focus on surveillance for the disease. The State must meet the following criteria:

(1) There is no known infection in the State, and Stage III surveillance has been in effect at least 2 years;

(2) Authority for farm-of-origin identification of cull sows and boars exists and is enforced;

(3) No new cases of PRV were confirmed during the year prior to Stage IV application; and,

(4) A management plan controlling exposure of commercial and breeding swine to feral swine is adopted.

**Stage V – Free**
This is the final stage, in which the State is considered free of PRV. To qualify for this stage, the State must meet the following:

(1) Stage IV standards are implemented;

(2) The State has been free of PRV for 1 year since stage IV recognition;

(3) Swine imports are controlled per Stage IV;

(4) PRV vaccination is generally not permitted;

(5) Intrastate movements are not PRV restricted; and,

(6) Stage IV feral swine requirements continue.

On an annual basis, Program Review Teams funded by VS and composed of highly qualified State, Federal, and industry representatives visited selected States and reviewed their programs for compliance with the Program Standards' requirements.

## Pilot Projects

The idea for pilot projects to test the feasibility of eradicating PRV from the United States was first proposed in May 1981 by the LCI PRV Committee at the annual meeting in St. Louis, Missouri.

USDA later requested that Congress appropriate $1.5 million to finance these projects. Several States submitted Pilot Project proposals to VS; each of the projects was planned to encompass the area of one county.

In February 1983, the executive board of the NPPC, while on a legislative visit to Washington, D.C., offered to contribute $100,000 for two State projects if VS would allocate $400,000 in funding. VS and the NPPC reached an agreement for this total of $500,000 in funding. The agreement specified that the projects would be conducted in two States with high swine densities and recognized PRV problems. Illinois and Iowa were subsequently selected as the two initial project States.

In addition, a Technical Advisory Committee—made up of PRV disease control and eradication experts—assisted in planning, implementing, and reporting the results of a total of five pilot projects. One Iowa county and two Illinois counties with a high prevalence of PRV infection were selected for two of the projects. The other projects were conducted as part of three operating State programs with a low PRV prevalence—North Carolina, Pennsylvania, and Wisconsin. The Iowa project (Marshall County) was intended to test methods for controlling PRV and preparing for its elimination from a major swine-producing county in an endemic area. The Illinois project sought to determine the spread of infection in the area and the effectiveness of three herd cleanup strategies, as well as to evaluate the efficacy of a newly developed skin test under field conditions. The North Carolina project evaluated slaughter surveillance as a method to identify PRV-infected herds and sought to determine if traceback and cleanup of infected herds would be feasible. The Pennsylvania and Wisconsin projects were organized to test surveillance efforts, cleanup strategies, and methods that may result in the successful eradication of PRV.

Upon completion, all five projects were identified as successful, practically achievable, and economically feasible (with the exception of the skin test studies in Illinois). USDA and the States used calculations from a benefit-cost analysis (see Chapter 10), which included data from the results of all 5 pilot projects, to estimate total PRV eradication program costs for 13 mid- and high-swine population States and 37 low-swine population States. Estimated total costs for a 10-year program were more than $257 million, with cleanup of infected herds amounting to approximately $105 million. These initial figures—which projected that Federal government, State government, and producers would each share one-third of the costs—were used as guides through the early years of an anticipated 10-year national effort, until an accelerated program was launched in the latter years.

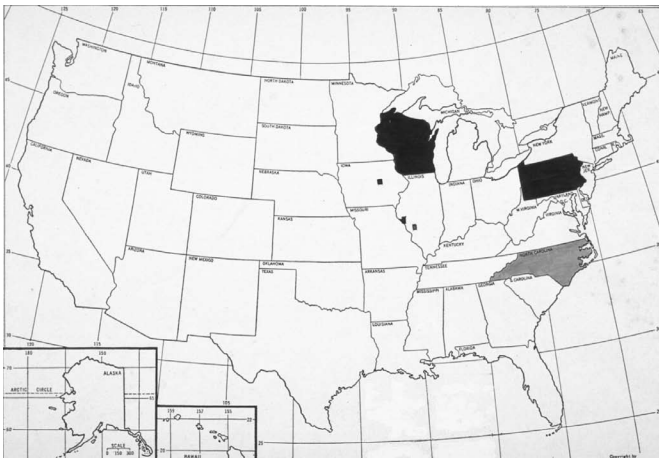


Figure 6.1. PRV Pilot Projects included: Marshall County, Iowa; Macoupin and Pike Counties, Illinois; North Carolina; Pennsylvania; and, Wisconsin. *(Figure by George W. Beran, R Allen Packer Heritage Room)*

Figure 6.1 displays the locations of the Pilot Project areas: Marshall County, Iowa; Pike and Macoupin Counties, Illinois; and, the States of North Carolina, Pennsylvania, and Wisconsin.

**Illinois**

To determine where the State's pilot project would be held, an Illinois county selection committee met during the 1981 Illinois State Fair. Three counties—Macoupin, McDonough, and Pike—were considered as possible project counties. Public meetings in each of the three counties were held in late 1981 to determine interest in the project and inform the pork producers of initial plans. However, due to a lack of funding in 1981 and 1982, the State made little progress, other than to develop an initial protocol for the PRV pilot project.

VS allocated $250,000 to Illinois to establish the State's pilot project. In doing so, the program took the position that this funding was not to be used for indemnity payments. The Illinois Pilot Project leaders disagreed with APHIS on this issue, believing that VS should allow a moderate amount of indemnity to be paid for the prompt slaughter of certain infected and exposed herds. A stalemate soon developed between the two groups. After several unsuccessful attempts to convince VS to modify its position, the Illinois project was almost dropped. In fact, had it not been for the efforts of a few individuals intensely interested in the project, this might have been the case.

The Illinois project underwent at least a dozen drafts and revisions before a proposal acceptable to most parties was finalized. In an emergency meeting of the Illinois PRV Advisory Committee, it was decided that the Illinois project would be initiated in a single township, with the possibility of expanding the project into a larger area. On February 9, 1983, the Illinois PRV Advisory Committee met to decide whether to present the pilot project proposal, without the indemnity provision, to producers in the designated counties for their response. The advisory committee formed a special Pilot Project Selection Committee. Its members included the president, executive vice-president, and an executive board member of the Illinois Pork Producers Association, along with the Association's representative to the NPPC; a representative of the Illinois Agriculture Association (now the Illinois Farm Bureau); the swine extension specialist and the swine extension veterinarian from the University of Illinois; the VS Area-Veterinarian-in-Charge (AVIC) for Illinois; and, the State's Chief Veterinarian. On April 19, 1983, this appointed committee, along with the swine disease staff veterinarian from VS, met with members of the county pork producers association, cooperative extension personnel, and local veterinarians in a series of meetings held in the three Illinois counties being considered for the project.

During the meetings, the committee outlined phases of the pilot project as follows:

(1) Designate a project area to one or slightly more than one township, with the area to expand if progress was made in the initial township and funds were available. (This was a reduction in the size of the project area from the original concept, which specified that the entire county would be designated for the project. This change in concept allowed for the selection of an area where State officials expected strong pork producer support for the project; they hoped that such significant levels of support would encourage cooperation and replace producers' desire for indemnity.);

(2) Survey the swine population in the designated area;

(3) Determine the PRV status of all herds in the area through testing;

(4) Develop individual herd cleanup plans for each infected herd with the objective of eliminating PRV infection from the herd;

(5) Determine if the area, once clean, would remain free of PRV through monitoring; and,

(6) Evaluate an intradermal skin test method using PRV capsular antigen as a proposed diagnostic test under field conditions.

The committee also discussed the optimum specifications for the pilot project township. The designated area should have the following:

(1) A swine population representative of the entire county;

(2) Known PRV-infected herds either presently or previously in the township;

(3) Somewhat natural boundaries as far as the swine population is concerned; and,

(4) Cooperation of the township's pork producers.

After hearing the phases of the project and requirements for the pilot project township, the county committees in both Pike and Macoupin requested that their county be selected, but McDonough County subsequently asked to be withdrawn from consideration. The Selection Committee then chose to initiate township projects in both Macoupin and Pike counties and consider these to be the Illinois Pilot Project.

In advance of the project, extension personnel and producer groups had prepared listings of all premises believed to have swine in the selected Illinois counties. With these listings as a starting point, two State employees surveyed each producer to obtain specific information about each herd.

State and Federal personnel then initiated a program to test a predetermined statistical sample of the swine in all herds within the project areas to determine the PRV status of each. A Federal or State veterinary epidemiologist developed plans to cleanup all infected herds. The LCI booklet, *Swine Pseudorabies Eradication Guidelines: Plans for Elimination of PRV from a Swine Herd,* was given to each owner of an infected herd, and herd plans were patterned generally after Plan A, B, or C (see Appendix II). Another LCI booklet, *The Epidemiology of Pseudorabies: A Field Guide,* was distributed during contacts with herd owners and during survey activity (see Appendix I).

During 6 months of testing, State and Federal officials identified a number of items worth noting:

(1) A greater number of positive herds were encountered than had been anticipated—15 out of 64 herds (or 23 percent) tested positive for PRV;

(2) Four herds had a single positive animal, which later proved to be a nonspecific, positive reaction;

(3) The skin test was not working as well as hoped when used as a herd diagnostic test;

(4) Producer cooperation was excellent—only 4 out of 69 producers in the Pike County portion of the project and 3 out of 75 in the Macoupin County portion chose not to participate in the project; and,

(5) The project areas expanded to include more townships in both counties during 1984.

At the urging of State and local pork producers in fiscal year (FY) 1984, the Illinois General Assembly approved a special appropriation of $70,000 in late May to be used to pay indemnities for PRV-infected breeding swine in these pilot project areas. Infected animals were required to be shipped to slaughter, and the producer received $25 per breeding animal, plus the market value of the animal. The indemnity applied to sows, boars, and replacement gilts over 6 months of age. This Illinois PRV Indemnity Program was the first in the United States to be used for the eradication of this disease. While producers and other stakeholders expressed considerable interest in the added depopulation-indemnity feature of the project, the late approval date (May 1984) for the funds—which had to be obligated by June 30, 1984—and the necessity of making long-range plans limited participation. However, despite this narrow window of time, two or three herd owners did take advantage of this opportunity for indemnity and depopulated their herds.

The APHIS pilot project funding was anticipated to end on September 30, 1985; however, in November 1985, the Illinois Department of Agriculture requested permission from VS to modify the existing pilot project agreement to include all quarantined herds in the State. VS granted permission to the State in January

1986 to use pilot project funds to pay for herd testing in quarantined herds throughout the State and develop voluntary herd cleanup plans.

On January 28, 1986, the State sent 427 letters to the owners of herds under quarantine, explaining this herd testing and cleanup program. Herd owners were asked to indicate their interest in the program. Out of the 229 owners (54 percent) who responded, 138 were interested in the program, 20 were in the process of liquidating, 24 had no swine on the premises, 27 were not interested, and 20 had miscellaneous responses.

Program work initially began with 90 herds the State deemed "priority one" due to the herd owners' prompt responses to the letter. This work included completing a detailed questionnaire regarding the herd, developing a herd cleanup plan, and conducting an initial test on a number of animals to determine the herd's status. When it became apparent in late April 1986 that funding would be adequate, more herds were added to the priority one list. By June 30 of that year, 138 herds were actively participating in the program.

The joint State-Federal cooperative pilot project in the Illinois counties of Macoupin and Pike was completed in 1986. Most of the activity in FY 1986 involved monitoring noninfected herds to determine if they would remain negative and reviewing various plans for cleanup of infected herds.

As a result of the project, State and Federal officials reached a number of conclusions about PRV eradication:

(1) PRV could be eradicated from an area without disrupting swine production. Even though there were uncooperative owners of infected herds in the pilot project area, it was possible to maintain the remainder of the area free of the disease by following procedures designed to reduce exposure to PRV. There were a few herds that became infected a second time in the PRV-free areas; however, each was traced to an unapproved procedure.

(2) Since the Illinois project was a voluntary program, all swine owners in the area did not cooperate with the program. This lack of cooperation established the need for regulatory authority to further a State or national program's objective to be successful.

(3) Statistical sampling or screening was an adequate PRV detection method rather than whole-herd testing.

(4) In herds exhibiting a low percentage of reactors, program officials developed a test-and-removal protocol that they used successfully as a cleanup strategy.

(5) While, in the planning stage of the project, Federal and State officials considered quarantined feedlots to be essential, the actual project did not demonstrate the need for quarantined feedlots.

(6) The reluctance of feeder-pig producers to participate in the voluntary program was an important factor in the promulgation of the Illinois Feeder Pig PRV Regulation, which required sow herds producing feeder pigs for qualification to be tested prior to movement.

(7) If indemnity had been available for depopulating infected herds, the project would have been more successful.

(8) The skin test did not prove to be as successful as a quick, accurate, and presumptive diagnostic test in the field.

(9) Nonspecific reactions were the likely cause for single animals in a herd testing positive on the serum virus neutralization assay. To reduce this event, program officials required that animals be bled from the jugular vein and only sterile, vacuum tubes be

used to collect and submit blood to the diagnostic laboratories. They also recommended that only serum be submitted—especially in hot weather and in cases where overnight delivery was not available—to reduce the number of cases involving a single animal in a herd testing positive, also known as a singleton reactor.

**Iowa**

In the early 1980s, many factors contributed to the PRV experience in Iowa. First, there was dense population of swine in the State; nearly 25 million hogs were produced annually in a State of approximately 60,000 square miles. Second, there were a large number of individually-managed operations, numbering at approximately 35,000 herds. Third, the State had an active and vibrant feeder-pig industry and market, which was transacted through both sale barns and farm-to-farm sales. Finally, the State's farm economy was in the midst of a crisis due to a severe loss of equity value, high interest rates, and low commodity prices. These factors, coupled with a virus that was easily spread by pig-to-pig contact, led to what was later documented in the program as an infected herd prevalence rate of more than 60 percent in several local areas of Iowa.

For the State's initial pilot project, the producer and veterinary members of the Iowa Pork Producers Association first defined the requirements that the county selected for this effort would need to meet. The primary criteria were as follows: (1) The county should represent the average number of hogs and producers located within an Iowa county so that the results obtained would apply to most counties; (2) The county should be relatively close to Ames, Iowa, to provide access to the diagnostic resources of Iowa State University and the College of Veterinary Medicine and allow researchers to experience first hand the applications of this study; and, (3) The county pork producer organization must be willing to commit to the program and be dedicated to take the necessary steps to organize the pilot project at the local level. These steps included identifying all producers in the county, contacting veterinarians who were willing to support the program, and sponsoring informational meetings that essentially led to a consensus of producers supporting the concepts and applications of the project.

Marshall County, Iowa, was selected for the project. The county included 580 farms, 224 swine herds, and 75,000 hogs. Eleven herds were under PRV quarantine at the start of the pilot project.

In what turned out to be an effective means of finding PRV-infected herds, veterinary practitioners collected on-farm blood samples from a statistically-based number of animals representing the herd's status. Negative herds were retested every six months. A sample size of 25 to 29 swine representing the breeding herd gave a 95 percent probability of detecting seropositive swine in a herd with at least 10 percent PRV prevalence. Once animal health officials identified the infected herds, they learned valuable information from studying the clinical picture and potential source(s) of PRV in susceptible herds.

Since vaccines were commonly used, and diagnostics differentiating vaccine titers from titers due to infection had not been developed, animal health officials used interpretations of the serum virus neutralization results instead. Antibody titers of less than or equal to 1:16 were considered to be of vaccination origin. When such titers were found, animal health officials performed the herd tests again in three months to validate the interpretation. Titers that were greater than 1:16 indicated PRV infection. During the pilot project, only inactivated PRV vaccine was authorized for use. Antibody titer determination tests were sufficiently accurate during the early period of the pilot project but were promptly discontinued when gene-deleted vaccines and their complementary test kits became available.

During the Iowa project, 45 herds (21 percent of Marshall County's total herds) were identified as infected. A major goal of the project was to determine the effectiveness of the herd cleanup plans. These cleanup efforts were successful in a total of 36, or 80 percent, of the infected herds. Of these herds, 12 were depopulated, and none subsequently repopulated with new stock. Four herds used the test-and-remove elimination plan, and 20 of 28 herds used offspring segregation to cleanup. Overall, the mean time of cleanup using offspring segregation after identifying the infection was 15.4 months. The test-and-remove method was found to be effective in a single action if less than 20 percent of the breeding swine were seropositive. In short, animal health officials concluded that all of these cleanup approaches were effective. The most effective method to use ultimately depended on the type of operation, the availability of clean, isolated facilities, and the prevalence of seropositive animals.

The Marshall County Pilot Project demonstrated that animal health officials, veterinarians and pork producers could make significant progress in first controlling the spread of PRV and then eliminating the disease. The project also demonstrated the importance of coordinating the local producers and veterinarians in an organized effort to eliminate the disease. However, even though the project was quickly instituted and showed a great deal of promise in those early months, it also had several challenges. First, some herds became reinfected, the sources of these infections were not always known. Animal health officials believed that such cases occurred from introducing PRV-infected animals into herds, transporting animals in trucks or trailers that had not been cleaned, or through area spread between herds. Another difficulty in the project was that, even though the interpretation of antibody titers was the best diagnostic tool at the time, this method presented a challenge in determining herd PRV status. This challenge was later resolved when technology to differentiate vaccine-induced antibody from infection-induced antibody became available.

Addressing and involving uncooperative producers in the project also proved to be a difficult challenge. In any disease program of this nature, there will always be producers who are not supportive of the effort. To address this issue, the State later passed legislation that provided authority to eventually require participation from producers. Lastly, the project showed that, because the PRV vaccine controlled the clinical signs of the disease (but not entirely the spread of disease between herds), it was very easy for many producers to be lured into a management system for PRV, relying on vaccination but forgetting about the importance of eradication.

Through this project, animal health officials learned several important lessons about PRV eradication. First, the PRV vaccines were very effective in lowering the infected herd prevalence. The vaccines also helped herds to shed lower amounts of the virus, which slowed the spread of the disease and allowed operations enough time to cull infected animals. Second, segregating offspring to other buildings and other production sites, along with all-in, all-out pig flow, proved to be a major management tool in preventing PRV spread from one group of pigs to another. Third, determining a herd's PRV status by sampling a statistically valid subset of swine representing the herd saved money and labor, without sacrificing proficiency in detecting herds having 10 percent seroprevalence or greater.

**North Carolina**

The North Carolina PRV Pilot Project was a statewide project initiated in February 1984. In this project, animal health officials established the sampling of culled breeding swine at slaughter plants and, if samples tested positive, traced the animals back to their farm of origin. Regulatory personnel or practicing veterinarians collected samples from a statistical subset of animals from the herd and used the results to confirm PRV infection. Infected herds were quarantined, and animals originating from these herds were allowed to

move only to approved slaughter plants. Animal health officials encouraged the owners of infected herds to clean up these herds by implementing the plans described in the LCI brochure, "Swine Pseudorabies Eradication Guidelines: Plans for Elimination of PRV from a Swine Herd" (see Appendix II). Most often, herd owners chose to use the test-and-removal plan. Animal health officials allowed vaccination only if the herd owner had a permit issued from the State Veterinarian's office.

At the initiation of the project, there were 83 PRV-quarantined herds in North Carolina. Animal health officials collected a total of 56,202 serum samples, and 4,117 (7.3 percent) of these tested positive. Excluding those swine originating from outside the State, animal health officials successfully traced 58 percent of the positive samples back to a farm located in North Carolina. This low rate of successful traceback indicated that the identification of swine going to slaughter was less than adequate. Approximately one-third of these traces led to herds already quarantined for PRV; however, 29 new infected herds were identified using this method.

The North Carolina Pilot Project concluded in August 1986. The results of the study demonstrated that slaughter surveillance could be used to successfully identify infected herds. However, monitoring for PRV could be improved with better identification of animals back to the farm of origin. In addition, cleaning up large herds proved to be difficult, and several examples in the project demonstrated that the virus remained on the premises to infect susceptible replacement animals. Another important finding was that PRV vaccination decreased baby pig mortality and reduced clinical signs, but it did not prevent latency or spread of the virus to susceptible animals. State and Federal officials therefore questioned the economic feasibility of eradicating PRV from large herds versus using vaccination to reduce the clinical impact of the disease.

**Pennsylvania**

During the early 1980s, many Pennsylvania swine owners began to feel that they should not have to accept regulatory action (without compensation) as a result of PRV, unless producers in other States were likewise affected. Since Pennsylvania producers had to compete with producers in other States, it became necessary to level the playing field.

At this point, the Pennsylvania Department of Agriculture (PDA) sought direct input and oversight into PRV control planning from the swine industry. State officials appointed a Swine Health Advisory Committee, which included owners of infected herds, swine veterinarians from the high-risk area in the State, and allied livestock and industry organizations. The committee was invited to review the State's PRV situation and the existing program procedures and make recommendations. As a result of the committee's recommendations, the PDA suspended aggressive eradication procedures in lieu of voluntary herd cleanup plans approved by the committee and the department. These plans could include use of PRV vaccine to minimize virus spread until infected animals were culled. The PDA offered free laboratory testing, paid private veterinarians to bleed swine, and provided nominal funds to the committee to promote the industry-sponsored program.

At about this time, the major swine-producing States collaborating with VS were reaching agreement on a very important issue—the necessity of eradicating PRV from the United States. These States proposed pilot projects to address the issue. Pennsylvania submitted a proposal, which was accepted by VS and an oversight committee from the NPPC.

The Pennsylvania Pilot Project began in October 1983 as a statewide effort that utilized slaughter sampling and traced seropositive samples back to the farm of origin. During 35 months, State officials collected 185,000 slaughter samples, with 1.2 percent test-

ing positive. Of the positive samples, State officials successfully traced 77 percent back to the farm of origin. At the beginning of the project, there were 11 PRV-quarantined herds. An additional 27 PRV-infected herds were detected through slaughter surveillance during the project. Herds found to be infected were quarantined, and herd cleanup was required. Depopulation/repopulation was the most common herd cleanup plan implemented, with depopulation expected to be completed within 8 months. State officials determined that 82 percent of the cleanup plans were completed successfully.

The Pennsylvania Pilot Project taught a number of lessons about the government or industry adoption of disease control measures. These lessons include:

(1) The classification of an animal disease as subject to governmental regulatory action should not be undertaken in the absence of compelling public concerns, unless there is a mandate from the industry involved and a willingness of that industry to influence its constituents to cooperate;

(2) Regulatory action should not be initiated unless the required technical and scientific knowledge, manpower, and monetary resources are available and committed to the task;

3) Regulatory action should be sensitive to unforeseen consequences and flexible enough to manage conflicting issues;

(4) Animal disease control programs should involve industry and academic oversight and advice; and,

(5) Animal disease control programs should be communicated to the animal owners affected by the program in order to achieve their understanding.

**Wisconsin**

Wisconsin initiated its PRV Pilot Project in February 1984. The project included herds located throughout the entire State. It was also incorporated into the State's existing PRV eradication program (initiated in 1976). The highest number of swine herds was located in the southwestern corner of the State. In order to find infected herds, the pilot project utilized testing of all hogs at markets, both at slaughter plants and at the first point of concentration. To control the spread of disease, the project traced PRV-positive animals back to the herd of origin and quarantined all animals, with the exception of those being moved to slaughter. State officials encouraged a 2-year time limit for herd cleanup. The majority of infected herds were cleaned up with depopulation of the whole herd.

The objectives of the Wisconsin Pilot Project included: (1) eradicate PRV from the State; (2) evaluate different PRV surveillance techniques; (3) determine PRV-infection rates among Wisconsin swine herds and pigs on Wisconsin farms; (4) determine the means by which PRV spreads to herds within the State; and (5) determine the effectiveness of various cleanup strategies.

Prior to initiating the project in Wisconsin, the seroprevalence of Wisconsin hogs tested by serum virus neutralization increased from 1.41 percent in the late 1970s to 2.96 percent in 1981. During the first 2 years of the project, State officials found the seroprevalence rate to be 4.76 percent in breeders and 1.7 percent in market hogs. This seroprevalence was low compared to other participating pilot project States where on average 18.8 percent of breeders and 8 percent of market hogs tested were seropositive. PRV vaccine was not permitted in the State allowing positive serum virus neutralization test results to accurately detect infected animals.

State officials found many infected herds during the project and worked with producers to carry out herd cleanup. Twelve herds were known to be infected at the beginning of the project. During the project's implementation, State officials tested 120 herds and identified 35 infected herds. These infected herds were found by successfully tracing positive samples collected from slaughter plants and markets back to the herd of origin. State officials supervised the collection of over 49,500 samples at slaughter plants and markets during the project. Thirty-five herds were cleaned up using depopulation, test-and-removal, or offspring-segregation herd cleanup techniques. Twenty of these 35 herds were depopulated. Wisconsin contributed funds for the project to compensate owners for value over and above slaughter market price. To complete the cleanup plan, State officials required the sale of infected breeding stock to slaughter plants. All owners of infected herds within the State were required to enroll in a cleanup plan.

**Table 6.1. Results of a survey of Wisconsin swine producers estimating the following costs to producers with PRV-infected herd**

| Losses | Costs USD (valued in 1986) |
|---|---|
| Loss of seedstock sales | $848 |
| Loss of feeder pig sales | $673 |
| Nursing pig mortality | $394 |
| Loss of other species of livestock | $172 |
| Stillbirths | $119 |
| Infertility in sows | $94 |
| Abortions | $78 |
| Growing pig mortality | $40 |
| Stunted/poorly growing pigs | $21 |
| Treatment, cleaning and disinfecting costs | Unknown |
| Average total costs/infected herd | $2,439 or about $33 per sow |

The Wisconsin Pilot Project produced several significant findings. First, the project found that sampling culled breeding stock at slaughter plants to find infected herds was most efficient in States with low PRV prevalence. In addition, interviewing Wisconsin producers with infected herds confirmed that not all infected herds experience clinical signs. Only 22 percent of owners of infected herds reported clinical outbreaks. These clinical cases manifested as deaths among baby pigs and stillbirths among females that farrowed. However, herds with lower average herd sizes (73 sows) had fewer abortion problems compared to herds with higher average herd sizes (130 sows). The project also found that the primary economic losses caused by PRV infection were due to quarantines and movement restrictions that prevented the marketing of breeding stock or feeder pigs. PRV caused other economic impacts as well, including deaths among steers due to the disease (reported by a few producers) and losses resulting from stunted/slow-growing pigs that occurred in increasing frequency after the herd contracted PRV. According to producers who participated in a depopulation/repopulation plan, the most costly item was downtime or a loss of cash flow until animals were once again ready for market. Table 6.1 ranks producer costs due to PRV infection from highest to lowest.

Following the pilot project, a Wisconsin economic study estimated the number of PRV-infected herds likely to occur in the State by 1986 for three alternative programs. If the current pilot project intending to eradicate PRV were followed, seven new infected herds would likely occur. If a surveillance-only plan were initiated, 21 new infected herds would likely occur. Lastly, with no PRV program at all, the study projected 130 new infected herds may occur by 1986. Attributing an average estimated cost of $2,439 per herd outbreak (in 1986 dollars), the difference in costs to the Wisconsin swine industry if nothing was done to address PRV would be 19 times greater then pursuing eradication. The obvious benefit to producers in pur-

suing an eradication program is to avoid the immediate losses and costs caused by the disease, as well as the long-term costs of preventing exposure if the disease was to become established within the State.

In summary, the Wisconsin Pilot Project demonstrated that the best method for finding infected herds in Midwestern States with lower-than-average swine herd populations was to sample culled breeding stock at slaughter plants. The project determined that there were significant costs to producers who were prevented from marketing feeder pigs and breeding stock if found to be infected. While depopulation and repopulation was an effective cleanup method, the estimated costs involved for lost animal sales between the time when infected animals were sold and replacement animals could produce marketable swine were significant. Finally, the project estimated that—if Wisconsin did nothing to address PRV—the disease would continue to spread among swine herds and cost the State's swine industry more in the long run.

# Chapter 7—Introducing Eradication

## Debate on Need and Philosophy of Program's Development

In the late 1970s, after a period when a consensus seemed to be developing for eradication, conflicting positions on how to handle the exploding PRV crisis began to emerge. The two sides of the argument were vaccination versus eradication.

There were two developments in 1977 that increased opposition to PRV eradication—CVB licensed a PRV vaccine, and APHIS announced proposed interstate movement regulations. The success of vaccines in limiting losses from PRV infection diminished interest in eradication. Controversy regarding these issues was so strong that it took three drafts and 2 years for APHIS' proposed rule to be finalized.

The major impact of PRV was on seedstock herds, as they were required to clean up the infection in order to remain in business. Hundreds of seedstock herds became infected—sometimes more than once—with cleanup costs ranging up to several hundred-thousand dollars in some herds.

By 1980, sentiment had jelled on controlling the disease until an eradication program could be established. Late that year, seedstock producers called for a relaxation of Federal rules to allow the interstate movement of vaccinated animals. Early in 1981, the NPPC board of directors wanted to drop Federal interstate movement regulations and depend on States to control movements. Several State pork-producer groups from the Midwest took a similar stance as anti-eradication sentiment grew.

A national meeting in St. Louis in early 1981 underscored the deep divisions in the industry. The LCI PRV Committee called on VS to set up a pilot project to establish whether eradication was feasible (see Chapter 6, "Pilot Projects"). A major stumbling block in discussions on eradication was the availability of indemnity funds, which many thought would be necessary in an eradication effort. The pilot project idea was gaining popularity in early 1982. However, the lack of Federal funding threatened to delay actual implementation of the projects.

The NPPC attempted to kick-start the pilot projects early in 1983 by calling on APHIS to either fund them or withdraw Federal regulations pertaining to PRV. After much discussion, the organization pledged $100,000, and APHIS provided $400,000 for the projects. The debate then turned to the issue of indemnity payments.

Between 1983 and 1984, State officials launched pilot projects in Iowa and Illinois (without indemnities) and later in Wisconsin, Pennsylvania, and North Carolina. The projects were designed to answer two questions: (1) Are the tools available to eradicate the disease? and (2) What would eradication cost, and would it be cost effective?

VS had established a Technical Advisory committee, composed of the five foremost authorities on PRV in the United States, to supervise the pilot projects. This committee came to the following conclusion: "By applying tools which we currently have, PRV area control is feasible. It can be accomplished by methods which are acceptable to swine producers and to the program coordinators." During the pilot projects, 97 percent of the herds initially identified as PRV-infected were successfully cleared of the infection.

A preliminary economic analysis indicated that the annual cost of PRV was more than $30 million, principally from vaccination costs. The analysis also showed that the cost of a 10-year program to eradicate the disease would be $167 million. When future program costs and benefits were discounted at a 6-percent rate, the PRV Eradication Program demonstrated an estimated benefit/cost ratio of two to one.

The "vaccination versus eradication" controversy had died down as observers awaited the results of the pilot projects. Those results were discussed at a unique "jury" hearing in January 1986. The jury heard presentations by anyone who wanted to interpret the project results. A month later, the jury met and voted six to one in favor of eradication, recommending that a task force be named to write an eradication plan. That task force, headed by Wisconsin pork producer Hilman Schroeder, presented the "Seventh Draft" eradication plan (named as such because the plan was revised seven times before the task force was satisfied with the contents of the document) for industry discussion in the fall and winter of 1986-87 (see Appendix V).

## Joint Participation and Decisionmaking

Producers were the driving force behind the eradication plan, mostly those whose herds had not been infected with PRV and did not want the infection. They represented the vast majority of pork producers and pushed State and Federal regulators to take action. An early example of this took place during the first national meeting on PRV (see Chapter 4, "Quarantines"), when producers insisted that infected herds be quarantined. This high level of pressure from producers continued throughout the program.

Early on, a number of groups representing both industry and government took responsibility for carrying out these efforts as follows: producers would secure funding, both at the State and Federal level; the LCI committee would pursue the necessary support within the industry; the USAHA PRV committee, with State veterinarians in leadership roles, would submit resolutions to the appropriate authority describing intended language for promulgating future program standards and regulations at the national level; and, State and Federal veterinarians would carry out the program.

State advisory committees comprised of all segments of the industry, an idea adopted from the successful Hog Cholera (also known as CSF) eradication campaign, were a vital part of the effort. Since the eradication program operated on a State-by-State basis, the support of those advisory committees in securing State funding and writing State regulations was invaluable.

Another novel idea involved creation of the National PRV Control Board (see Chapter 6). This six-member board, which included two members each appointed by LCI, USAHA, and the NPPC, respectively, granted initial PRV status to States before the eradication program even began. The functions of the Board continued throughout the program to review the States' applications for a specific PRV status, determine if States qualified for that status, and recommend that VS recognize this status.

## The Role of the Nation's Pork Producers

In an undated speech, titled "Major Obstacles and Solutions in PRV Eradication," at the beginning of the PRV Eradication Program, Dr. Frank Mulhern gave his perspectives about the program. He acknowledged the importance of producer participation in the variety of eradication efforts he had experienced after, at that time, 38 years with the Government and his most current 3 years with the pork industry.

Dr. Mulhern started his speech as follows:

> "Industry participation and active support – it's always been my contention that none of these types of [animal disease eradication] programs can or could be successful without the industry's participation and active support. So that has to be the number one obstacle to the eradication of PRV. This is the first program I know of that is being touted as a producer's program, which is interpreted as their having more control over it. It's really a new role for producers that need[s] to be fully understood by the membership, because it carries a lot of responsibility."

Near the beginning of the eradication program, the NPPC was the primary contractor with the National Pork Board to use producer checkoff funds to deliver programming for research, promotion, and consumer education. For its producer advocacy in policy and legislation, the NPPC used non-checkoff money that was raised through donations and a variety of fund-raising activities. Since the organization had two sources of funding, it could perform an educational and technology-transfer role as well as an advocacy role with Congress and with USDA officials.

In November 1987, a "Summary of Responsibilities" document, proposed by LCI and approved by the organizations involved, outlined the responsibilities of stakeholders in the State-Federal-industry cooperative eradication effort. Those responsibilities stated that the NPPC was to assume leadership for:

(1) Organizing State committees;

(2) Gathering information on progress from State committees;

(3) Preparing and distributing information to State committees, including models of other States' regulations, States' PRV eradication plans, and examples of systems to maintain uniform recordkeeping;

(4) Maintaining relations with members of Congressional delegations, in cooperation with the AFBF, regarding funding for FY 1988 and future years and support for a declaration by Congress on the objective to eradicate PRV;

(5) Consulting with States on preferences and methods to conduct surveillance (case finding) and provide advice to VS;

(6) Preparing and distributing information/education programs targeting the pork producer audience; and,

(7) Coordinating State PRV programs jointly with VS.

The State PRV committees were State pork producer association-driven committees involving the State's producers, animal health officials, and allied industry. These committees reviewed, discussed, and influenced the eradication program within the State. They were central to funneling information and advocacy, beginning with producers and their county organizations to the State level, continuing with coordination by the NPPC at the national level, and ending with APHIS

and Congress. The list of responsibilities delegated to the State PRV committees was as follows:

(1) Provide guidance and advice to State authorities on the type of PRV eradication plan to be developed and initiated in the State;

(2) Provide ongoing guidance and advice to State authorities during the course of the PRV Eradication Program and assume joint leadership with State regulatory officials in carrying out the program in the State;

(3) Keep the NPPC and other interested groups informed of the committee's actions and maintain liaisons with other States and with the national program through the NPPC, LCI, and VS; and,

(4) Provide information/education programs to all segments of the pork industry in the State, appointing an information officer to disseminate this information and keep LCI and others advised.

Most of the program's participants realized that the producers assumed much of the responsibility for organizing, maintaining, and making this program work. The leadership had to start at the farm level within counties. The first objective of the State associations and the NPPC was to take all action possible to eradicate the disease while minimizing the impact on producers. Eradication at the expense of putting producers out of business was not an acceptable conclusion. The program developed several options—including vaccination with a test-and-removal approach, offspring segregation, and depopulation/repopulation—so that producers could have a choice of cleanup methods for virus elimination that would fit with their unique operational and marketing needs.

However, counties that had significant populations of pigs within the State had to have a producer or producers in that county who were willing to help promote the eradication effort at that local level. Those counties held periodic meetings, facilitated by County Extension Education Directors or local veterinarians, to promote the program, provide information, share successes and failures, and give producers the opportunity to express their opinions. At the beginning of the program, those opinions were often not positive. The costs of vaccine, labor, diagnostic laboratory fees (other than those supported by the program), veterinary services, and implementation of biosecurity practices affected producer's profits. The actual costs were substantial but impossible to accurately calculate.

The producer leaders at the local levels were an important factor contributing to this successful eradication campaign. They organized, talked with, and encouraged their fellow producers to participate in the program. They offered their time to their State associations and to the NPPC. In doing so, they set a positive example for other producers.

State producer leaders and their associations had to ensure that their State had the infrastructure and funding necessary for eradication. Working with their State animal health officials and legislators, the State associations developed and implemented an effective premises identification program and data-collecting system within the State with sufficient staff to maintain it. They also lobbied their respective legislatures to pass laws and regulations providing guidelines to follow in a uniform manner to promote progress and avoid setbacks.

Each State was unique in its approach to implement the program because of individual situations. The program was gaining momentum at the same time that the industry was undergoing substantial growth and consolidation. Iowa, for instance, was responsible for finishing approximately 20 percent of the Nation's pigs, but had substantially more small-to-medium sized operations than other States. As an example, in 1992, Iowa reported to VS that 19,599 herds were eligible

to participate in 51 of the 99 counties (34,000 herds estimated Statewide). The State had tested 12,134 of these herds, with 69 percent (8,369) determined not to be infected. Iowa reported that 3,223 (27 percent) of the State's herds were infected, with 2,808 (87 percent) of these infected herds participating in herd cleanup plans. Another 4 percent were under investigation. The magnitude of the effort required a measured approach, because the program had to build acceptance among producers. State officials succeeded in gaining trust by implementing scientifically sound methods that also fit with current pork production practices.

North Carolina was an example in which the majority of pigs in the State were produced by a relatively few companies. Advancing the program in that State required the backing of those companies. In 1992, North Carolina program officials reported to VS an inventory of 8,895 herds, which included 554,000 breeding animals. Of these herds, 412 (5 percent) had been diagnosed as infected, and 97 percent of the infected herds were enrolled in a herd cleanup plan. However, not all herds within the State had been tested. Without the support of the North Carolina producers, the National PRV Eradication Program was at risk of faltering. At the request of VS and with the NPPC's support, LCI called a meeting of the North Carolina companies. At this pivotal meeting, the producers were able to talk as a group to the North Carolina Commissioner of Agriculture about the disease and the eradication program in their State. The cohesiveness of purpose that developed from this meeting spurred the State and producer support necessary to finish the program in that State.

Another unique result of the State-Federal-industry partnership was the industry's role in offering the producer perspective on Federal funding for PRV eradication. The NPPC was particularly vocal in expressing to Congress the industry's strong support for PRV program funding. In addition, VS was willing to accept the industry's input on how Federal funds were allocated to the regions and States to support eradication.

VS' formula for distributing the funds among the States took into account the number of breeding animals and the prevalence of PRV in the State. Since the virus had the ability to become latent in older animals, the breeding herd was considered the most likely to harbor the virus over time. Thus, for eradication purposes, the Federal funds were divided among the States according to the amount needed to eliminate the virus from the breeding herds.

Each year, the VS Regional Directors would meet with the NPPC Swine Health Committee leadership to review the proposed budget and allocate funding to respective States for the following year. The amount derived from VS' formula was the starting point for the discussion; however, producer experience and knowledge of the States' needs played a role in negotiating the final allocations. While the Swine Health Committee had no authority over the allocation of Federal funds, the producer recommendations were carefully considered in VS' decisionmaking. This was another example of a new, cooperative approach that helped in successfully administering a Federal eradication program.

The producers experienced many benefits due to their strong support for the program over the long term. Market and production advantages were a main result of producers' efforts. For example, in December 1998, the Canadian government recognized the United States' great strides in eradicating PRV when that country opened its border for the import (for immediate slaughter) of U.S. hogs from States qualifying for Stage V (Free) PRV status. In 2006, Canada accounted for more than $470 million in trade for the industry, making it the third largest market for U.S. pork products. In

addition, the PRV Eradication Program saw the advent of gene-deleted vaccine technology. Differentiating infected animals from vaccinated animals is now the goal of other disease control and future eradication efforts. The industry also learned a great deal about biosecurity. The program made biosecurity a familiar term to producers, and most have implemented the concept in order to keep their herds secure from the introduction of PRV, as well as other diseases.

Another significant benefit for producers was the advancement of the U.S. swine disease surveillance system. Premises identification was introduced as part of the PRV Eradication Program, and individual sow and pig identification developed further into a usable system. During an NPPC-facilitated effort, State, Federal, and industry partners agreed to an "end game plan." The plan provides an outline of issues that need to be resolved for the country to be officially declared free of PRV in the commercial swine herd. The resulting surveillance plan for PRV is a template for a comprehensive, integrated swine disease surveillance plan in which diseases are selected based on the industry providing input and prioritizing these diseases.

At the close of Dr. Mulhern's speech on the PRV Eradication Program, he concluded:

> "...I have identified what I consider major obstacles facing the program. Namely industry, State and Federal roles, epidemiology, vaccination, large herds, seedstock, feral swine, information/education, communication and cost/benefits.... However, I see the major challenge being the recognition and the need to clearly understand the new roles between the industry, state officials and VS in what is being called 'The Producers' Program of the Future.'"

Certainly, Dr. Mulhern would be proud of the PRV Eradication Program's many accomplishments and the progress it achieved for the swine industry.

## The Role of the Nation's Veterinarians

Veterinarians also played an important role in the evolution of the PRV Eradication Program. In the beginning of the program, they learned from direct experiences about the economic devastation PRV caused for pork producers and the suffering of animals affected by the disease. When PRV spread herd-to-herd through an area, veterinarians were making diagnoses based on the post-mortem results obtained from the necropsy of 5 to 10 baby pigs. High mortality rates, high fever, central nervous system signs, and recognizable gross lesions were evidence confirming the suspected PRV infection and alerting veterinarians to return to the clinic for a shower and a change of coveralls and boots before proceeding to the next farm call.

At first, veterinarians felt helpless to address the disease because there was no treatment available. They were eager to try anything resulting from research efforts that were ongoing at the universities. They conducted on-farm antiserum trials and reported results back to the researcher. They discussed both successful and unsuccessful herd cleanup experiences at annual meetings of the American Association of Swine Practitioners (now the American Association of Swine Veterinarians).

Then, a vaccine for PRV became available. The vaccine was licensed to be distributed only through veterinarians because modified-live products such as this are lethal if injected into non-targeted species. In addition, vaccines can cause antibody response and make differentiating vaccinated from infected animals nearly impossible. For these two reasons, veterinarians were the only animal health care providers permitted to buy and redistribute this product. Disappointment occurred when demand for this new and efficacious product consumed the supply. On several occasions, requests for the product were back ordered, and the product was not available.

At the time the eradication program was initiated, the veterinarian was the natural conduit to disseminate information and facts about the program to his or her respective swine producer clientele. Some States convened meetings to purposefully inform the veterinary community about the latest news regarding the program's progress and new technologies. Producers trusted their veterinarians to explain what the PRV-positive results meant and what would happen when the State department of agriculture quarantined their herds. In fact, many times, the veterinarian was the person entrusted with explaining, implementing, and monitoring an infected herd's cleanup plan.

Veterinarians from various veterinary clinics met with one another to discuss PRV outbreaks, the locations of infected herds, and strategies to clean up herds in specific neighborhoods during a specific time period. They had noticed previously that, if cleanup of infected herds located in close proximity with one another was not synchronized, some of the herds became re-infected. Therefore, veterinarians from several clinics representing different clients organized plans to clean up all infected herds in the same area. By working together and following a similar timeline, area-wide cleanup was possible and progress was demonstrated to the participating producers, veterinarians, and regulatory officials.

Once the number of PRV-infected herds declined, the eradication program placed its emphasis on detecting the last few infected herds. At that time, veterinarians conveyed information to regulatory officials to assist them in selecting prospective herds to monitor through testing. Utilizing information from practicing veterinarians helped regulatory officials design surveillance herd-sampling strategies that yielded better results than random selection alone (see Chapter 8, "Certified Accredited Veterinarians").

In summary, the PRV Eradication Program had numerous factors that contributed to its success. The program was designed well, due in large part to the involvement of a variety of groups and individuals. Regulatory officials gathered comprehensive data and drew on the experiences of veterinarians and others with relevant expertise in order to make informed decisions. And, perhaps most importantly, they solicited input from most stakeholders before proceeding with the program and provided benefits to program participants far beyond the original objective of eliminating PRV from swine herds.

# Chapter 8—Implementing the Plan

## Surveillance and Case Finding

For the purpose of animal health protection, monitoring is the routine collection of information for a disease condition, characteristic, or state in an animal population. The purpose of collecting this information is to detect changes in the epidemiologic parameters affecting the population. Surveillance then involves the analysis of those collected data so that VS officials can plan and take the proper actions to ensure the safety of U.S. animal health.

As with all animal disease eradication programs, case finding and surveillance are important components of the PRV program. These activities are required to determine whether the occurrence of PRV is being affected by new factors. Results from implementing surveillance methods may disclose PRV reactors (animals with positive results on a PRV test) that originate from PRV-infected herds. Program officials may also implement sample collection methods to monitor swine herds and ensure that the populations remain negative.

The PRV Eradication Program used six sampling methods for monitoring commercial swine populations. A few States also monitored the risk of PRV transmission to commercial swine posed by feral swine populations. Program officials must consider several factors when deciding which sample selection method to implement. These factors include: (1) the stage of the eradication program; (2) the number of available trained staff to collect samples; (3) the amount of funding available to collect and test samples; (4) the sample testing capacity at the laboratory; (5) the expected disease prevalence within the population; and, (6) the purpose for collecting samples.

In most cases, a combination of sample selection methods may provide the best information. For example, in areas with dense swine populations and a high prevalence of infected herds, funding may be better utilized to find new cases quickly. In areas where new outbreaks are not expected, it may be more prudent to randomly select herds for testing, provide equal chance for animals to be sampled, and monitor disease incidences over time. This long-term disease monitoring may be used to provide information regarding the effectiveness of the program.

**Area Testing**

Sampling all swine herds within a designated area during a specified time period was called either area testing or "down-the-road testing" (DTR). The areas were defined as a county, township, or region within a State. Herds within the area were first identified by individuals who were most familiar with the area, such as pork producers, county extension education directors, or veterinarians. Since PRV serological tests were known to have sensitivity and specificity rates approaching 100 percent, program officials determined that sampling a statistical subset of the total number of animals comprising the herd would satisfactorily detect at least one PRV reactor if present.

Prior to and during the Illinois PRV Pilot Project, State officials tested a subset of breeding animals to determine the disease risk associated with moving feeder pigs from a herd. The subset included testing all animals in breeding herds containing 10 or fewer animals, testing 10 animals in herds containing 11 to 35 animals, and testing 30 percent (or up to 30 animals) in herds with 36 or more breeding animals. Later, other States adopted similar subset sampling criteria using statistical formulas that determined sample sizes based on changing prevalence, population size, and a selected probability.

It was common with area testing to use the official random-sample test as published in the State-Federal-industry Program Standards, also known as the "95/10 test." This subset determined the number of samples to test from the population if the expected PRV se-

rological prevalence was 10 percent or greater, and the confidence for detecting at least one serological positive animal was 95 percent. In herds with fewer than 100 animals, 25 animals were sampled; with 100 to 200 animals, 27 animals were sampled; with 201 to 999 animals, 28 animals were sampled; and, when herd size was 1,000 animals or greater, 29 animals were sampled. In order for this subset to be statistically valid and accurately determine the PRV status of the herd, the sample collector had to select animals at random or ensure that all animals in the group being tested had equal likelihood for being exposed to the virus. Whenever offspring of breeding animals were raised separately without exposure to their dams, these grow-finish hogs were considered a separate population. These subsets seemed to predict herd PRV status accurately because most infected herds had greater than 10 percent seroprevalence.

In States where many herds were vaccinated for PRV, and fewer herds were being diagnosed with PRV, a statistical subset was based on an official random-sample test meeting a 95/5 criteria. Program officials would collect additional samples from the herds to ensure that at least one seropositive animal would be detected with a 95 percent confidence if the seroprevalence was expected to be 5 percent or more. A 95/5 sample size included the following: in herds with fewer than 100 animals, 45 animals were sampled; with 100 to 200 animals, 51 animals were sampled; with 201 to 999 animals, 57 animals were sampled; and, when herd size was 1,000 animals or greater, 59 animals were sampled.

There were several advantages to using area testing. Program officials would determine the PRV status of the herd as soon as test results were available. In addition, they could determine and record the animal's identity and description at the time of sample collection. The animal's vaccination status and the brand of vaccine used on the animal were also known at the time of sample collection. If test results were suspicious, the animal could be retested, and herd sampling intervals could be scheduled. Furthermore, the sample size was predictable even from herds of varying and large population sizes. This helped program officials estimate budget and laboratory capacity needs more accurately. This method also permitted the sampling of animals from different age groups. In some instances, veterinary practitioners were hired on a fee-for-service basis to collect samples from their client's herds (see fig. 8.1). This method of sampling produced satisfactory results in areas with high PRV prevalence, high vaccine use, and dense swine populations.

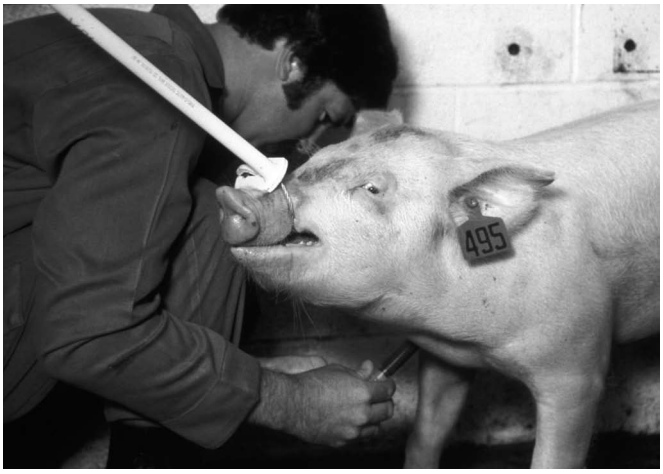



Figure 8.1. Collecting a blood sample for PRV testing. *(Photo by George W. Beran, R Allen Packer Heritage Room)*

At the same time, program officials found several disadvantages when using area testing. First, because it was necessary to pay sample collectors to drive to the farm and spend time restraining animals, recording information, and collecting blood samples, the total cost of collecting the samples was higher. Second, the results of area testing only represented a snapshot in time, as the herd status was determined on the same date the samples were collected. Although random sampling of animals was encouraged, animal selection bias may have occurred. Lastly, herds that had not been identified could not be sampled. In fact, a herd owner could refuse to present their herd for testing unless regulations were in place to mandate the sampling.

**First-Point Testing**

Collecting samples at the first point where animals were transported and a change of ownership occurred was called first-point testing. Change of ownership occurred whenever breeding animals were removed from the herd and sold to a slaughter market or to a livestock auction market. Some States used these market locations to collect blood samples. This strategy provided a method to periodically sample animals originating from many herds that were being gathered at relatively few concentration points.

There were a number of advantages to first-point testing. First, this method allowed for swine to be tested soon after they left the herd of origin. Second, program officials could obtain an accurate identity for the herd of origin at the time of the sale. Third, a record system could be used to control the number of samples collected annually from each farm. Fourth, because the animals were in marketing channels for only a short time period prior to the collection of the sample, the animal was unlikely to seroconvert from contact with infected swine originating from other herds. Fifth, since samples could be collected from animals originating from multiple herds at one location with less labor cost, first-point testing was less expensive than area testing on a per herd basis. And finally, this method identified herds not previously listed by program officials.

There were several disadvantages to first-point testing as well. For example, it was necessary to hire additional staff to collect samples at these markets. Another disadvantage was that the animal's vaccine status was not likely available at the time the samples were collected. In addition, first-point testing may oversample large breeding herds and undersample smaller breeding herds due to the frequency of marketing animals from these herds, respectively. This method also required additional tracing and testing at the herd of origin before a herd status could be confirmed. Lastly, market weight swine were less likely to be sampled using this method since they were customarily hauled directly from the farm to the packing plant. As a result, unless adjacent States followed the same sample collection method, animals transported to markets bordering several States were not sampled.

**Slaughter Surveillance**

Collecting samples when swine were processed at the slaughter plant was known as slaughter surveillance, or market swine testing. When breeding swine were culled from their herd of origin, they were either delivered directly to a hog market or to a packing plant. In either case, the animals were identified by waterproof identification tags, each containing a unique number. The tag was affixed with glue to the hide on the back of each animal. Due to its location on the animal, the identification tag was also referred to as a "backtag" (see fig. 8.2).

The owner of the animal was recorded based on each numbered tag or series of tags. When the animal was stunned and exsanguinated, a blood sample and the identification tag were collected and maintained together. At the laboratory, samples that tested positive were reported, along with the unique tag number, to officials of the State in which the market was located. Program officials used records kept at the market to match the identification tag number with the owner. Once they identified the herd of origin, program of-

Figure 8.2. Culled sow identified with a backtag. *(APHIS photo by Lowell Anderson)*

ficials conducted an investigation to determine how many additional blood samples to collect from animals comprising this herd. They then used the results of these tests to determine the herd's PRV status.

Like the other surveillance testing methods, the collection of samples at slaughter plants had many advantages. Most notably, the cost of collection per sample was lower than any other collection method implemented. In addition, throughout the year, shipments of animals originating from the same herd were likely to be sampled numerous times; this provided the opportunity to monitor the herd year-round. Another important advantage of slaughter surveillance was that it provided the opportunity to test all herds transporting culled breeding swine to slaughter, as long as backtagging procedures were followed, and tags remained affixed to the hide until program officials could collect a sample and the identification tag. And finally, this method identified breeding herds not previously listed by program officials.

However, there were also several disadvantages to using slaughter surveillance. First, this method required accurate placement of backtags, accurate recordkeeping, and adequate retention of identification tags. Slaughter surveillance also required contacting a third party—who was not hired by the regulatory authority or the swine owner—to review records and report the owner's name that matched the identification number to the sample. In addition, program officials would not know the PRV vaccination status of the animal until they completed an investigation of the farm of origin. Furthermore, tracing the animal to the correct herd of origin was dependent upon the accurate pairing of the identification tag with the blood sample, both at the packing plant and at the laboratory.

Several other disadvantages of slaughter surveillance were that, because the herd's PRV status was unknown at the time of sampling, program officials collected and tested extra samples that otherwise were not needed. The program also incurred additional expenses to trace back and investigate known infected herds, due to repeated positive samples from PRV-infected breeding swine that were sent to slaughter plants. Samples were likely to be of poorer quality and arrive at the laboratory in less than ideal condition for testing because shipping to regional laboratories for testing would take several days, and samples could not be maintained at chilled temperatures during summer months. Market swine were not routinely processed at slaughter plants that receive breeding swine and therefore were not included in this type of slaughter surveillance. However, a method to sample these market swine was developed later in the program. See the "Meat Juice Testing" section later in this chapter for a description of a method to sample market swine at other slaughter plants.

**Monitoring at Diagnostic Laboratories**

Another method of monitoring the swine population for PRV was to test specimens from sick or dying pigs submitted to diagnostic laboratories (see fig. 8.3). This method of detecting PRV cases was established early in the eradication program. Veterinarians who suspected PRV in their clients' herds would submit samples and request testing for the disease. Many of the States required both veterinarians and diagnostic laboratories to report PRV-positive cases to the State Veterinarian. However, near the end of the eradication program, requests for PRV testing occurred less frequently. This was due to the breakthroughs in technology that occurred as the program progressed and resulted in the creation of more specific tests—namely, immunohistochemistry and polymerase chain reaction (PCR)—to detect the presence of disease-causing agents. With these new testing methods available, laboratories seldom used the isolation of viruses in cell cultures for diagnosis. Therefore, unless PRV was specifically included on the disease rule-out list, an assay specific to PRV may not have been used.

Figure 8.3. Maintaining vigilance for cases that may involve PRV at the diagnostic laboratory.
*(Photo by George W. Beran, R Allen Packer Heritage Room)*

In response to this decrease in PRV diagnostic testing, several States established monitoring programs that provided laboratory diagnosticians with a case definition for PRV and funding to perform Direct Fluorescent Antibody and confirmatory PCR on tissues submitted from PRV-suspicious cases. The programs also allowed for PRV testing on up to five serum samples submitted from field cases. This type of monitoring gave program officials an important advantage—the ability to target cases that exhibited clinical signs similar to PRV. Laboratories were able to detect clinical cases involving PRV that otherwise could have been missed if tests for PRV had not been requested when diagnostic samples were submitted. This method of targeting PRV-suspicious cases allowed program officials to detect PRV at the start of a clinical outbreak perhaps more rapidly than any other surveillance method described. In addition, the cost to the PRV program was minimal, as the samples had already been collected for other reasons, and the program was only obligated to pay for PRV assays.

The main disadvantage of monitoring for PRV at diagnostic laboratories was that the samples collected and tested were at best convenience samples and dependent on being submitted to the laboratories. Owners of PRV-infected herds who feared detection or possible quarantine could choose simply not to submit samples. Furthermore, small-scale farmers with limited financial resources might not submit samples to diagnostic laboratories due to costs. As a result, cases of PRV could be missed using this disease-monitoring approach.

**Herd Testing for Certification**

Testing has occurred throughout the PRV program to maintain known negative herd status, or the negative status of individual animals moving between States or to exhibitions. Although negative herd status and individual animal testing were not usually included in monitoring or surveillance methodologies, the results do provide useful information regarding animals that comprise these segments of the swine population.

The terms PRV-monitored feeder-pig herd, Qualified PRV-Negative (QN) herd, and Qualified-negative Gene-altered Vaccinated (QNV) herd provided assurances to purchasers of animals originating from these herds that periodic PRV testing had been completed with negative results. This was particularly advantageous to purchasers of breeding swine or feeder pigs wanting assurance that purchased stock were not infected with PRV. If breeding animals did not originate from a QN or QNV herd, each animal being sold would have to be sampled and test negative. Individual animal testing was not only an inconvenience but also costly for herd owners who sold high numbers of breeding swine frequently. A history of repeated negative PRV tests helped buyers and regulatory officials develop confidence that these herds were not infected, and that animals moving out of these herds were not likely to spread PRV to other herds. The Pseudorabies Eradication State-Federal-Industry Program Standards are found in the appendix of this booklet (see Appendixes III and IV). These standards provide details about how herds attained and maintained these negative herd statuses.

**Meat Juice Testing**

The swine industry incurred substantial changes in structure and production practices after the initiation of the National PRV Eradication Program. Prior to 1989, farms were predominately single-site or locally-based production operations, with breeding sows and finishing pigs held in close contact and under the same daily management. Breeding herds were situated in all major production areas. Therefore, testing resident breeding herds provided diagnostic inferences for all classes of swine. With the institution of multi-site and early-weaning production, geographically-dispersed farms and concentrated production of age-specific swine became the norm. Farrowing and nursery capacities moved to areas with previously low swine density, while finishing sites congregated in contiguous geographic areas to facilitate feed, marketing, transport and management controls, regardless of breeding herd location. As a result of these changes, large concentrations of finishing swine were held in areas without the presence of breeding animals to act as PRV sentinels under established surveillance programs. In Iowa, historic feeder pig sources in Missouri, Minnesota, and Wisconsin were supplanted with weaned pigs being delivered from North Carolina, Georgia, Oklahoma, Colorado, and Canada. During the 1990s, new finishing capacity was being built daily, often with minimal knowledge on the part of local animal health officials. As a result, a large population of swine was deployed without a regulatory apparatus to monitor PRV program progress. These conditions were not unique to Iowa, having been replicated to a lesser extent throughout the Midwest, the southeastern States and southwestern plains of the United States, and the western plains of Canada.

The emergence of large populations of finishing swine that were not linked geographically to their breeding sites created surveillance voids for PRV. Test-negative breeding herd offspring and feeder swine delivered (interstate or intrastate) to the finishing sites became infected by local aerosol spread or breaks in biosecurity, maintaining an undetected reservoir of PRV infection. Reliance on traditional breeding animal and movement testing to determine area PRV status became less meaningful. Monitoring these reservoirs through DTR testing was also limited, due to the volume and frequency of shipments involved. Without an active market swine surveillance system, a substantial PRV reservoir could—and did—exist without detection.

In 2000, a researcher from Iowa State University (ISU) proposed a pilot market swine project to assess PRV antibody presence in infected herds utilizing meat juice technology, as previously developed and implemented in the Danish Salmonella Control Program. Meat juice, a liquid released from a meat sample after it is frozen and allowed to thaw at room temperature, contains antibodies and other extra- and intra-cellular materials that reflect antemortem animal status. Meat samples

are readily available after carcass evisceration, which enables flexibility in sample procurement, and can be readily obtained under safe and sanitary conditions without materially reducing the value of the carcass (see figures 8.4 and 8.5). Abattoirs routinely used lot identification (tattoo, lot number) for producer payment. Therefore, this identification method, a mechanism previously verified by State or Federal regulatory agencies and by producer oversight, was proposed as the best choice for sample procurement and tracking (see fig. 8.6).

Also in 2000, researchers at ISU, in cooperation with USDA's APEP, conducted a preliminary test of 196 paired sera and meat juice samples obtained from finishing swine in 4 PRV-infected herds. Both negative and positive sera values were present in these four herds. After the meat samples were frozen and thawed, and the juices decanted, the samples were tested using the IDEXX HerdChek® ELISA-gpE protocol for sera. The same positive-negative cut-offs were used for both sera and meat juice, and the meat juice samples received no further processing. The individual comparative results indicated a 97 percent agreement between sera and meat juice samples for the 196 test animals. All but six animals were classified the same as the paired samples. Meat juice samples in these six animals were either suspect (five) or negative (one) and sera positive. Based on this data, a task force of State and Federal regulatory officials, State and national pork producer representatives, and the ISU College of

Figure 8.4. Collecting a meat sample from the pillar (crus) of the diaphragm. *(APHIS photo by Lowell Anderson)*

Figure 8.5. Meat sample sealed in a container and identified by sample number. Will be frozen overnight then thawed to yield meat juice for testing. *(APHIS photo by Lowell Anderson)*

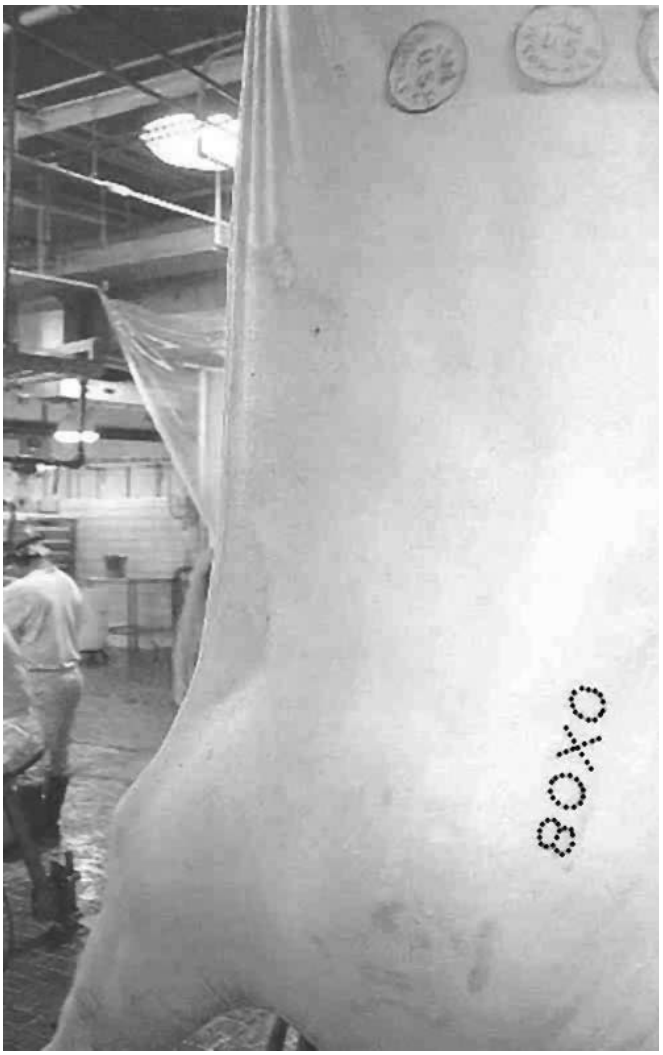


Figure 8.6. Tattoo (photo enhanced) placed on carcass, identifying carcass to the owner. *(APHIS photo by Lowell Anderson)*

Veterinary Medicine (CVM) was assembled by individuals interested in garnering support for a pilot program. Based on the task force's deliberations and its vision for requisite characteristics of a case-finding project, State and Federal PRV officials approved a 3-month pilot project to determine the potential of meat juice technology as a market swine surveillance tool.

The project leaders solicited cooperation from meat packers to enable sample and ownership data procurement and established a processing laboratory at ISU CVM. In March 2001, the first three meat packing plants began sampling and reporting ownership for each lot of swine presented daily. The ISU Veterinary Diagnostic Laboratory analyzed these samples and reported all positive results to the Iowa State Veterinarian for evaluation and traceback. Based on early evidence of its effectiveness, this pilot was expanded in 3 months to 8 major abattoirs in Iowa, representing approximately 25 percent of the daily national market swine capacity. Producer identification data indicated that approximately 66 percent of the herds being monitored for PRV using this method originated in Iowa; the remaining herds were traced to 10 surrounding States, predominately the 7 contiguous States. The pilot project detected a total of 13 new infected sites in Iowa from March to October 2001. These sites had not been discovered during extensive semi-annual DTR testing in the Stage II counties of Iowa throughout 2000 and 2001. Members of the task force modified sampling rates based on the findings of the pilot project and as program needs shifted from case finding to area surveillance.

Over the next 3 years, animal health officials found no new infected herds using market or other surveillance methods in Iowa. This demonstrated the value of market swine surveillance in both case finding and area surveillance. Subsequent studies have demonstrated meat juice as a satisfactory antibody detection medium for a range of viral, bacterial and parasitic agents in swine. These market surveillance techniques offer opportunities for a variety of antibody detection projects which may generate population data that will be useful in the development or monitoring of future control/eradication or certification programs.

**Feral Swine Monitoring**

States with populations of feral swine may have a reservoir of PRV that continues to be a risk factor for reintroducing PRV into the commercial swine population (see Chapter 11). In several of these States, animal health officials created a method of monitoring and surveillance to assess this risk. These monitoring programs were implemented as a portion of the State's feral swine management plan. The programs included sampling feral swine and commercial herds that were raised outdoors and faced potential exposure from feral swine in areas where those animals had been reported. State departments of natural resources and/or State agriculture departments encouraged active trapping and hunting programs and instructed trappers/hunters to alert regulatory officials regarding the capture or kill of feral swine. Whenever possible, State or Federal officials harvested blood or tissue samples and submitted them to diagnostic laboratories for PRV testing. Furthermore, because swine from herds raised outdoors were at risk for direct exposure to feral swine, they were selected for area testing to redetermine their PRV status. In addition, States with longstanding populations of feral swine recognized that feral swine were sometimes captured and sold as feeder pigs. These States understood the interface and possible contact within markets between commercial swine and captured feral swine. Therefore, a number of States initiated first-point testing to detect PRV-infected feral swine or domestic swine exposed via contact with feral swine at these markets.

In summary, regulatory officials used a variety of methods to collect samples for PRV surveillance or case finding. Each of these methods had several advantages and disadvantages, as described above. Overall, States were able to select a combination of methods

based on their swine populations, disease prevalence, available funding, and individual objectives.

## Herd Cleanup Options

Individual plans for eliminating PRV from each infected swine herd were critical to the success of the eradication program. State officials and producers found several types of herd cleanup plans to be effective. They implemented each plan according to specific factors pertaining to the herd, the owner's short- and long-range pork production plans, and the associated costs. The Pilot Projects (see Chapter 6) provided information to help resolve which plans were of benefit and under what conditions each plan was most effective in eliminating PRV from the herd. Details for each type of plan and guidelines for their use can be found in a brochure printed in 1990 by LCI, titled "Swine Pseudorabies Eradication Guidelines: Plans for Elimination of PRV from a Swine Herd" (see Appendix II).

The PRV Eradication Program used several plans to eliminate the disease from swine herds. The three most commonly used plans were test-and-removal, offspring segregation, and depopulation/repopulation.

**Test-and-removal** was a plan that eliminated PRV from breeding herds by testing all sows and boars, removing all seropositive animals, and transporting those animals to slaughter. Thirty days after the removal of seropositive animals, all remaining animals in the herd were tested again. Testing the whole breeding herd continued every 30 days until no reactors were detected in 2 consecutive tests. This plan worked best if the breeding herd's seroprevalence was initially 20 to 25 percent or lower. The plan also worked better for herds in which the spread of PRV from infected to susceptible animals had been stabilized. Another main factor in the success of this plan was that breeding swine were not exposed to infected weaned pigs. PRV vaccines could also be used to help reduce virus shed, minimize the duration of the shedding period, and increase the dose needed to infect susceptible animals. The test-and-removal plan helped producers save valued genetic lines. However, if this plan failed, State officials and producers considered other plans. An optional phased test-and-removal plan with vaccination was implemented in some cases. In this plan, the breeding herd was vaccinated, and the seropositive animals were identified. Instead of removing the reactors immediately from the herd, the animals were allowed to farrow and wean their litters prior to culling. This helped the owner maintain pig flow and plan for replacing reactors with breeding females that had tested negative for PRV.

**Offspring segregation** was another plan that eliminated PRV from the breeding herd. The implementation of this plan included vaccinating the infected breeding herd, weaning their piglets into a separate nursery, segregating replacement gilts from older breeding swine, and replacing all older breeding animals with new, known negative, vaccinated, bred gilts. This complete removal of the older infected breeding herd over time ensured that pig flow was maintained. The plan also allowed genetic lines to be maintained, was cost efficient, and was most effective in areas of high swine density and areas with a high prevalence of PRV-infected herds.

**Depopulation/repopulation** was the third method used to eliminate PRV from swine herds. Although this plan was costly, it was most likely to succeed compared to the other two herd cleanup plans. The depopulation/repopulation plan was designed for implementation in herds with active PRV infection, PRV seroprevalence rates above 75 percent, and other significant production problems. It could also be used in herds with multiple existing disease conditions, or in herds that had tried other cleanup plans but failed. This plan called for 100 percent removal of every porcine animal from the farm site and cleaning and disinfection of all equipment, pens, and manure handling systems to eliminate the virus. It was also

recommended that no swine be permitted to repopulate the premises for at least 30 days following disinfection with an approved disinfectant. Furthermore, it was strongly recommended that the owner design and implement a pest control management plan and a biosecurity plan to prevent reintroduction of PRV from varmints and other sources of the virus.

State officials and herd owners considered many factors in determining which cleanup plan would be most effective in eliminating PRV from an infected herd. These factors included the type of operation involved; genetic value of the animals; status of the clinical outbreak; seroprevalence; density of other herds in the area; number of other PRV-infected herds in the area; the owner's future production goals; any other existing diseases in the herd; time limits to eliminate PRV; season of the year; and, cost to implement the plan. With this broad number of factors to consider, program officials strongly encouraged the owners of PRV-infected herds to contact their animal health care professional and a regulatory veterinarian to work cooperatively with them in designing a cleanup plan unique to their respective herd. The details of these plans were documented in writing and included periodic testing and evaluation to monitor the plan's progress. Giving producers flexibility to choose from several types of plans helped to eliminate PRV from many herds over varying periods of time.

Some herd cleanup plans worked better than others, but all were designed to coordinate with the producer's current and future production plans. In areas with high herd densities and high infected-herd prevalence, it worked best to implement these plans in a coordinated effort among multiple owners. The use of PRV vaccine—especially the gene-deleted vaccines that permitted differentiation of field-strain antibody from vaccine antibody using companion ELISA serum assays (see Chapter 5)—proved to be a benefit for assessing the effectiveness and progress of elimination plans.

## Data Management

Data management systems created during the PRV pilot projects and widely implemented during the PRV Eradication Program spanned nearly 20 years. In that time period, there were drastic changes in the computing platforms available for use; many new communication routes and technologies (i.e., e-mail, cell phones, and Internet) developed and advanced during this time. This section will outline in general terms the flow and utilization of data during the PRV pilot projects and eradication program.

**Eradication Network**

Beginning at the local level, producers and private veterinarians discussed and debated the incentives versus disincentives for participating in and advocating for the eradication program. They received information from the State-Federal regulatory officials including test results, written cleanup plans, and requests/justifications for testing. They attended local meetings on PRV with other producers and private veterinarians, as well as industry representatives and veterinarians representing the State and Federal governments and universities.

At the State level, there were field veterinarians who also worked at the local level. The State Veterinarian and Federal AVIC maintained separate but interdependent staffs that included data entry clerks, animal identification coordinators, animal health technicians, epidemiologists, livestock inspectors, compliance officers, laboratory technicians, and field veterinarians. These staffs maintained data flow and records for PRV eradication activities within the State. They utilized computer and other databases to record the activities and plans.

At the Federal level within each region, there was a staff that included an epidemiologist to facilitate data sharing among States within the region and among regions. These staffs were also charged with oversight of the programs within the States of their respective region. At the national level, a staff of veterinarians dedicated to swine health/diseases was charged with compiling national statistics on the program and administering the policy aspects and funding of the eradication program. Following a review of a State's application and a recommendation by the National PRV Control Board, this staff recognized the program stage status for each State.

**Routine Reporting Elements and Channels**

The Veterinary Services Form 7-1, entitled "Pseudorabies Control/Eradication Quarterly Report (VS 7-1)," was available in 1988 and, in subsequent years, became a major reporting instrument throughout the eradication program. The report contained the data elements maintained at the State levels that were reported to VS and tracked on a national basis. A small committee consisting of a university professor, a Federal regional epidemiologist, a Federal field veterinarian, and the national PRV program leader characterized the data elements and developed the structure of this form in 1987 to 1988. The VS 7-1 was rapidly adopted for use in the program.

USDA required the VS 7-1 report to be completed at the State level and sent to both the VS regional and national offices within 30 days of the end of each quarter. The reports were typically submitted by mail; however, in the last few years of the eradication program, these reports were submitted electronically on a monthly basis. There were six major sections or categories of data elements on the VS 7-1 report (see Appendix VI).

Section A was entitled "Herd Status Data" and tracked the number of herds and number of swine that were classified in several status categories: infected, qualified-negative, feeder-pig monitored, qualified-negative vaccinated, and under a herd cleanup plan. Only one of the first four categories was appropriate for a herd at one time, and positive herds may or may not have been under a cleanup plan. For each status category, the number of herd/swine at the beginning of the report quarter, end of the quarter, and added/removed during the quarter was recorded.

Section B, "Market/Slaughter Surveillance Data," summarized data from slaughter and first-point testing programs, including the number of samples and number of positive swine tested. The data was further characterized by reporting samples collected within the State and collected in other States. Testing completed by other States on swine originating from the reporting State was also summarized in the same manner. This section included both breeding stock and finishing pigs.

Section C, "Traceback of Market/Slaughter Surveillance Positives," recorded the results of tracing individual PRV-positive animals whose blood was collected from both slaughter plants and first-point testing programs. There were nine possible result categories: total positive samples, trace not required, trace to known infected herd, traced and herd test required, traced and herd test not required, traced to sold out herd, traced to another State, unable to trace, and pending. States reported the number of tracebacks that occurred within the quarter for each of these categories.

Section D was the "Summary of PRV Vaccination." A checkmark indicated whether or not vaccination was permitted or not in the State. If vaccination was permitted, the name of the vaccine product, the number of breeding herds/swine vaccinated with the product, and the number of finishing herds/swine vaccinated were listed.

Section E, "Source of New Herd Infections," listed the herds with new infections based on eight categories for the possible source of infection. These categories included purchased feeder pigs, purchased breeding swine, feral swine, feed bedding, area spread, infected swine carcasses, created by herd division, and unknown.

Section F was the "Summary of On-Farm Testing Results." This section included 15 different reasons for testing and asked States to report the number of herds and corresponding swine they tested, specifying the numbers where no infection was found and where infection was found. On-farm testing for surveillance purposes—using a statistically-based sampling of the herds within the State—was recorded under the reason of area testing.

Another routine mechanism for reporting PRV data occurred as a result of the five eradication stages (see Chapter 6, "Program Standards") that were developed to demonstrate the progress of States in meeting eradication objectives. States made a yearly application for either a new status or renewal of the previous year's status. The National Animal Health Programs staff and the National PRV Control Board received these applications from the States for evaluation. The applications changed in structure and format over the course of the eradication depending on the issues of importance. Data presented by the States included demographics of the swine industry; surveillance methods and results; results of traceback investigations on positive tests; progress of cleanup plans, if any; and in the later years, a management plan for the prevention of infection posed by feral swine. The State's specific practices were compared with the criteria detailed in the Program Standards of the stage for which the State applied.

**Systems for Managing Pseudorabies Data at the State Level**

Data maintained at the State level was important for accurate reporting throughout the PRV eradication network. With the development of the VS 7-1, the data requirements were solidified in the first year or two of the eradication program and remained very consistent to the end of the program. Having consistent data requirements and elements simplified the recordkeeping aspects of the PRV Eradication Program. Computers were utilized to maintain records of the data, even from as early on as the pilot project years. Over the course of the eradication program, computer software and hardware changed as new technology became available.

During the pilot projects and in the first couple of years of the eradication program, individual State-developed computer recordkeeping systems were used for PRV data. State officials developed such a system to record information during the Iowa Pilot Project. This system and those in other States were written in Dbase III and related database languages for MS-DOS, the standards at that time. These systems maintained the basic data to complete the VS 7-1–herd information, herd testing results, herd status information, herd cleanup plan options, vaccine usage, and surveillance testing, among other things. In 1990, an Oracle database system named Pseudorabies Reporting Management System (PRMS) was made available from VS' Centers for Epidemiology and Animal Health (CEAH). This database was based on the data elements of the earlier systems. However, the PRMS included additional features—such as invoicing and fee basis payment to accredited veterinarians—to assist in managing the program at the State/local level. Fifty percent of the States utilized the PRMS for their recordkeeping needs; those not utilizing the PRMS de-

veloped their own State-based systems, which ranged from relatively simple spreadsheets to very sophisticated database management systems. The PRMS was used until 1999, when the Generic Database (GDB)—another oracle-based application—was introduced to replace the PRMS and other program-specific systems from CEAH. The GDB was a Microsoft Windows-based, client-server application. The major change it introduced was the combination of data models from multiple program-specific databases into a single database structure.

Near the end of the PRV program and during implementation of the APEP, VS provided a public Web site to publish fair-market value prices. This site provided for the first time a real-time reference for information used to calculate indemnity payments, ensuring rapid depopulation of PRV-infected herds and prompt payment to herd owners. This information was accessible to both program officials and to pork producers.

## Laboratories

Laboratories were critical to the eradication effort and provided important information regarding the PRV status of not only animals, but also swine herds. Nearly all States had testing capabilities for PRV during most of the eradication program; some States had more than one laboratory approved to conduct PRV assays (see fig. 8.7). In later years of the program, when the numbers of tests were decreasing, there was a gradual consolidation of laboratory testing with several high-volume regional laboratories doing the bulk of the testing.

Early on in the program, many States had State-Federal cooperative laboratories conducting PRV tests. These laboratories were often under the direct supervision of State animal health officials. Some States arranged contracts for PRV testing with their respective university diagnostic laboratory. From the beginning of the PRV Eradication Program, NVSL maintained

Figure 8.7. Assaying serum samples at the laboratory. *(APHIS photo by Lowell Anderson)*

oversight over these diagnostic laboratories, formally approved each diagnostic assay, and evaluated the proficiency of the laboratories to match the results by testing a panel of serum samples with known PRV status. State and Federal officials were responsible for coordinating with the laboratories to maintain records and track test results.

## Review/Oversight

Data from the recordkeeping systems was crucial for program oversight at the regional and national levels. Regional epidemiologists conducted informal review visits in States at various intervals, but not usually more than once each year. During these visits, the epidemiologists reviewed computer and paper records related to the PRV program. They presented their findings and recommendations to State and Federal officials with the intent of bolstering the State program. Other, more formal reviews provided oversight to States regarding their programs; these reviews—known as station reviews or program reviews—were conducted every few years, with certain key States reviewed more frequently, sometimes on a yearly basis. Station reviews were generally conducted by Federal employees and involved evaluating the operations of the Federal office in the State. The PRV program was often a part of this review. Program reviews were focused on a specific disease program, such as the PRV

program. In general, these reviews were conducted by a team of people, including: one to three Federal employees (veterinary epidemiologist, animal identification coordinator, and others), one State-employed veterinarian, and one producer or industry representative. The team's participants—representing State, Federal, and industry interests—corresponded with the cooperative State-Federal-industry nature of the eradication program. The team visited the State for one to two weeks, reviewing the computer data and documents, interviewing the appropriate officials, and visiting field, laboratory, and office sites, among other activities. The team members wrote the results of their evaluations, and a team leader compiled these results into a single report for distribution back to State, Federal, and industry stakeholders. The States were then asked to respond to the recommendations in the team's report. This review and oversight process helped to facilitate modifications in individual State programs, if needed, that would ultimately hasten the nationwide eradication of PRV.

## The Iowa Effort

This chapter would not be complete without a description of the methods used on a statewide basis to achieve the PRV eradication objectives. Those involved in the eradication effort had recognized many times that the infected herd prevalence and within herd seroprevalence were usually greatest in areas containing higher numbers of swine herds located within relatively small areas. In Iowa, the State had experienced PRV since the 1970s. Because of the disease's longstanding presence in the State, program officials expected Iowa to detect more PRV-infected herds per 1,000 herds than any other area. Therefore, it was necessary to develop and implement a special plan to achieve success in addressing the State's PRV situation. The goal of success was not only meaningful to the stakeholders residing in this State, but also to the rest of the pork industry anxiously awaiting the outcome. The actions taken to eradicate PRV in Iowa stand as a useful example of what to consider when planning to eliminate the disease from areas with high densities of both swine and swine herds.

Prior to 1989, there was recognition within Iowa's pork industry that PRV control/eradication was a laudable goal. However, a majority of producers had established procedures that minimized the economic impacts of the disease, and they were reticent to begin an eradication program of undetermined structure and scope. Pressures building from other States—particularly in their limitations on the movement of breeding stock from Iowa—and strong influence from other State pork producer organizations and the Federal government caused industry leadership to recognize in the late 1980s that PRV eradication efforts must be undertaken in Iowa. In 1987 to 1988, a group of Iowa legislators, with the assistance of a small cadre of industry and scientific advisors, set about to devise a PRV eradication strategy that could be codified to describe future control/eradication actions, would be scientifically sound, and would be acceptable to the majority within the Iowa pork industry. The culmination of this effort was the introduction, passage, and implementation—beginning in 1989—of Iowa Code Chapter 166D.

Chapter 166D was developed under the following guiding principles: (1) the PRV control/eradication strategy would enable the scientifically-based, methodical elimination of the virus from Iowa herds, without requiring producer actions that would have a severe economic impact on individual herds; (2) the strategy would emphasize voluntary participation at the county level, with specified State regulatory actions implemented as recognizable eradication benchmarks were met; and, (3) the strategy would involve swine movement requirements for all pork producers and markets to follow in participating counties. Prior experiences with the Marshall County Pilot Project (see Chapter 6, "Iowa Pilot Project") provided valuable science-based methods that enabled producers to

eliminate the virus from their herds and minimize intergenerational spread during the transition period by using offspring segregation. In addition, lessons learned from the Marshall County project allowed animal health officials and producers to use statistical testing to determine herd status, which was a more efficient way to monitor for PRV than requiring whole-herd testing. Statistical testing also helped to: (1) increase the willingness of producers and veterinarians to cooperate; (2) engage more herds and counties by utilizing available funding and laboratory testing capacity more efficiently; and, (3) evaluate the effectiveness of herd cleanup and feeder-pig cooperator plan strategies.

Chapter 166D became the roadmap for the phased-in implementation of PRV eradication in Iowa and remained largely unchanged for more than a decade. Iowa's program was recognized as attaining split-State status; the PRV control board designated 66 northern counties as Stage II and 33 southern counties as Stage III. Then, in 2000, the State legislature mandated vaccination of herds and semi-annual testing in Stage II counties and annual testing in Stage III counties; these changes replaced many completed sections of the State's PRV eradication plan. However, the established roadmap contained key elements that contributed to its continued success: (1) producer-driven efforts guided by the State PRV Advisory Committee; (2) recognition of the potential for area spread in testing and movement controls; (3) Phased-in enrollments to maximize financial and personnel resources; (4) movement from voluntary to mandatory actions based on clearly defined benchmarks, which were tied to local eradication progress; (5) involvement of all classes of swine production and markets; (6) movement restraints based on the risk of PRV transmission, including the use of restricted movements to slaughter for swine with unknown PRV status; and, (7) flexible herd cleanup guidelines tailored to each producer's management style and herd to obtain non-infected herds.

The PRV advisory committee was mandated by Chapter 166D to be seven members; of these members, a minimum of four were to be active in pork production. The remaining committee members were to represent veterinary practitioners, sale barn operators, and other associated businesses. All were appointed by the Iowa Pork Producer Association for 2-year terms with the potential for up to two reappointments. This committee served in an advisory capacity to the Iowa State legislature and actively interacted with both VS and the Iowa Department of Agriculture and Land Stewardship (IDALS) throughout the eradication period. The committee was instrumental in forming and implementing county, area, and State strategies to facilitate the mandates of the Chapter 166D roadmap. The committee approved which counties could participate in the eradication program based on the required county votes, the location and size of its swine population, and available financial and personnel resources. In addition, the committee encouraged the development of industry training programs and producer education efforts. It also offered a sounding board for local and industry complaints about program implementation actions. The committee's responses to a range of pressures resulting from Chapter 166D were central to the success of the initiation, progress, and eventual completion of State eradication efforts.

PRV was recognized by the scientific veterinary community as having unique characteristics that were not necessarily comparable to previous experiences with hog cholera eradication efforts. Therefore, in developing the PRV eradication roadmap, legislators and other involved parties considered the need for a unique approach, recognizing the disease's potential for area spread by wildlife, roaming pets, and aerosol transmission and the resulting need for time-coordinated local producer actions. Chapter 166D named 10 counties in 4 geographic areas as the inaugural program areas—Northwest (3 counties), Central (5 counties), South-

east (1 county), and Northeast (1 county). Each area formed a central point around which to build control efforts by demonstrating program mechanisms locally. Chapter 166D required that counties outside of these areas apply for program admission following an educational forum and affirmative vote of 75 percent of attending pork producers. The PRV Advisory Committee had purview over the approval of new counties. Placing the committee in this role enabled the strategic admission of counties based on available financial, personnel, and testing laboratory capacities (see fig. 8.8).

In addition to increasing the efficiency of eradication efforts, the phased-in implementation approach generated producer interest and enthusiasm, as program monies could only be expended in designated program counties. This structure enabled all counties to be included over a 5-year period with only two counties initially declining to participate. In both of these counties, the negative votes were quickly overturned by a subsequent referendum, demonstrating general producer acceptance of the PRV roadmap. The phased-in program also enabled the recognition of producer and program successes and provided op-

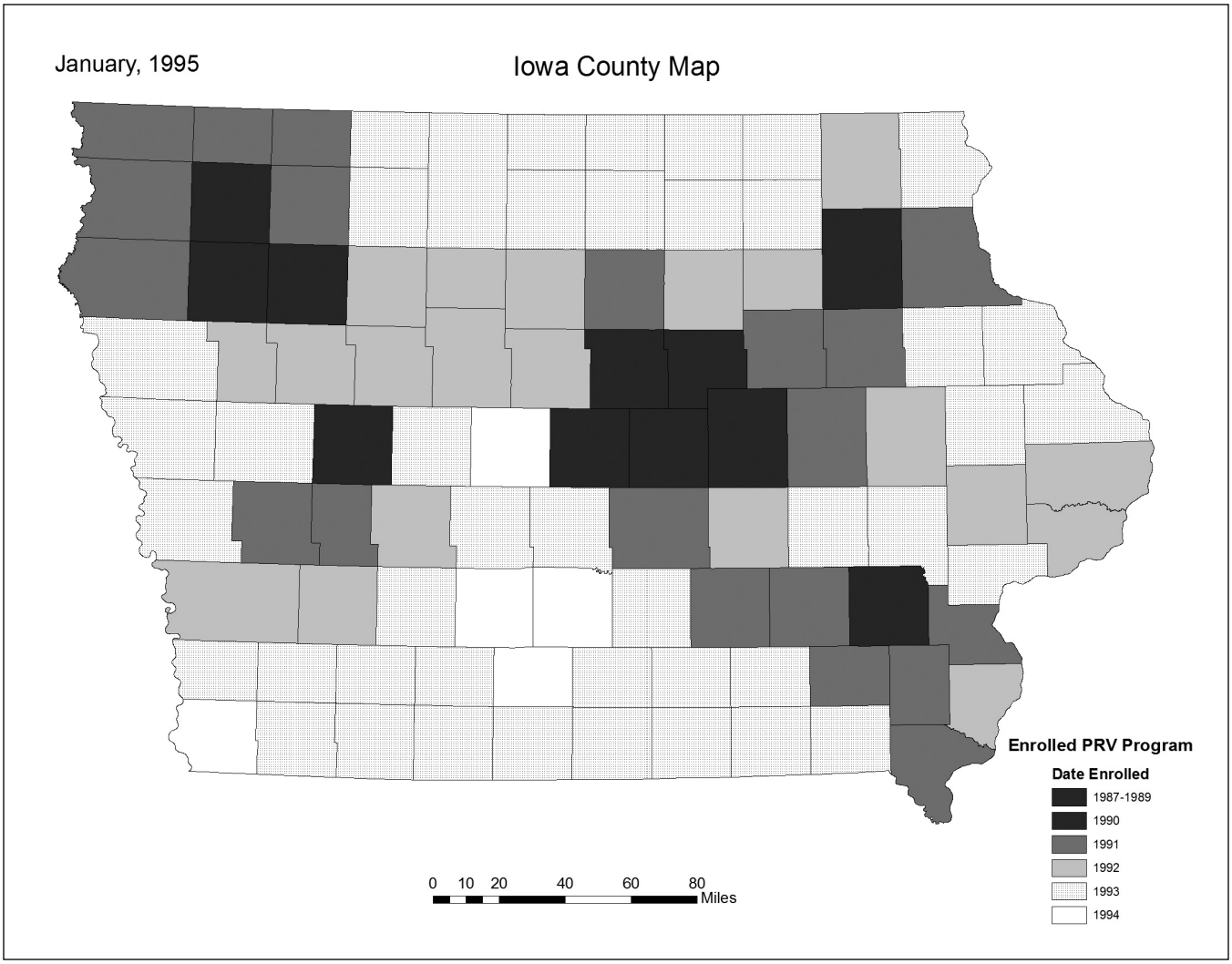



Figure 8.8. Iowa counties enrolled in the program by year. *(Data provided by James D. McKean, Iowa State University)*

portunities to overcome obstacles on a case-by-case basis, rather than in a diffused, statewide effort.

Upon admission to the program, all producers in newly enrolled counties were encouraged to voluntarily test their herds to determine PRV status using established statistical testing methods. However, there was no defined completion timetable for testing every herd in the county. In most counties, a large majority of tested herds were negative on the initial test, which caused local pressure for other producers to test and identify their respective herd's status. For those herds tested and diagnosed as PRV infected, program officials encouraged a herd cleanup plan or feeder-pig cooperator plan. Program officials also set a benchmark—triggered when greater than 50 percent of herds in the county were tested—to protect the tested herds from undetected infected herds. Achieving this level of participation initiated a requirement that the untested minority must complete initial testing to determine their status within 12 months; a programmatic incentive to complete these tests was built into the roadmap. Failure to test within the prescribed 12-month period required the untested herd to move swine under restricted movement by permit until testing was completed, with all associated expenses paid by the owner of the untested herd.

Involving all classes of swine was central to the success of this eradication effort. Prior to Chapter 166D, seedstock herds and the movement of breeding stock were the primary regulatory focus. When seedstock herds were tested and determined to be infected, severe economic repercussions—including loss of sales and damage to the herd owner's reputation—followed. By involving all classes of swine production in the control/eradication effort, program officials were able to increase the community's acceptance of the program and make area success more likely. Risk-based movement limitations through markets and other intrastate channels and participation of known infected herds in herd cleanup or feeder-pig cooperator plans reduced virus spread, but still enabled producers to maintain business continuity during the cleanup process. Feeder-pig cooperator plans were a specialized herd cleanup plan designed for PRV-infected feeder-pig-producing herds. In order to maintain feeder pig sales and permit customers to receive an uninterrupted source of feeder pigs, the owner agreed to guidelines designed to produce noninfected pigs. The movement of these pigs was regulated, and the pigs were not permitted to move outside of the State.

An important designation in addition to negative and infected pigs was an "unknown" pig status classification. The rationale for this designation recognized that not all pigs requiring movement within the State could practically be tested prior to movement at the start of the program, and that failure to allow movement would negatively impact individual producers and general program acceptance. Accordingly, the program allowed these animals—designated as unknown—to move within Iowa under restricted movement to a location for feeding until moved directly to a slaughter establishment; such animals typically included feeding swine from untested herds in non-program or partially-tested program counties and from feeder-pig cooperator plan herds. Designating these animals as unknown—but not affording them the movement freedom of negative status—enabled intrastate movements of pigs that were expected to present a relatively low risk of transmitting PRV. Further movements, except to slaughter or to approved premises, were only permitted with individual negative PRV tests and other requirements. The unknown designation facilitated the movement of lower-risk pigs within intrastate commerce while encouraging source herds to work toward a known negative status to remove the restricted movement requirements. Such activities were consistent with the program's goal of not requiring actions affecting producers that inflicted substantial economic losses, particularly during the early phases of the eradication program.

Chapter 166D allowed program-approved premises to act as feeding locations where infected cull or feeder animals could be aggregated for market. Only slaughter-market-bound swine were allowed into these facilities. Each approved premises had to meet regulatory requirements and be certified annually for compliance. The program required that movement and vaccination records for feeder swine be maintained for one year. Failure to meet standards could result in a repeal of the premises' approval designation. Such sites could not be located in the vicinity of a PRV-qualified negative herd (this offered increased protection for seedstock herds). In addition, if the county reached a PRV infection prevalence below 10 percent, these premises were required to lose their approval upon annual review in that year; this requirement provided incentive for owners of negative herds to encourage other pork producers in the county to collectively reach the <10 percent designation. The approved premises functioned to receive swine from owners of known infected herds who wished to depopulate or needed a regular outlet for feeder pigs that did not conform to the feeder-pig cooperator plan criteria. The premises performed a useful commercial role in providing a known repository for infected swine under a controlled environment until the animals reached marketable weights. Approved premises were phased out as eradication efforts succeeded and the need for their presence decreased.

From the beginning of its implementation, the Chapter 166D roadmap enabled and encouraged—but did not mandate—the use of PRV vaccine to lessen the economic losses associated with the disease and reduce viral shedding and area spread. Differential vaccines were exclusively required by the Iowa State Legislature in 1991. The Iowa Administrative Rules in 1993 stated that gE-deleted vaccines must be selected over other deletions to minimize confusion and to improve the effectiveness of herd classification. Vaccine usage became a requirement as part of the State's program in 2000 under a legislative mandate for intensified vaccine and testing. This program change—a reaction to finding a large number of previously undetected infected finishing herds in 1999—required semi-annual vaccination of all breeding animals and regular vaccination of finishers in Stage II counties. Prior to this time, feeder swine entering the State were required to be vaccinated, but pigs moving intrastate were not subject to this requirement. Vaccination offered a cost-effective and popular incentive to reduce the spread of PRV within production areas and was recognized as an important adjunct to eradication efforts.

In addition to following the Chapter 166D roadmap, other programs and entities provided assistance and shared in eliminating PRV from the State's swine population: the Certified Accredited Veterinarians program, Market Swine Surveillance, the APEP, and the Iowa State University Veterinary Diagnostic Laboratory (IVDL). The first three are described in separate chapters of this document but warrant mention as part of the complete Iowa plan. The IVDL responded to substantial testing requirements under short notice.

The IVDL played a central role throughout the Iowa PRV eradication program. During the initial program stages, the IVDL made efforts to manage the flow of herd serologic tests based on the phased sequence of county admissions to the State program. In addition to herd and individual animal serologic activities, postmortem examinations for lesions and virus isolation contributed to the PRV caseload. In 2000, the Iowa State Legislature mandated increased serological testing. The normal pressures of completing the eradication program and finding the last PRV-infected herds in Iowa also contributed to the need for this increase in testing. Additionally, in March 2001, market swine surveillance introduced a substantial new sample stream for testing (see fig. 8.9). Due to this increased sample volume, the IVDL stepped up efforts to meet these substantial challenges in support of the eradication program. Without this diagnostic support, the program would not have attained the rapid progress it experienced from 2000 to 2001 in reducing the number

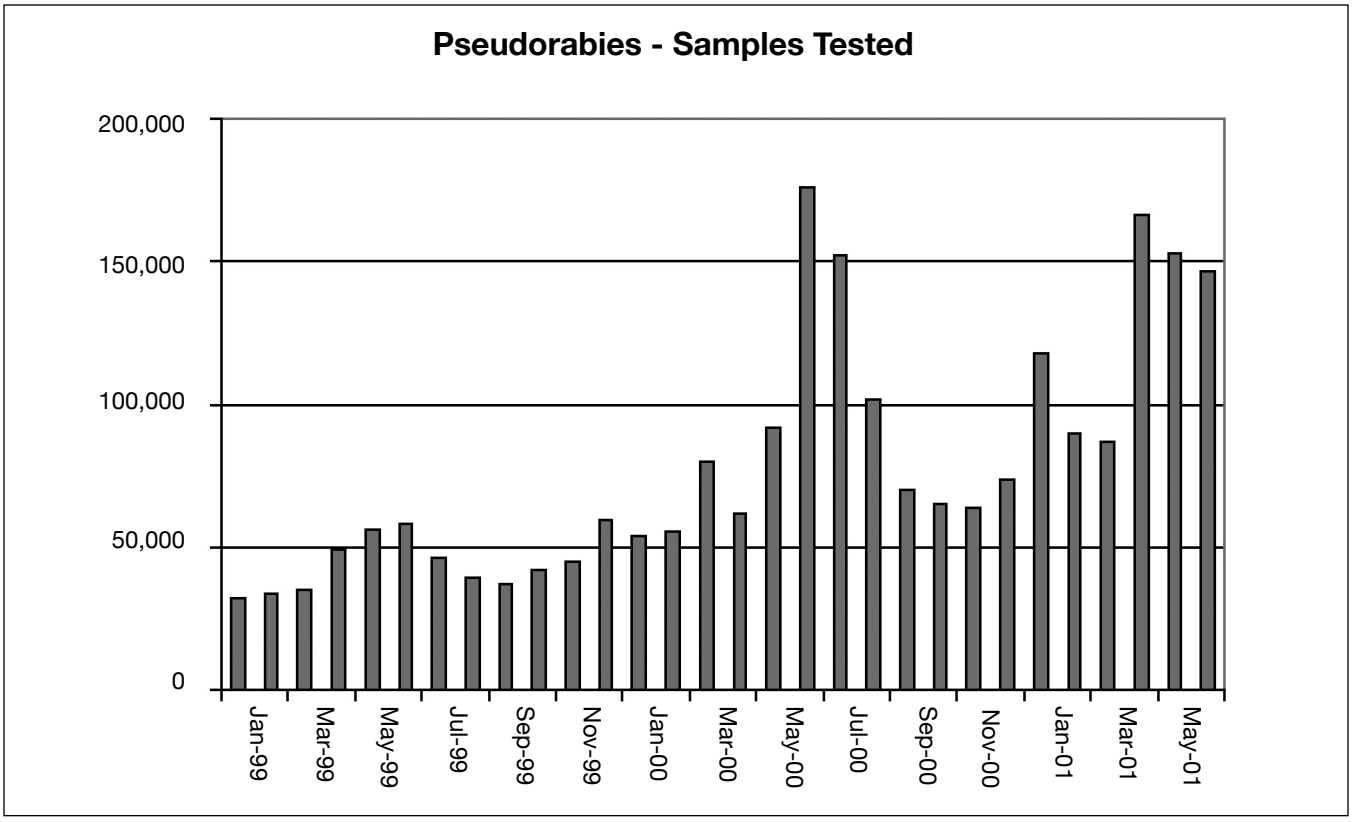



Figure 8.9. Samples tested for PRV at the Iowa Veterinary Diagnostic Laboratory by month. Testing of meat juice samples increased the volume of testing beginning March 1, 2001. *(Data provided by James D. McKean, Iowa State University)*

of PRV-infected herds.

The success of the Iowa PRV eradication program was a culmination of both scientific and political forces. Iowa Code Chapter 166D provided the roadmap for producers, regulators, and others who relied on measurable county achievements—rather than temporal benchmarks—for progress. This system enabled producers and veterinarians to advance the program in their respective counties with appropriate expediency, while also recognizing the importance of controlling area spread through the orderly finding and cleaning up of PRV-infected herds. Economic incentives related to program costs, herd cleanup plan structures, risk-based movement restrictions, and locations of approved premises encouraged producers to achieve county benchmarks for personal and community interests, but did not mandate solutions. In addition, the application of herd cleanup lessons from the Marshall County Pilot Project enabled producers to meet PRV eradication goals without jeopardizing the economic viability of their herds. All of these factors—along with strong leadership from local producers–contributed to easing concerns about the program and the economic impacts of eradication. As a result of these efforts, PRV was successfully eradicated from Iowa swine in a manner that did not leave producers and veterinarians with concerns that the effort "eradicated" producers as well.

## The North Carolina Effort

North Carolina's pork production is largely consolidated, with the majority of the sow base owned by four large production companies. These production companies own the animals and provide transportation, feed, vaccinations, and health care products. In many situations, a contract grower owns the land and provides the facilities and labor necessary for animal care. Although North Carolina used many of the same PRV cleanup strategies as the other States, these strategies were applied from a swine production company's perspective. Therefore, this perspective informs the following explanation of the methods used to eradicate PRV from North Carolina's swine populations.

The PRV Eradication Program was implemented in North Carolina several years before the State reached PRV Stage V status. North Carolina is a net exporter of weaned and feeder pigs, and it had become increasingly apparent that those markets were being threatened by the State's PRV status. Therefore, the pace to eliminate PRV from North Carolina's swine herds increased. In March 1997, the State began an aggressive PRV eradication program.

There were two distinct tools utilized to eradicate PRV that are not available for most diseases faced in swine production medicine. PRV vaccines worked extremely well, and diagnostic tests were accurate or erred toward the side of false positives. PRV eradication has taught important lessons about disease eradication in large swine production systems. The information learned to eliminate PRV has also been used in the control of other swine pathogens.

Virus circulation had to be stopped, both within a herd and within the pig production system containing multiple sites. Stopping circulation within a herd required scheduling the administration of vaccinations so that herd immunity could be established. Monitoring by periodic testing was necessary to ensure that the objective had been met in a timely manner. Employee turnover and understaffing at farms became excuses for getting behind schedule. The movement of people and livestock between farms were concerns in large production systems. It was essential for all employees to understand herd health status and the importance of visiting clean farms first. The truck driver assigned to pick up and transport animals culled from the herd, for example, needed to understand why his schedule required him to drive past Farm A only to loop back, out of his way, to get animals from Farm A later in the day. If the driver assumed the schedule was incorrect and did not call for confirmation, biosecurity was breached, and another infected farm may have had to be added to the list. If a significant number of farms were infected within the system, a dedicated fleet of transport vehicles, drivers, and a truck wash were established to prevent the spread of PRV to non-infected farms.

Disease prevalence had to be determined. If the system had multiple PRV-infected farms, a test-and-remove herd plan was developed for large herds. The usual policy was to blood test the entire breeding stock population on all known infected farms. If the cleanup timeline permitted, the seropositive sows were allowed to farrow and then were culled at weaning. Determining the number of positive animals to replace in each breeding group allowed the managers and veterinarians to design a strategic plan for elimination, while still maintaining the continuity of business operations. To accommodate the plan, farms were ranked in order of priority for culling seropositive animals and developing replacement gilts for scheduled entry into the breeding herd.

Whole-herd testing required careful planning. Prior to testing, every animal on the farm was required to have a readable eartag or tattoo. The company's veterinarian scheduled a visit to the farm as soon as test results

became available. Each positive animal was physically marked both on the animal and on the sow's identification card. It was also important for all PRV-positive breeding animal identification numbers to be recorded in the production system's recordkeeping database. Because eartags can fall out, and sow information cards can disappear, positive animals can become "lost," and it was essential to monitor these identification protocols carefully.

The company's veterinarians and regulatory officials needed to set a deadline for completion of the eradication plan for each infected farm. The veterinarian and farm's manager clearly explained the plan to all employees. The company evaluated sow farm personnel on the number of quality pigs shipped in a given period. This encouraged the breeding of positive sows in order to meet a breeding and pig production target, unless employees were specifically instructed by their supervisor to cull all PRV-positive sows at weaning.

North Carolina's large herds presented some extraordinary issues regarding the elimination of PRV. Producers recognized that PRV eradication was necessary to ensure a steady flow of grower pigs moving interstate and maintain production efficiencies. Establishing vaccine schedules to ensure herd immunity and reduce virus transmission among animals was the program's first consideration. Conducting whole-herd testing to detect positive animals and identify them for culling provided a method to eliminate the disease. It was also important to train and educate employees about preventing the introduction of PRV, which included explaining why procedures needed to be accomplished exactly as prescribed. Many staff hours were required to vaccinate, test, and identify animals in order to achieve successful results. Finally, the program designed strategies to prevent the reintroduction of PRV into the herd once it had been cleaned up. These strategies were necessary to have in place until State officials and owners determined that all infected herds within the production system were no longer infected.

## Certified Accredited Veterinarians

The Certified Accredited Veterinarians' program was constructed during 1991 through State-Federal-producer cooperation with the veterinary practice community in Iowa to cope with several emerging program implementation limitations posed by the PRV eradication effort. The program faced prospects of managing an anticipated 3,000 to 4,000 infected herds within which to control the virus, producer reluctance to work directly with regulatory officials, and limited State and Federal regulatory personnel to implement program requirements. The PRV Advisory Board proposed an innovative solution to develop and implement PRV herd cleanup plans and locally manage program performance. Accredited large-animal veterinarians represented a pool of knowledgeable, geographically-dispersed individuals whom producers respected and readily consulted. The veterinarians' professional time and expertise, local producer acceptance/credibility, and disease control experiences could be harnessed to perform the complex functions of contouring scientifically-based herd cleanup and disease control practices for individual farm needs and conditions. With Federal approval and State-Federal-producer financial support, the Certified Accredited Veterinarians' program was promulgated and offered throughout Iowa. In 1991, the State educated and trained an initial group of approximately 300 certified accredited practitioners. From this initial group, an active cadre of Iowa practitioners was available each year to perform PRV eradication activities and supplement State and Federal district veterinarian activities.

These certified veterinarians were required to be USDA-accredited. As an adjunct to their accreditation, the veterinarians completed an educational program designed to implement the best epidemiologic and disease control science in the formulation of herd PRV cleanup plans and participated in training to ensure uniform program deployment and financial remuneration practices. An important and novel aspect of this

program was the proposed payment schedule for professional time and experiences (as opposed to compensation based upon the number of samples collected or herd size impacted, which was being used in the case finding and surveillance portion of the Iowa PRV eradication program). The operational rationale for this product-based payment schedule was that the time and professional expertise for the development of the herd cleanup plan was not dependent on the size of the herd. In comparison to large herds, smaller herds might require more biosecurity and other disease education efforts to develop and implement a herd plan. Therefore, if paid predominantly according to herd size, practitioners would be expected to focus preferentially with the larger herds and their higher financial returns, leaving the smaller or more difficult herds within program areas for others. The Iowa PRV Advisory Committee initially set the payment rates, which were later approved by State and Federal authorities at $100 per completed herd plan. Federal government, State government, and producers each paid one-third of this amount, with the producers being billed by their veterinarian for their portion of the herd cleanup plan costs. District veterinarians were responsible to perform reviews of proposed herd plans for completeness and implementation merit prior to payment of the State and Federal funds. This verification step enabled district veterinarians to oversee substantial numbers of cleanup plans, regularly encourage practitioners to maintain herd plan progress, stimulate local veterinary support for eradication efforts, and maintain communications between practitioners, producers, and other regulatory officials to further State eradication goals.

In the first year of the program, four geographically separate, day-long meetings were convened by the State to encourage maximum veterinary community participation. For these meetings and for annual educational and training in subsequent years, attendance for the entire session was required to obtain or maintain certified accredited veterinarian status. The educational portion of the program—presented by university researchers, extension personnel and district veterinarians—took approximately 4 to 5 hours to complete and was specifically designed to answer current or emerging questions and concerns about PRV control and eradication practices, laboratory findings, and sample submission. This educational effort enabled the regular transfer of current scientific information and diagnostic advancements to the veterinary practice community in an organized and efficient manner, while providing a forum for questions from practitioners. The remainder of the 6- to 7-hour program was spent in training aspects related to techniques or requirements for plan development, reporting and quality assurance concerns, payment considerations, and certification activities. With successful completion of this program, accredited veterinarians were certified for 1 year and eligible to write and monitor implementation strategies for PRV elimination for herds enrolled in the program.

By 1996, PRV eradication efforts were spread across the entire State, and the need to encourage completion of herd cleanup plans became a major program focus. State officials enlisted certified accredited veterinarians to help in this effort by placing the emphasis on payment for the annual monitoring of herd plan progress and for the completion of cleanup plans (herd negative status confirmed), which was $50, respectively. These professional service payments to certified accredited veterinarians occurred in addition to the traditional fees received for PRV program activities related to service calls (herd stops) and blood sample collection for herd status and surveillance, the movement of animals, and general disease control activities. Implementing this professional services contract provided a cadre of educated, supportive, and local representatives who regularly interacted with pork producers to facilitate PRV control and eradication efforts, formulated and oversaw farm-specific cleanup plans, and played an important and cost-effective role in efforts to advance successful PRV eradication efforts in Iowa.

## Challenges of Carcass Disposal

During the Pennsylvania PRV outbreak of 2002, the State faced a significant challenge—disposing of 15,000 head of swine within a 6-day time period. Costs associated with the indemnity and disposals were approximately $2 million. Some animals were eligible to go to commercial slaughter plants for human consumption, but most of the carcasses were scheduled to go to rendering facilities. However, State officials discovered that rendering plants may refuse animals associated with a disease outbreak, and that the facilities also have a limit to the number of carcasses they can process. This limit had the potential to impact the number of hogs that could be depopulated during a designated time period. The State's solution was to dispose of the majority of the 15,000 animals by burial in landfills, with two truckloads (~80,000 lbs) of carcasses being disposed of by on-farm burial.

Problems occurred with all disposal methods considered. The slaughter plant disposal problems included drug residue issues, pigs of improper size for the commercial slaughter market, large numbers of animals that overwhelmed slaughter plant capacity, and the depression of local and regional commercial market prices by "adding" a large number of swine into the meat-processing system. There were also problems with the disposal of animals at rendering plants. These included the facilities' flat-out refusal to receive animals associated with a specific disease and too many carcasses overwhelming plant capacity. Finally, there were issues with landfill disposal as well. These problems included human health concerns, the need to obtain regulatory permits from the State Department of Environmental Protection, limited hours of operation at privately-owned landfills, and biosecurity concerns for transporting large numbers of carcasses over long distances. Coordinating the depopulation effort with the limited availability of transport vehicles and limited landfill operating hours was constantly a challenge.

In this case, the on-farm burial site was approved by State Department of Environmental Protection officials at the time of burial. Concerns over groundwater quality did not become an issue. Some soil leaching did occur, but was corrected and did not create a problem. Alternative methods for disposing of swine carcasses should continue to be explored.

## Accelerated Pseudorabies Eradication Program

The Accelerated Pseudorabies Eradication Program (APEP) was created in 1998 and implemented in 1999 as a response to severely depressed hog markets in the United States. For example, in November 1997, market swine were being sold at $45.10 per hundredweight. As of the fourth week of December 1998, market swine were valued at $11.90 per hundredweight and even lower at the local market level. Swine producers were unable to sell their animals at a profit and were losing more money by continuing to feed and maintain them. Furthermore, as owners were forced to reduce expenses, they discontinued PRV vaccination. This posed a serious risk of increasing herd-to-herd PRV transmission and delayed progress in the eradication program. Most stakeholders recognized that, if funded by the Federal government, a program to depopulate PRV-infected herds would be the most reliable method to eliminate PRV from premises. Furthermore, purchasing animals at depressed market prices made this accelerated approach economically feasible. The APEP also decreased the supply of hogs, thereby alleviating the surplus of animals competing for slaughter space. These actions were believed to affect markets and allow prices to increase toward profitable levels.

The expected setback to the PRV Eradication Program due to depressed markets had the potential to be costly not only for the swine industry, but also costly for the State and Federal governments. Therefore,

VS officials determined that it was necessary to begin a voluntary, accelerated PRV eradication program, in which USDA would purchase swine from owners of PRV-infected herds as quickly as possible. Removing these infected swine would reduce the risk of exposing herds that were not currently infected with this disease. However, additional funding was needed for USDA to implement this plan, which included purchasing swine herds at a fair market value, depopulating these swine, disposing of the carcasses, and conducting surveillance testing of adjacent herds. Therefore, effective January 7, 1999, former Secretary of Agriculture Dan Glickman declared the PRV situation to be an emergency that threatened the U.S. livestock industry. With this declaration, Secretary Glickman authorized the transfer of $80 million in funding from the Commodity Credit Corporation to conduct a voluntary, accelerated PRV eradication program—the APEP.

USDA also implemented a number of other programs to assist struggling pork producers. These included the purchase of more than $70 million of pork during 1998 and another $15 million in early 1999 to bolster prices and provide nutritious food for Federal food assistance programs. Other Government agencies that routinely make large-volume meat purchases were also encouraged to purchase pork products. A moratorium on USDA hog facility construction loans discouraged herd expansion. In addition, the Vice President of the United States announced that USDA would make available approximately $50 million in direct cash payments to owners of small hog operations. These producers would receive up to $5 per hog marketed in the last 6 months of 1998, not to exceed a maximum payment of $2,500. USDA' Farm Service Agency administered the sign-up and payment process for this program. Producers were eligible if they marketed fewer than 1,000 hogs in the last 6 months, were still raising hogs, did not participate in fixed-price or cost-plus marketing contracts, and their farming operation had an annual gross income of less than $2.5 million in 1998. All of these Government programs were meant to increase cash flow to pork producers, increase the price packers paid for market hogs and culled breeding swine, and discourage the expansion of hog facilities until the market could stabilize itself. The APEP also provided incentives to eliminate PRV from the U.S. swine population in an accelerated manner.

On January 14, 1999, USDA published in the *Federal Register* an interim rule (Docket No. 98-123-2) that established regulations to implement this accelerated program. In addition to paying pork producers a fair market value for purchasing their swine, the regulation provided payment for other costs associated with depopulating these PRV-infected herds (i.e., transporting swine and the cleaning/disinfection of transportation conveyances). These regulations were later published in Title 9, Part 52 of the *Code of Federal Regulations.* APEP funding also paid for costs associated with the euthanasia and disposal of swine as part of PRV eradication efforts.

APEP Fair Market Values provided a means to determine swine values based on changes in the market over time and the variability of swine type and use. The value was determined and reported weekly and based on a weighted average calculated from prices reported by USDA's Agricultural Marketing Service (AMS). In addition to this base price per pound, a producer cost offset was paid based on pig type. For example, if the animal weighed over 200 pounds and was used as a breeding animal, an additional $50 per head was added over and above the value determined by weight. This was necessary to account for added expenses previously incurred by the producer in procuring a reproductive animal and the value of unborn piglets if that animal was pregnant. Swine less than 200 pounds were valued with an additional $20 per head to account for additional expenses already incurred for care, housing, and increased feed and medication costs in rearing a feeder-type pig that had not yet reached an ideal slaughter weight. Finishing swine near or at market weight were valued at an

additional $5 per head to encourage the completion of herd depopulation in as short a time as possible and to offer an incentive over and above the posted market price for that week. Producer cost offsets were reduced slightly ($45, $15, and $4, respectively) if producers waited longer than 30 days after determination of infection in the herd to volunteer to participate in the program.

In order to further stimulate the depressed hog markets, swine purchased in accordance with the APEP were not sent to slaughter plants. Economists determined that market prices would become further depressed if additional market-ready swine were sold to slaughter plants, since most plants were unable to process the current supply. Therefore, swine purchased through the APEP were not permitted to be slaughtered. Instead, the carcasses were disposed of by either burial or rendering. However, reports from rendering companies suggested that the increased quantity of rendered pork carcasses did depress markets for rendered products.

To ensure that PRV was eliminated from premises being depopulated, the APEP made herd owners responsible for cleaning and disinfecting their hog-rearing equipment and facilities in such a manner that was acceptable after inspection by a State or Federal regulatory official. The owner could not repopulate the premises for at least 30 days to further ensure that the virus was no longer viable. The herd owner assumed the cost of cleaning up and disinfecting barns, pens, and equipment.

The benefits derived from implementation of APEP were three-fold:

(1) The successful implementation of this program was expected to reduce the prevalence of PRV in the United States at a faster rate than expected by the target date of 2000;

(2) Resources currently expended to maintain the PRV eradication effort could be diverted to other disease eradication and prevention efforts, including surveillance and monitoring; and,

(3) Producers participating in the APEP would be paid a fair market value plus an incentive for all of their animals. While not making a profit, they would at least be spared the continued expense of feeding and managing the animals.

Initially, the APEP was to run for a period of 6 months; however, USDA extended the program because an increasing number of producers were interested in depopulating their herds. Ten months after the program's initiation, USDA made available an additional $40 million for the effort, and the program continued.

The procedure for the owner of a PRV-infected herd to voluntarily participate in the APEP was deliberate and presented in five steps. The five steps included contact, estimate, enroll, accept, and deliver. When the producer contacted the APEP office's phone number and signed up for the program, a base market price was locked in according to the date of the call. Next, regulatory officials visited the owner, explaining the details of the program and answering any questions. At that time, officials calculated an estimate of the fair market value of the animals comprising the herd and established the inventory of breeding animals. However, the program soon realized sows would continue to farrow until the herd was depopulated, and total pig numbers would increase. Accordingly, the estimate provided the owner with an approximate value to be received from the program for agreeing to participate. The owner was given 7 days to review the estimate and sign documents signaling the intention to enroll the herd into the APEP. Program supervisors would then review the estimate, consider the location of the herd, and determine the availability of depopulation teams. If all items were approved, the enrollment of the herd was accepted.

Once accepted for depopulation, many details had to be coordinated. With cooperation of the owner, program officials scheduled a date to depopulate the herd; the date selected was called the delivery date. The APEP assigned teams to scout the farm facilities and estimate the number of personnel and loading equipment needed to remove the animals. Trucking firms, hired under contract to haul swine, were scheduled. Program officials also alerted rendering companies and provided the estimated pounds of carcasses they could expect to receive. Finally, the program assigned depopulation teams to meet with all parties on the scheduled depopulation date, assist in loading, count the swine, categorize cost offset values, determine the total pounds from weight tickets, calculate the exact amount of payment due to the owner, and submit the claim for payment. The owner received the weekly established market price per pound based on the contact date or delivery date, whichever was higher. The payment process was accelerated in order to ensure rapid reimbursement to the owner. Early on in the APEP, the program managers were given authority to sign and present reimbursements directly to owners, which included checks valued at up to $1 million. In later years, once the total payment was determined, APEP claim forms were electronically transmitted to the USDA's Marketing and Regulatory Business Office, and when approved, dollars were electronically transferred to a bank account stipulated by the owner. At anytime throughout these procedures, the owner could decline any further participation since this was a voluntary program.

The APEP also provided and followed procedures to load and euthanize swine in a humane manner. Specifically, the program adhered to accepted euthanasia methods published in the *1993 Report of the American Veterinary Medical Association Panel on Euthanasia.* These accepted methods included electrocution, captive bolt stunning (both followed by exanguination or bilateral thoracotomy), CO2 gas, and barbiturates administered intraveneously. Swine receiving barbiturates were not disposed by rendering due to potential residue issues. Most swine were euthanized at slaughter plants through contracts with APHIS. Carcasses were removed from the slaughter plants by rendering companies. In addition, VS provided information to APEP personnel titled "Humane Treatment of Livestock," as well as a copy of an article published in the *Journal of the American Veterinary Medical Association* (published May 1, 1994) titled "Euthanasia and Slaughter of Livestock." This information reminded program officials to keep humane-handling methods in mind when restraining and loading swine. All teams assigned to on-farm activities received training on euthanasia methods and proper handling methods prior to dispatch to the field. Hog panels, slappers, and rattles were also issued to the teams to effectively and humanely move the swine. Swine that were too young or too weak to be transported were euthanized on the farm.

In April 2000, USDA modified the APEP rules. This modification was in response to the strengthening of the depressed hog market. As a result, hog slaughter plants regained capacity to process the available market-ready hogs, and changes were needed in the APEP to conserve program funding while still maintaining the objective of reducing the number of infected herds. For example, USDA's weekly fair market value paid a value of $29.60 per hundredweight during the first week that values were posted on the APEP website (January 18, 1999). This value had increased to $48.40 per hundredweight for the week of April 17, 2000. Profits were once again being realized by producers. Figure 8.10 shows the loss of profits experienced by pork producers located in a major hog- producing State prior to initiation of APEP.

Therefore, on April 18, 2000, USDA published another interim rule (Docket No. 98-123-6) in the *Federal Register.* While this rule provided similar fair market value calculations to those previously used in the APEP, it permitted eligible hogs to be removed and transported

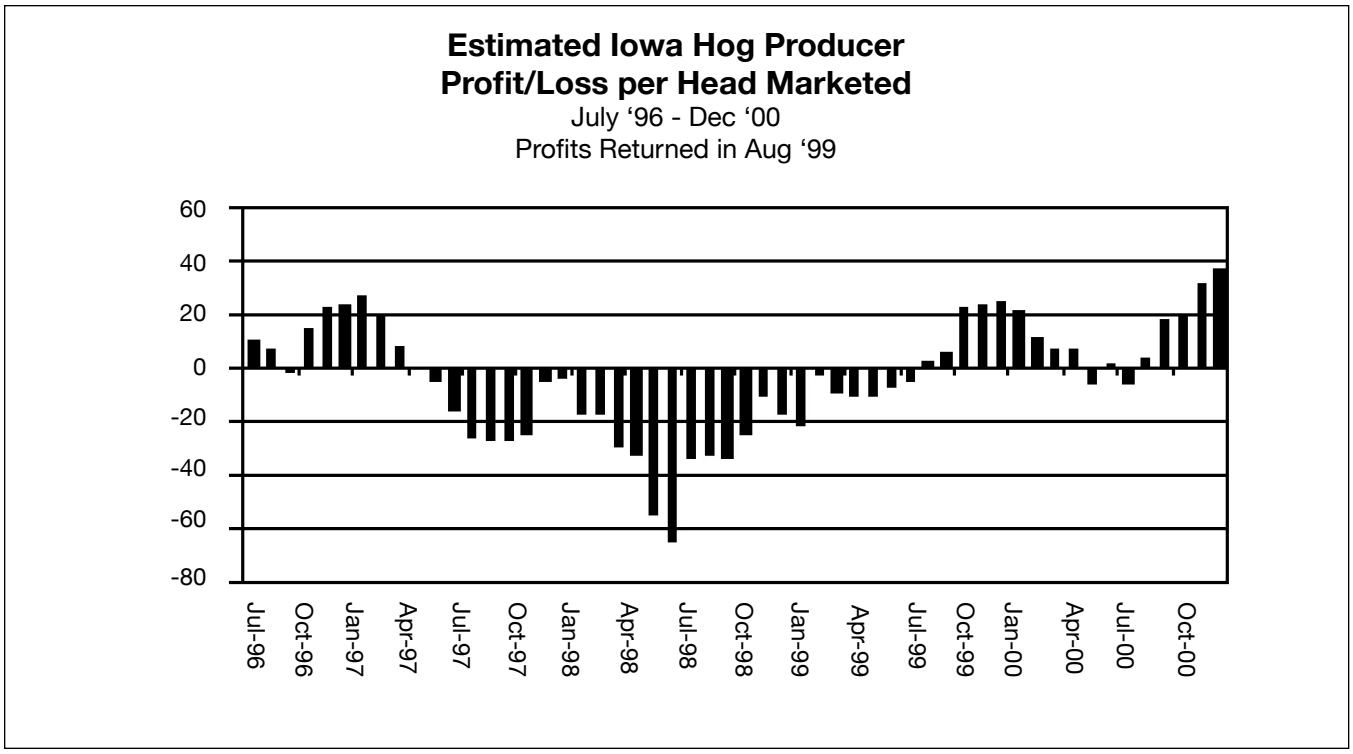



Figure 8.10. Shows the loss of profits experienced by hog producers in Iowa from July 1996 until profits were again restored in August 1999. Negative values indicate money lost per head marketed *(Source of data points: Iowa State University Web site, http://www.econ.iastate.edu/faculty/lawrence/Lawrence_website/historicalreturns.htm).*

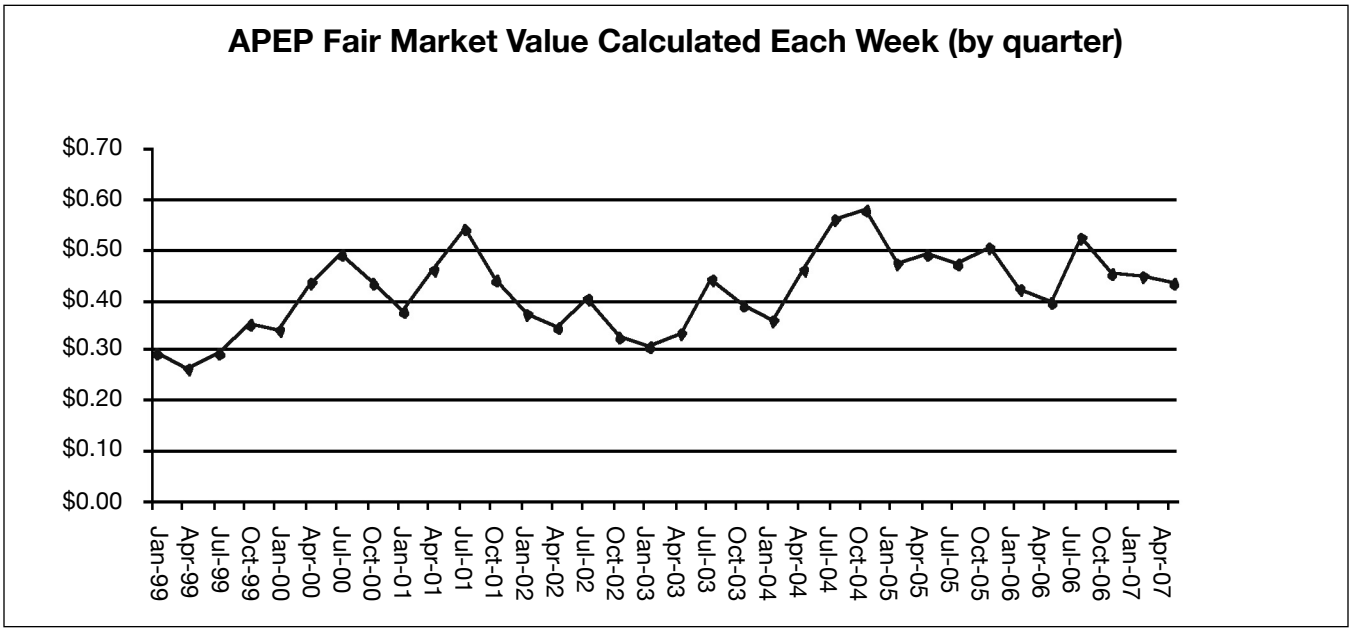
to slaughter plants rather than disposing of them by either burial or rendering. Furthermore, owners of infected breeding herds were encouraged to test all breeding animals for PRV and remove the seropositives to slaughter and receive fair market value. This test-and-remove herd cleanup plan was an attractive new option for producers who had not previously enrolled in the APEP because total depopulation creates many months of zero cash flow. With total depopulation, income did not return until repopulated animals became productive, and hogs had grown to the point of being eligible to sell. In contrast, testing only continued until all infected swine were removed and the herd was declared not infected with PRV. In this case, the owner received fair market value less salvage value. Salvage value was the amount paid to the owner by selling the hogs to a packing plant less the costs incurred for arranging the sale. Such costs included transportation fees, commission fees, and yardage fees. However, the original option to enroll the herd in a whole-herd depopulation cleanup plan continued to be available for producers.

APEP funds were also utilized to enhance surveillance, detect infected herds, and enhance the use of PRV vaccine to decrease disease transmission to susceptible herds. With USDA's modification to the APEP, the rate of program spending decreased as a result of smaller payments to herd owners and more herd owners choosing test-and-remove cleanup plans. Accordingly, USDA began redirecting APEP funds to testing and PRV vaccine incentives. The program encouraged and paid for additional testing. This allowed more herds to be tested and additional PRV-infected herds to be detected. Furthermore, program officials recognized that herd-to-herd transmission was still occurring in States with dense herd populations, especially among grow-finish herds in which thousands of

animals were located in the same square mile. APEP funds were therefore used for States to compensate veterinary practitioners for a portion of their costs in distributing PRV vaccine doses to their swine clients. In addition, USDA made funds available to develop and implement a Market Swine Surveillance Pilot Project designed to collect meat juice and lot identification and monitor grow-finish populations for PRV at slaughter plants. This method of surveillance for this age of pig had not occurred previously (see "Meat Juice Testing" in this chapter).

In December 2001, USDA implemented another modification to the APEP by creating a revised method to calculate fair market value. As market prices continued increasing, producers became hesitant to enroll into the APEP for whole-herd depopulation. APEP Fair Market Values were posted weekly on the VS Web site (see fig. 8.11). The APEP Weekly Fair Market Value is a price per pound calculated by averaging the previous week's Wednesday, Thursday, and Friday, Iowa/Southern Minnesota-weighted average base market price for a 185-pound dressed carcass (49-51 percent lean), multiplied by 74 percent, and rounded to the nearest $0.05 per hundredweight. This calculation is generally in the price range of the cash market price for a live, top butcher hog.

Producers realized undervaluing of underweight hogs could occur. In other words, producers could gain additional profits if their hogs were fed to reach ideal slaughter weight. In response to these concerns, the NPB proposed a spreadsheet that required the input of 11 variables. The input variables were obtained from two Web sites—USDA-AMS for current market prices and the Chicago Merchantile Exchange for future price bids. These two pricing opportunities afforded the producer the ability to select the higher of the two calculated values offered for a whole-herd purchase. If prices forecast into the future were higher, there would be no disincentive for agreeing to depopulate lightweight hogs. However, the APEP did not compensate the owner for the loss of cash flow income from the date of delivery until a new herd was purchased and income reestablished. Furthermore, USDA increased the amount of producer cost offset from $50 to $100 for breeding swine. If the herd was a seedstock herd and had been maintained as a PRV Qualified Nega-




*Fig*ure 8.11. Fair Market Values in cents per pound for 1999 through First Quarter, 2007. *(Source of data points: APHIS Web site http://www.aphis.usda.gov/animal_health/animal_diseases/pseudorabies/apep.shtml).*

tive Herd or a PRV Negative Gene-Altered Vaccinated Herd, the producer cost offset for breeding animals was doubled to $200 per animal. These increased values were only available to owners whose herds were diagnosed as PRV-infected after December 18, 2001, and who had completed whole-herd depopulation within 15 days. This requirement was necessary to rapidly eliminate the last few remaining infected herds and, therefore, prevent the spread of disease among herds. If pharmaceuticals had been administered prior to the detection of PRV, hog carcasses were disposed of in a manner not including slaughter plants or rendering plants. If the owner did not agree to depopulate all animals within 15 days, he or she remained eligible to receive payments based on the original APEP pricing formula.

The implementation of the APEP resulted in other benefits as well. The program offered a unique opportunity to university researchers who could benefit by examining inter-relationships between farms and abattoirs that would not have been financially feasible otherwise. From these efforts, researchers produced a substantial *Salmonella enterica* epidemiology study that demonstrated the importance of abattoir pen contamination to *Salmonella* infections (see fig. 8.12).

In addition, the APEP developed a valuable working relationship between VS and packing plants. Some plants contracted with VS to euthanize large numbers of swine purchased through the APEP and release these carcasses to rendering companies for disposal. Other benefits realized from implementing the APEP include the adaptation of cell-phone technology to rapidly communicate information from headquarters to depopulation teams and packing plants; the adaptation of electronic spreadsheets and sophisticated pricing formulas to provide producers with a fair and rapid payment method to value and pay for the depopulated herd; and, the adaptation of laptop computer technology in the field to send and receive information and electronic spreadsheet files via e-mail messaging.

Figure 8.12. Hogs in lairage at the packing plant. The APEP also facilitated adjunct studies, such as studying hogs both on-farm and at packing plants. *(APHIS photo by Lowell Anderson)*

In addition, the APEP provided the animal health officials with the opportunity to learn about and implement methods to rapidly depopulate swine herds if needed. This included methods to humanely handle and euthanize large numbers and varying sizes and types of animals found on a typical swine premises. Through the APEP, animal health officials developed a project management plan to coordinate the activities of State-Federal regulatory officials detailed to assist with depopulation efforts and originating from many States. Federal and State officials also developed orientation and training courses that included information about the swine industry, APEP rules, safety issues, and the proper utilization of equipment. The program created and dispatched specialized teams to the field to explain the APEP to producers, implement the removal of swine from the farm, and coordinate with packing plants, trucking firms, and rendering plants to haul and process these animals.

Lastly, the APEP established operation centers that coordinated the assembly of teams and directed assignments in an efficient and productive manner. These operation centers were implemented in a similar manner to what is known today as an incident command post. Completing the objectives of the APEP

helped to exercise a rapid response plan developed to eradicate a virulent disease-causing pathogen from swine. Ultimately, the APEP helped to accomplish two important objectives—accelerating the eradication of PRV from the U.S. swine population and assisting financially-stressed pork producers during a time period of depressed hog markets until those markets could stabilize.

# Chapter 9—Completing Eradication

By the late 1990s, most States had made substantial progress toward completing the PRV eradication plan. However, several major hog-producing States—Indiana, Minnesota, Nebraska, and Pennsylvania—reported setbacks and an unexpected number of new PRV cases. This is a brief report of those setbacks and what was done in those States to complete the final steps of the PRV eradication process.

## The Indiana Experience

Although, at the beginning of 1998, there were 197 Indiana swine farms quarantined for PRV, 41 additional infected herds were detected in the early part of the year. PRV infection was found in counties that had not had any infection for several years, and counties with known PRV infection recorded significant increases in infected herd numbers. For example, Montgomery County had no new cases of PRV for several years, and 10 herds became infected in 1998. Clinton County went from 14 PRV-infected herds to 28 during that year, and Tippecanoe County went from 8 to 15 infected herds. In addition, Rush County started 1998 with only 1 quarantined herd, but by July of that year, its number of PRV-infected herds increased to 11. At the end of July 1998, Indiana's total number of herds under quarantine for PRV had a net increase from 197 to 232.

State officials responded by convening the Indiana Swine Health Advisory Committee. In order to maintain the integrity of the eradication program, the committee voted to revert Rush and Montgomery counties to Stage II from Stage III status. This move required that all swine herds in those counties be tested annually, and that all Validated/Qualified herds be tested monthly instead of quarterly.

In June 1998, Indiana's State Veterinarian declared PRV an emergency condition and required that all possible steps be taken to achieve eradication by the year 2000. The State formed a PRV Task Force, which identified and outlined new regulatory changes to control and eradicate the disease. The Indiana State Board of Animal Health (BOAH) adopted these changes, and the regulations became effective at the end of 1998. The new rules addressed the following critical areas:

(1) Required all PRV-quarantined herds to file an updated cleanup plan within 30 days;

(2) Established specific testing requirements for quarantined herds;

(3) Established vaccination requirements for quarantined herds, including all swine less than 6 months of age;

(4) Required sealed trucks for the movement of swine from all herds under quarantine as of January 1, 2000, and all herds in violation of the rules;

(5) Required the shipment of quarantined hogs only to approved destinations;

(6) Established the qualifications for approved destinations;

(7) Required testing and removal of all positive breeding swine from herds that did not meet the deadlines for quarantine release as of January 1, 2000;

(8) Allowed BOAH to order depopulation under a staged slaughter plan for all herds under quarantine on January 1, 2000;

(9) Mandated depopulation of PRV-infected herds once Indiana had reached Stage V status according to the Program Standards;

(10) Outlined staged slaughter requirements for herds ordered to depopulate; and,

(11) Established a circle-vaccination policy for swine herds within a two-mile radius of quarantined herds after January 1, 1999.

There were 181 herds under quarantine in Indiana on January 1, 1999. These new and stringent rules came into effect just as the swine market hit record lows. The owners of quarantined animals and all owners that had swine within a two-mile radius of a quarantined herd were to purchase and administer PRV vaccine at their own expense. One week prior to the new rules becoming effective, the Lieutenant Governor (Indiana's Commissioner of Agriculture) announced a $1 million emergency allocation to be used for subsidizing PRV vaccine in those herds required to vaccinate. All breeding swine were eligible for two vaccine doses each, and all offspring one dose each. Veterinary practitioners were to dispense the vaccine to the herd owners according to the number of animals in the herd. The veterinarian then sent an invoice to BOAH and was reimbursed for the vaccine.

On January 14, 1999, USDA announced the APEP (see Chapter 8), which was a very successful program in Indiana. Swine were taken to a former slaughter facility that had a large stockyard. They were euthanized there, and the carcasses were hauled in sealed vehicles to rendering facilities within the State. By the end of 1999, over 100 swine herds had participated in the APEP. There were a total of 41 weeks of activity at the depopulation center (from February 15, 1999, to May 1, 2000). During that time, a total of 244,822 head of swine were processed at the center, with the peak number processed per week being 28,682 head. The APEP hired 25 trucking companies to haul live animals. These companies delivered 1,153 loads of live animals to the depopulation center. A total of 944 loads of carcasses went to 6 rendering facilities (in 50,000 pound capacity trucks). The average weight of animals processed was 136 pounds, and the peak weight of animals processed in 1 week was more than 4.233 million pounds. In addition, each truck was sealed from the farm to the processing plant, and each rendering truck was sealed from the processing plant to the rendering facility. On January 1, 2000, 26 herds remained under quarantine.

A new set of rules also became effective on January 1. These rules established a number of requirements for owners of swine herds quarantined for PRV:

(1) All sows in the breeding herd were required to be tested for PRV prior to or at farrowing, and all boars in the breeding herd were also required to be tested;

(2) Sows that tested positive had to be isolated from the rest of the herd within 15 days after weaning a litter;

(3) Boars that tested positive had to be isolated from the rest of the herd within 15 days after the test results were reported from the laboratory;

(4) Sows and boars that were isolated under the rule could not be used for breeding and were required to be isolated until they were slaughtered or sold for slaughter;

(5) Only PRV-negative breeding animals could be added to a quarantined herd;

(6) All breeding animals added to a quarantined herd had to be vaccinated for PRV as described in the owner's herd cleanup plan;

(7) All swine in quarantined herds and in herds within a two-mile radius of quarantined herds were required to be vaccinated for PRV;

(8) All swine movements from quarantined herds—including shipments to slaughter—were required to be transported in sealed vehicles, sent to approved destinations only, and accompanied by VS Form 1-27 (Permit for Movement of Restricted Animals);

(9) Vehicles used to transport swine from quarantined herds were required to be cleaned and disinfected according to procedures approved by the State Veterinarian before being used to transport any other swine;

(10) The owner/agent was responsible for any fees or charges levied by markets, haulers, or other parties for extra expenses involved in the handling of quarantined swine;
(11) State-Federal personnel were available to issue permits (VS Form 1-27) and apply seals to transport vehicles only between the hours of 8 a.m. and 4:30 p.m. on weekdays; and,

(12) Owners of quarantined herds were subject to monetary fines if any of the State PRV laws, including deadlines for quarantine release and the above requirements, were violated.

By July 1, 2000, Indiana reported only nine quarantined herds. The last herd quarantine was released in September 2000, which represented the first time in more than 20 years that there were no PRV-quarantined herds in the State. Indiana was granted split-State status, stage III/IV in November 2000, with only four counties remaining in Stage III and no quarantines statewide.

Subsequently, two new Indiana herds were diagnosed with PRV—one in late 2000 and another early in 2001. They were cleaned up quickly with no disease spread to other herds. Similarly, four sows were found to be seropositive for PRV in February 2002. All were euthanized and necropsied at the Animal Disease Diagnostic Laboratory at Purdue University, and virus could not be isolated from any of the tissues submitted. Complete herd tests of the infected herd and neighboring herds indicated that no spread of the virus had occurred.

On November 1, 2001, Indiana achieved Stage IV status statewide, and on November 1, 2002, Indiana was recognized as qualifying for Stage V and declared free of PRV.

## The Minnesota Experience

In Minnesota, efforts to eradicate PRV from swine herds began in 1975. The State issued two quarantines that year (see fig. 9.1). For the next decade, State officials identified cases and issued quarantines even though procedures for quarantine release were limited. In 1986, Minnesota adopted rules to require a feeder-pig monitoring test on all herds in the northern half of the State. The monitoring test with negative results was required in order for producers to sell feeder pigs. With the new rules in place, the rate of herd testing in the State increased, and more infected herds were identified.

The real push toward eradication began in 1989 when USDA established the National PRV Eradication Program. Stringent, statewide herd-testing requirements were phased in over the next 2 years. After January 1, 1991, the State required all Minnesota swine herds to be tested for PRV on an annual basis. The number of PRV cases identified in the State soared following the enactment of this new rule.

The cumulative number of herds under quarantine in Minnesota continued to climb until 1992. In June of that year, there were a total of 903 Minnesota swine herds under quarantine. All herds in the State had been tested at least once, and all existing infected herds had been identified. In the months to follow, the

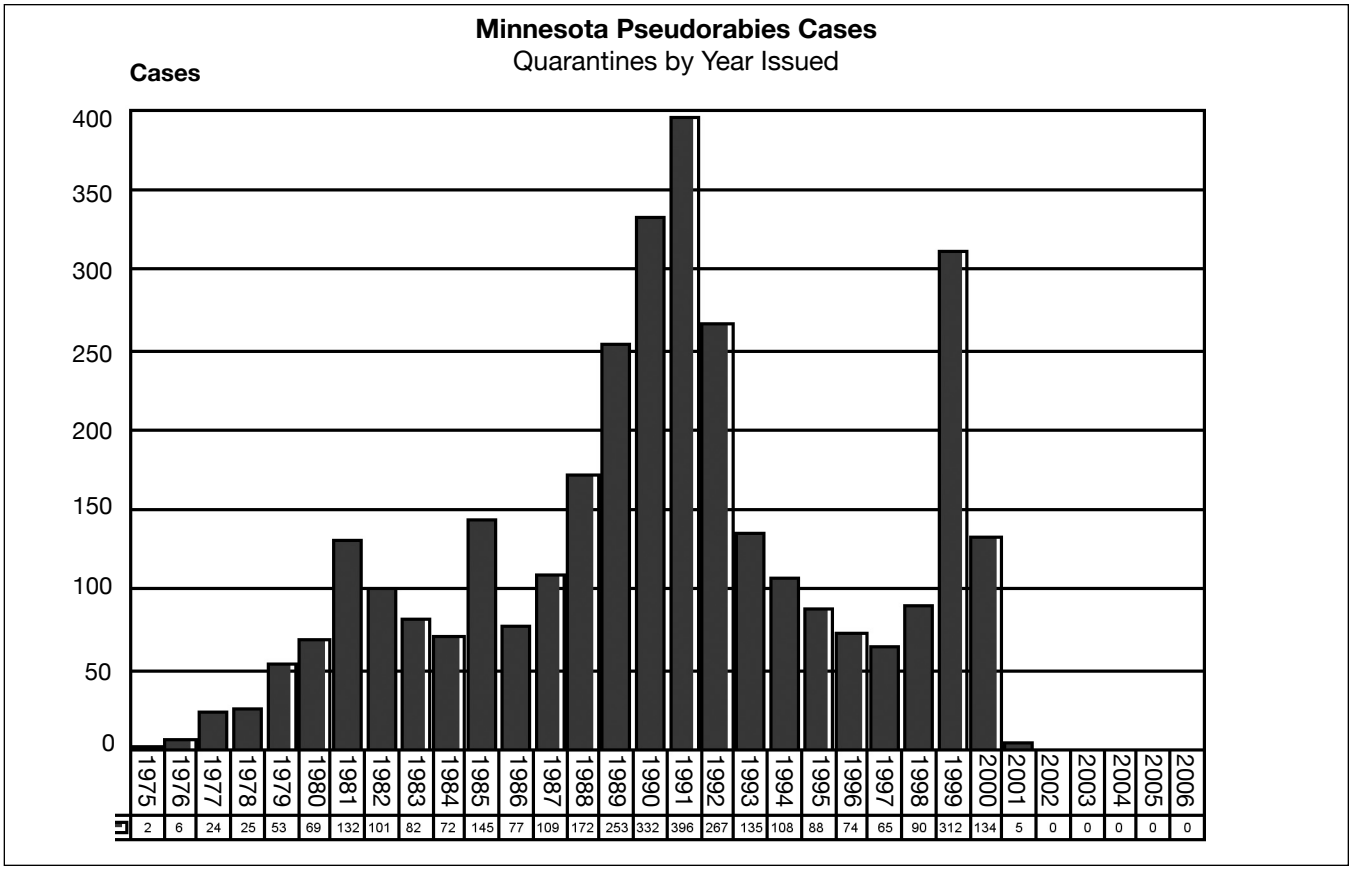



Figure 9.1. PRV Cases Detected 1975 through 2001 in Minnesota. *(Data provided by Paul L. Anderson, Minnesota Board of Animal Health)*

rate of herd cleanup surpassed the rate of new case identification, and the number of quarantines began to drop.

Progress toward eradication continued at a steady pace in subsequent years. By December 1998, only 144 herds remained under quarantine in Minnesota. Despite the low prices for slaughter pigs, this trend suggested that complete eradication in Minnesota could be accomplished within the next 12 months. Just before the end of the year, hog prices plummeted to eight cents per pound. In an effort to speed the eradication effort and help market prices recover, USDA launched the APEP. Many Minnesota producers took advantage of the program and signed up to depopulate their herds.

Hopes for a swift completion of the eradication effort in Minnesota evaporated in late January 1999. Reports of new PRV cases began to flood into the State office with stories of unusually high death losses in pigs and other species such as cattle, sheep, and dogs. Swine facilities across southern Minnesota were being diagnosed as infected with PRV in record numbers. Epidemiologists were puzzled by the situation, as the new PRV cases were not related to the movement of infected swine, people, or equipment. In addition, new cases most often affected finishing pigs but spared breeding facilities. Traditional explanations for how the PRV virus was spreading no longer fit the situation in Minnesota. For the first time, it appeared that aerosol transmission of the virus between farms separated by as much as three miles might be a real possibility.

Throughout the winter and early spring of 1999, the number of new PRV cases in Minnesota soared. In February alone, the State identified 81 new cases. Most of these cases involved large finishing units with 100 percent morbidity and high death losses. Practitioners began to report PRV cases even before laboratory results were confirmed. PRV cases were reported all across southern Minnesota. Counties especially hard hit were Nobles, Martin, Blue Earth, and Mower. By the end of the year, 312 Minnesota farms had become infected with PRV.

Aerosol virus transmission between farms was a new phenomenon. It was clear to epidemiologists that several factors must have changed to allow this to happen. The winter and spring of 1999 was unusually mild, cloudy, and wet. Temperatures were mainly in the 30s (in degrees Fahrenheit), and thick cloud cover effectively blocked the ultraviolet rays of the sun. Under these conditions, the PRV virus seemed to survive for long periods in the air. The swine industry itself had also changed. Large finishing facilities had been built in recent years across southern Minnesota, and it was not unusual to have 3,000 finishing pigs on each site. Pigs in these facilities were not vaccinated for PRV and became extremely sick when infected. With each new outbreak, infected pigs exhaled large quantities of virus into an environment that supported its survival. All of the factors necessary to support farm-to-farm spread were now present.

Producers and veterinarians realized that a new eradication strategy was necessary. In an effort to stop or at least decrease virus spread, they proposed vaccinating all pigs located in these high-risk areas. Their goal was to vaccinate every pig in southern Minnesota as quickly as possible. They also proposed a plan to decrease response times following an outbreak. Producers and veterinarians also wanted to be notified immediately of new cases so that pigs in the affected area could be quickly vaccinated or revaccinated if necessary.

State officials implemented both parts of the response plan. They constructed e-mail distribution lists and developed a protocol for PRV alerts. After a few weeks of practice, the State had reduced disease response times to minutes following the identification of new cases. Veterinarians and producers were notified of the exact location of each new case, and all herds within a five-mile radius of the case were vaccinated as quickly as possible.

Early in 1999, vaccination for PRV with producer reimbursement began in Minnesota. USDA provided initial funding for this effort as part of the APEP program. By the end of that year, more than 2.7 million pigs in southern Minnesota had been vaccinated. Producers were reimbursed for vaccine at a rate of 25 cents per dose.

The new strategy helped the PRV eradication effort. In the hardest hit areas of the State, reports of new cases slowed to a trickle. The vaccination plan continued, and infected finishers were depopulated with APEP funding. The State also tightened restrictions preventing the movement of infected pigs. Specifically, pigs that moved to slaughter from infected premises were required to move with VS Form 1-27 (Permit for Movement of Restricted Animals) documents in trailers that were sealed by regulatory personnel. By November 1999, only four infected premises remained under quarantine in Minnesota.

The State's eradication efforts faltered once again in December 1999. Weather conditions were similar to the previous winter, which had supported virus survival in the air. Temperatures remained slightly above freezing with thick clouds and high humidity. In late December, the Minnesota Board of Animal Health received reports of three dogs that had died from PRV in Waseca County. The county had been virtually untouched by the virus for more than 3 years, a period of time that also saw a rapid increase in the number of large swine-finishing units in the county. Produc-

ers in the area had chosen not to vaccinate their pigs for PRV because they thought the risk of infection was low. Unfortunately, their assumption was wrong. Within days, the reports of sick pigs and high death losses began. The State issued 24 new PRV quarantines in just 1 week.

Weather conditions favoring epidemic virus spread persisted into the early months of 2000. Seventeen new cases were reported in January, 7 in February, and 38 in March. By the end of the year, 134 new cases in Waseca and Blue Earth counties had been reported. Although the PRV outbreak of 2000 was a setback, producers and veterinarians were much better prepared to respond this time. The State distributed notices of new cases to producers within minutes. Farms were quarantined quickly, and pigs were vaccinated in record numbers. By the end of the year, more than 2.2 million pigs were vaccinated.

As 2001 began, everyone involved in the PRV eradication effort realized that an aggressive plan was required to ensure success. The State would need to vaccinate more pigs than in previous years to prevent further area spread. With support from swine producers, the Minnesota State Legislature provided over $1 million in funding to be used for vaccine reimbursement. Together with existing Federal dollars, adequate funding was now available to support the vaccination of all pigs in the southern half of Minnesota. In an effort of unprecedented proportion, Minnesota swine producers and veterinarians vaccinated more than 5.5 million pigs that year. Their efforts paid off—only five new cases of PRV were identified in Minnesota during the year.

Minnesota maintained momentum to complete the eradication program at a high level throughout 2002. The State and USDA provided funding for PRV vaccine, and producers and veterinarians vaccinated more than 4.4 million Minnesota pigs. In addition, they tested all herds in southern Minnesota for PRV and followed biosecurity practices. As a result of these efforts, no new PRV cases were reported in Minnesota during the year. The State was recognized as attaining Stage IV program status on October 1, 2002.

The reason PRV was ultimately eradicated from Minnesota swine was that producers, veterinarians, diagnostic laboratory personnel, and State and Federal regulatory officials came together to accomplish a common task. By working together, they were able to shorten disease response times and control the movement of infected swine. In addition, Federal funding was made available to depopulate infected herds, and State and Federal funding was available for vaccine reimbursement. Producers and veterinarians vaccinated millions of pigs in areas of high risk to prevent aerosol spread. Most importantly, the swine producers of Minnesota actively supported the eradication effort. They were the ones who responded to disease alerts, vaccinated their pigs, facilitated the testing of their herds, and ultimately sacrificed their animals when PRV infection was diagnosed.

Minnesota qualified for Stage V (Free) PRV status on October 13, 2003, two full years after the last quarantine was released. That year, more than 1.1 million pigs were vaccinated before the vaccine reimbursement program finally came to an end.

## The Nebraska Experience

Nebraska was recognized as qualifying for Stage IV status by the PRV Control Board in November 2000. The PRV quarterly report for the last quarter of 2000 indicated the State had no infected herds or infected swine. During that quarter, 355 herds were tested for various reasons, with 15,339 animals testing negative for PRV. Slaughter surveillance data for that quarter

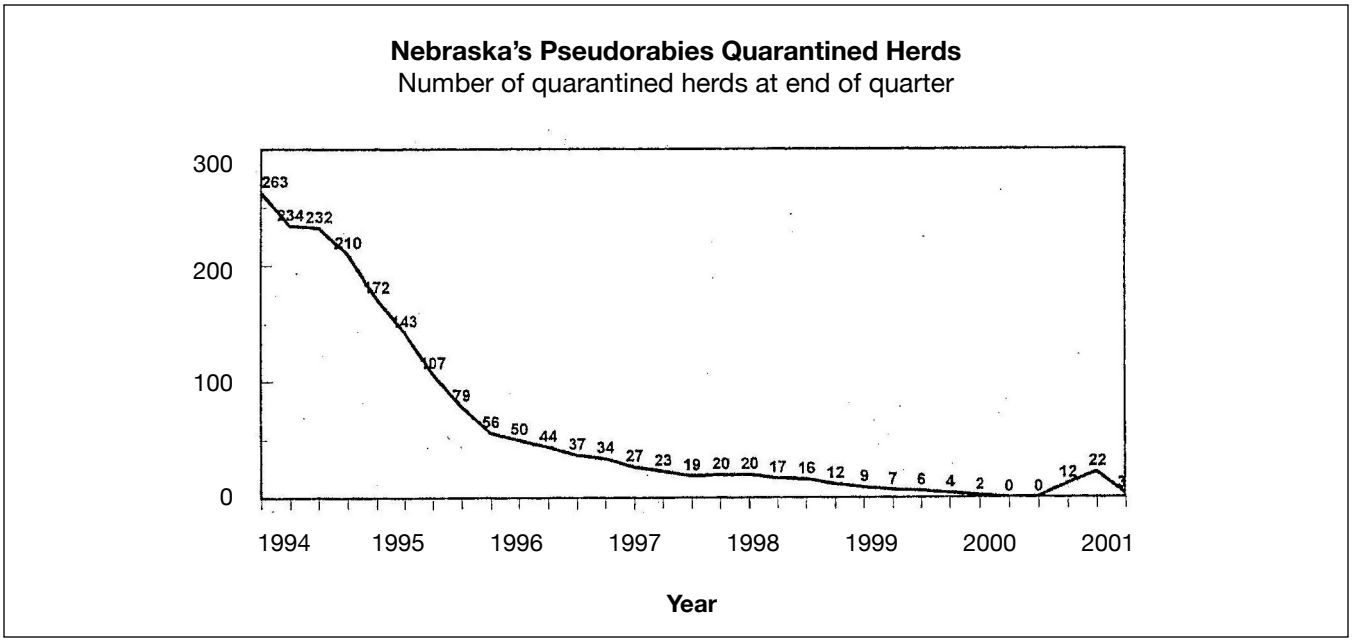



Figure 9.2. PRV-Quarantined Herds in Nebraska. *(Data provided by Larry L. Williams, former Nebraska State Veterinarian)*

revealed only 41 of 11,660 samples collected from Nebraska swine slaughtered in other States to be suspicious or positive. In addition, tracing back and testing these herds did not detect a PRV-infected herd. The PRV Eradication Program in Nebraska was on track to become recognized as free from PRV.

After an interval of 9 months with no new cases of PRV (see fig. 9.2), an outbreak of PRV in Nebraska began. A case of PRV was found on January 18, 2001, in a herd in northeastern Nebraska as a result of classical clinical signs appearing in a 2,500 sow farrowing operation. On January 31, 2001, a second case was found on a farm specializing in feeding lightweight hogs as a result of circle testing around the first herd. Both herds were located in Colfax County, and both were depopulated within 1 week.

Prior to being quarantined, pigs from the sow herd—which subsequently tested positive for PRV on February 5, 2001—had moved to a Minnesota farm. Due, in part, to this situation, Minnesota began enforcing new import requirements for swine imported from the affected Nebraska counties. Additionally, in March 2001, replacements from an infected sow herd in Nebraska were sent to a South Dakota herd prior to the Nebraska herd being quarantined. The South Dakota herd was depopulated as a result. South Dakota officials responded to the incident by establishing additional restrictions for Nebraska hogs being imported into the State.

During the first 9 months of 2001, PRV-infected herds were reported in several counties. The following provides a monthly summary of PRV-infected herds detected for that period, including the month and the number of new cases (in parentheses): January (2); February (1); March (12); April (3); May (12); June (12); July (3); August (0); and September (3).

Epidemiological investigations of the first PRV cases in Colfax County were inconclusive in determining the origin of the outbreak. However, epidemiologists offered two theories explaining the cause of the outbreak. One theory suggested that the introduction of PRV into Platte County herds could have occurred in slaughter channels, where producers and possibly plant personnel had relaxed in following established bi-

osecurity procedures. Some producers who delivered hogs to a Nebraska slaughter facility admitted they often helped unload their hogs and assisted in moving them to holding pens. It was questionable how well shoes, boots, clothing, and vehicles were cleaned and disinfected prior to returning to the farm and working among their animals.

A second theory was that a facility specializing in feeding lightweight hogs in Colfax County could have been infected with no apparent clinical signs for a significant time. This could have been the source for spread to the initial case. However, epidemiologists could not determine how the disease might have been introduced into that herd.

According to reports from field staff, several factors occurred in Nebraska during the preceding year(s), which probably attributed to the rapid spread of PRV once it was introduced. For example, the voluntary vaccination of swine herds had decreased, hog prices had declined to new lows, and producers were looking for ways to cut costs. Breaches in biosecurity—when combined with decreased vaccination—also resulted in the introduction of PRV into Nebraska's susceptible herds and then contributed to its rapid spread. Furthermore, on at least one occasion, a straw dealer loaded contaminated bedding from a customer's farm and hauled it to his farm for use as soil conditioner. The dealer did not clean his hauling equipment before making deliveries to other customers. His herd and several others in the vicinity were infected with PRV. In addition, sharing equipment and labor among neighbors was a common practice.

Another possible factor was that, as mentioned by many producers, it was difficult to convince rendering companies to pick up carcasses in a timely and cost-effective manner. As a result, producers often disposed of swine carcasses (mostly baby pig mortalities) by scattering them on crop land. This practice was not only unwise, but also illegal per Nebraska dead animal disposal regulations. Wildlife was plentiful in the area. The State had received reports of eagles carrying what appeared to be carcass parts. Moreover, coyotes, raccoons, and stray dogs—as well as farm dogs—were all capable of dragging infected carcass parts from farm to farm.

Ultimately, the State depopulated 44 out of the 46 herds that had been quarantined in the zone encompassing Platte County and parts of adjacent counties. Of the two herds that were not depopulated, one completed a test-and-remove herd cleanup plan and the other—after multiple herd tests—was determined not to be infected with PRV.

The APEP was available to Nebraska producers, and most quarantined herds were depopulated within 7 to 14 days after the quarantine was issued. A few herds had to wait for drug withdrawal times to expire before animals could be safely slaughtered for human consumption or rendered. In total, nearly 44,000 animals were depopulated, most of which were slaughtered in the State or at federally inspected slaughter plants. Although slaughter is the ultimate destiny of nearly all meat-producing animals, it was still devastating for producers to load their last animals on the farm and send them away. Owners of breeding herds also lost valuable genetics that they had acquired over many years.

In addition to the PRV-related laws, policies, and procedures that had been in effect since 1997, there were a number of aspects that contributed to Nebraska's successful response to this outbreak. First, State and Federal animal health officials and field staff were very experienced, as they had dealt with livestock disease control and eradication programs in the past. Second, the State carried out rapid disease response upon the detection of infected herds. In May 2001, for example, Nebraska officials set up an operations center at the

edge of the outbreak area and directed field activities from there. Field staff members were then assigned to the center for 6-week tours of duty. Third, a dedicated and effective PRV working group and advisory committee—made up of swine producers and industry representatives—worked cooperatively with State and Federal officials and provided valuable assistance for the development and management of the control/eradication program. Fourth, Nebraska's producers voluntarily depopulated their herds through the APEP within days of being quarantined. Fifth, the State provided sufficient funding for support of the eradication program. Sixth, Federal funding was available to purchase eligible, infected herds and to provide funds for vaccine, which encouraged owners to immunize their herds. Lastly, county attorneys threatened legal action upon producers who allegedly violated the State's laws and regulations. Corrective action occurred before cases were tried, and the county courts levied fines as appropriate.

There were several lessons learned in responding to the Nebraska PRV outbreak. One important lesson was that the State needed an up-to-date listing of producers currently raising pigs. An effective herd and animal tracking system was essential if animal health officials were expected to trace diseased and exposed animals within a timeframe that would make a significant difference in the outcome of disease spread. The Nebraska swine producer's database, populated in the early 1990s by entering test results for surveillance and herd statuses, no longer contained current information. This lack of current data required the field staff to spend weeks traveling up and down rural roads and going door to door to verify the location of swine farms in the area. Another lesson was that Nebraska should utilize compatible State and Federal geographic information systems, databases, and animal tracking programs (i.e., the Federal Emergency Management Reporting System) in its daily regulatory activities so that employees could gain expertise in using the systems. This would be a way to avoid wasting valuable time on computer training when a disease emergency occurred.

Finally, Nebraska's experience with the PRV outbreak showed that an even more rapid response would have reduced the number of herds affected, lessening the economic impact of the outbreak and avoiding the anguish suffered by many producers. Many times during the outbreak, the lead veterinary field officer stated that he felt he was always about 3 weeks behind the virus. Having an effective herd and animal tracking system and personnel who were well-trained on the appropriate computer systems would have given the lead veterinary field officer—and the Nebraska agriculture department—the tools necessary to trace animals quickly, track the progress of the disease response, and calculate the cost of eradication activities.

The Nebraska experience also provided an opportunity to reflect on the successes and perhaps failures in delivering an effective eradication program to the producers and other stakeholders. After completing any cooperative State-Federal disease control/eradication campaign, and with the clarity of hindsight, animal health officials and affected livestock producers should discuss the finite details of how regulatory officials administered the response and how it was received by the producers. This post-response and recovery analyses would verify the actual benefits versus costs of the program, its affects on producers, and the long-range impact on the industry. Regulatory officials and producers should also evaluate the decisions made during the response, not to second guess the decisionmakers but to learn from the experience and validate whether the decisions were made correctly. In the event of another disease outbreak, this analysis should prepare individuals to respond to the situation as efficiently and effectively as possible.

## The Pennsylvania Experience

Pennsylvania has a diverse swine industry made up of integrated companies and independent producers. In 2007, there were approximately 2,900 swine herds located in the State, representing 1.090 million head of swine.

The PRV Eradication Program in Pennsylvania was progressing quickly as a result of State and Federal cooperative efforts. Most PRV cases had been confined to a two-county endemic area within the State. Beginning in July 1992, VS hired two full-time veterinarians to assist and advise the State about PRV. In 1995, Pennsylvania tested all herds within the endemic areas in Lancaster and Lebanon Counties in order to advance to Stage III.

By the fall of 1997, PRV was on the decline in Pennsylvania. Most of the few remaining quarantined herds were either depopulating or were in the process of testing for quarantine release (following test-and-removal guidelines). Only four infected herds remained in the State, three of which were grow-finish operations. To accelerate cleanup, the Pennsylvania Department of Agriculture (PDA) developed a depopulation program with indemnity. The PDA allocated an additional $250,000 in indemnity funds for the fiscal year starting July 1, 1998. The funding was allocated for the depopulation of existing infected herds and the immediate depopulation of any new infected herds. Along with this funding, the PDA implemented new regulations requiring the mandatory depopulation of newly diagnosed PRV-infected herds. The target date for releasing the last quarantine was the end of 1998.

In July 1998, in anticipation of applying for Stage IV and to further establish PRV-free status, Pennsylvania initiated an area surveillance program within the endemic area. The State defined high-risk herds as all herds located within two miles of a herd that had been quarantined in the last 30 months and required that they be tested for PRV. During the summer, the State developed a database listing these high-risk herds. In the fall, both Federal and private veterinarians conducted the required PRV testing. All herds tested negative.

On June 1, 1999, Pennsylvania was recognized as qualifying for Stage IV according to the Pseudorabies Eradication State-Federal-Industry Program Standards. On June 1, 2000, Pennsylvania qualified for Stage V status.

In 2002, Pennsylvania received notice of a Latex Agglutination seropositive test result reported by an out-of-state diagnostic lab. The sample also tested positive on ELISA-gE at PDA's diagnostic laboratory in Harrisburg. The sample was traced to a farrow-nursery pig operation in Lebanon County (Farm A) (see fig. 9.3). On July 10, 2002, at PDA's request, the herd veterinarian collected serum samples from 30 sows; of these, 24 tested positive for PRV on the ELISA-gE. On July 17, 2002, a State regulatory veterinarian collected

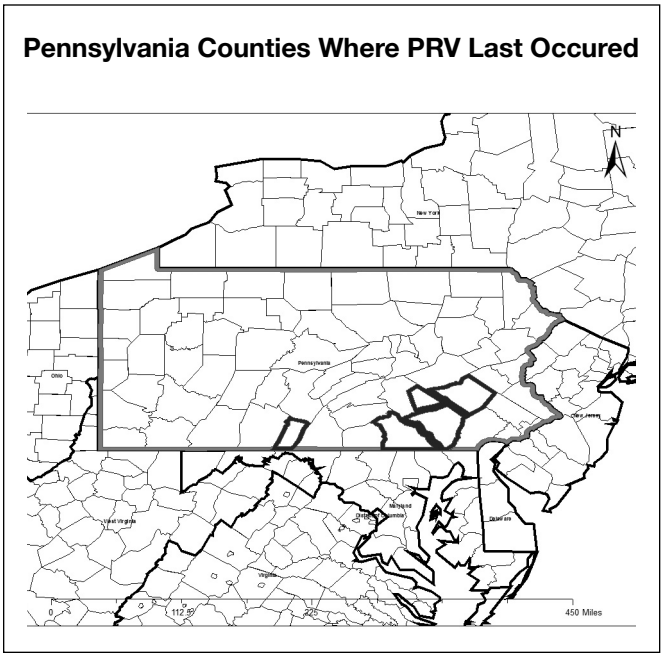



Figure 9.3. A map of Pennsylvania's counties where PRV events last occurred. Berks, Lancaster, Lebanon, and York are clustered in southeast PA. Fulton County is outlined in southcentral PA. *(APHIS map)*

60 additional samples from sows; of these, 48 tested positive. Combining these two herd test results suggested a herd seroprevalence of 80 percent (72/90). An off-site gilt isolation barn in Lebanon County, epidemiologically related to Farm A, also tested positive for PRV. This site had received cull sows from Farm A. Farm A's sow herd supplied 3 nurseries and up to 18 finishing floors. However, not all of these finishing floors contained pigs. Four other sow units also supplied pigs to the same nurseries and finishing floors. Testing of the associated sow units yielded negative results. Testing the pigs that originated from the infected sow farm (identified by ear notches at the nurseries) yielded one positive premises located in York County. All piglets at the nurseries were depopulated due to exposure from Farm A's piglets. The pigs at the finishing floors were each tested twice, with 30 animals tested during the initial test and 60 head of swine sampled during the second herd test.

Five of the finishing sites (one in Fulton County and four in Lancaster County) had seropositive results and were depopulated. PRV prevalence on the finishing floors ranged from 5 to 6 percent. (Note: Each finishing floor contained approximately 20 percent of the pigs originating from Farm A). Two other finishing floors were depopulated due to being epidemiologically linked to the other infected herds. State officials completed testing on all herds located within a three-mile radius of the infected herds and repeated testing 30 to 60 days after depopulation of the infected herds.

One herd (Farm B) inside the three-mile buffer zone tested positive for PRV. This herd included three pigs that had been purchased from the infected nursery in York County. Infected Farm A was the first herd depopulated on July 30, 2002. The last herd to be depopulated (on August 28) was located at a finishing floor in Lancaster County. All premises were depopulated within two weeks of the PRV diagnosis. Most of the animals at the finishing floors tested negative initially and were not diagnosed as infected until the second test of 60 samples detected positive animals.

Production records and clinical signs suggest that Farm A was infected in March 2002. The sow herd also experienced a severe porcine reproductive and respiratory syndrome (PRRS) infection. Incoming gilts and boars were ruled out as the source of infection, as they originated from Qualified PRV-Negative herds and Stage V States and were delivered in split loads to the other unaffected sow units. Area spread or mechanical spread was possible, but circle testing ruled out this reason. A detailed epidemiological investigation of the outbreak suggested that older parity sows (4 to 6 years old) had been latently infected with PRV, had an immune system challenge by PRRS virus, and had subsequently reactivated PRV, which then spread to the rest of the herd.

In August 2002, Farm C—a waste-feeding operation located in Berks County—sold a few heavy finishers to a buying station in Pennsylvania which were then slaughtered in another State. Blood samples were collected at slaughter, and one of three samples tested positive for PRV. The sample was forwarded to PDA's diagnostic laboratory in Harrisburg for confirmatory testing. The result was positive by the ELISA-gE test and reported to State officials on August 19, 2002. A PDA veterinarian collected 45 samples from animals at Farm C on September 9, 2002, and 14 of these samples tested positive for PRV.

Farm C was a 689 head finisher. The owner had originally purchased all of the farm's feeder pigs from an auction in Ohio. Tracebacks failed to find an infected source herd. All herds within a three-mile radius of Farm C were tested and found negative with one exception—Farm D, a farrow-to-finish herd with 24 sows and 346 hogs being fed food wastes. (This farm was owned by sisters related to the owner of Farm C.)

Farm D was located about one mile east and slightly south of Farm C. A herd test on September 18, 2002, resulted in 1 PRV-positive pig (a finisher) out of 63 tested. There was movement of people and equipment between the two operations. A second three-mile circle was created, which identified the herds to test that were located around Farm D. All samples tested negative. All swine residing on Farm C and Farm D were depopulated.

On January 6, 2003, Farm E sold culled sows at a local auction. One sow was slaughtered on January 13th at a plant located in another State and tested positive for PRV at a State-Federal regional laboratory. Another one of these sows was slaughtered and tested positive in yet another different State than the previous sow. Both samples were confirmed positive on the ELISA-gE assay.

Farm E operated a farrow-to-wean operation in Lancaster County. The owner had 56 sows and 5 boars. Feeder pigs were sold at a local auction. Tracing feeder pigs and testing them confirmed that the other Pennsylvania farms were negative for PRV. Two of thirty sows tested at Farm E were positive on the ELISA-gE test. The herd was depopulated between February 25 and 27, 2003.

This herd had a history of using both gX(gG) and gI(gE) PRV gene-deleted vaccines. In March 1998, a herd test of 30 head of swine resulted in 7 positive and 11 inconclusive samples on the ELISA-gE test. Discussion with the producer revealed that he had run out of his usual vaccine and then purchased new vaccine (gG deleted) at a local veterinary clinic in January 1998. The testing veterinarian had not been aware of this and had requested the ELISA-gE test. Once this issue was identified, samples were retested for PRV on the ELISA-gG assay with all samples testing negative.

By 2003, the ELISA-gG test kit was no longer available. Therefore, it was not possible to rule out antibody titers due to the administration of PRV vaccine having only the gG gene-deletion, as was done in 1998. However, a regulatory official collected tissue samples and forwarded them to NVSL for virus isolation. NVSL was unable to isolate any virus (neither vaccine nor field-strain). Furthermore, all herds located within the immediate vicinity of this herd were tested with no additional PRV-infected herds found.

In the past, Pennsylvania has conducted extensive area testing in the Lancaster/Lebanon counties. Pennsylvania continued to test swine for Feeder Pig Monitored Status, Qualified PRV Negative Status and at shows, fairs, and slaughter. The State's sow-boar slaughter surveillance index was 31.8 percent in 2001 and was 19.9 percent in 2002. Pennsylvania has been testing market swine monthly at the two major packing plants located in the State. In 2006, approximately 400 grow-finish sites were sampled using this method of surveillance. However, due to these recent PRV outbreaks, State officials developed an enhanced surveillance program for the disease.

The goal in developing an enhanced PRV surveillance program was to identify herds that might not be included in the current surveillance systems. The plan was developed as follows:

(1) First-Point Testing. Market hogs and cull pigs (other than sows and boars) were tested at auction markets in southeast Pennsylvania for a minimum of 60 days. The State tested a minimum of 10 percent of the animals in a lot. During this time period, regulatory personnel continued to enforce the feeder-pig monitored requirements for feeder pigs entering the auction. Personnel also collected information about continuous flow finishing floors during this testing phase and used it to further develop grow-finisher surveillance methods.

(2) Slaughter Surveillance. All slaughter plants in southeast Pennsylvania were targeted for sampling.

This also included other Pennsylvania slaughter plants that received a significant number of hogs from southeast Pennsylvania. The State developed a cooperative program to ensure the sampling of Pennsylvania-origin hogs during a 60 to 180 day time period. Previously, only sows and boars were sampled. The two largest plants located in the State continued to collect samples on a monthly basis. The goal was to sample all Pennsylvania premises that sold hogs to these plants at least once.

(3) Identify swine vaccinated with PRV gG deleted vaccine. Pennsylvania field staff interviewed accredited swine veterinarians to identify and test any of their client's herds that had used gG deleted vaccine. Any sows that received gG deleted vaccine were removed. In closing, despite the few setbacks that occurred in Indiana, Minnesota, Nebraska, and Pennsylvania, PRV cases and the number of infected herds continued to decline in the United States (see fig. 9.4). When these setbacks did occur, those involved in the eradication effort learned important lessons, updated State and Federal PRV programs, and made improvements to prevent future setbacks. As a result, by 2004, all of the States and U.S. Territories had been recognized as qualifying for Stage V (Free) status.

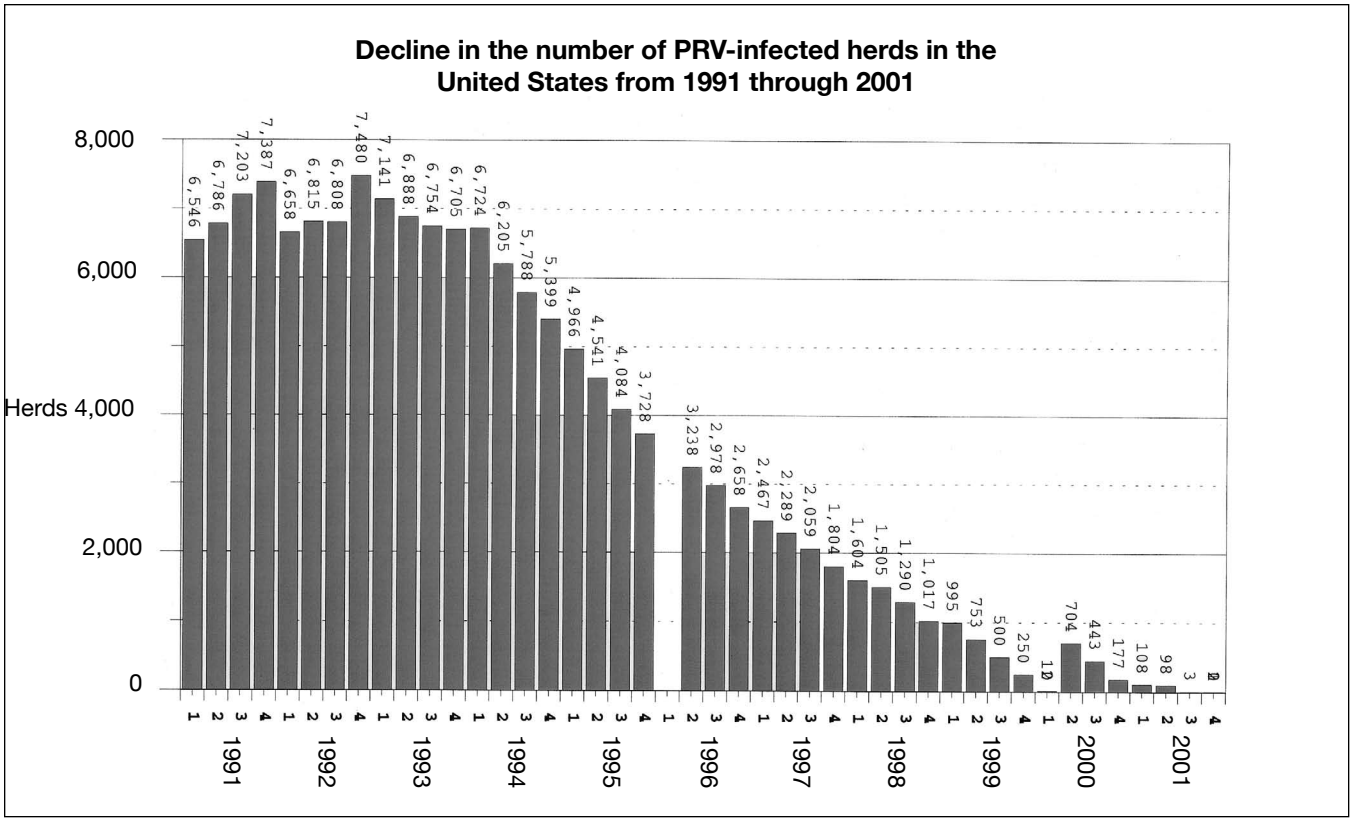



Figure 9.4. Decline in the number of PRV-infected herds in the United States from 1991 through 2001.
*(APHIS data provided by Joseph F. Annelli)*

# Chapter 10—Benefit-Cost Analysis

## Iowa State University

Prior to commencing with a proposed National PRV Eradication Program, USDA requested a benefit-cost analysis of the program. The analysis was performed by an economist and others at ISU in Ames, Iowa. The sources of data used in the analysis included results from the five pilot projects (see Chapter 6), a survey of State veterinarians, and a formal research and literature review. The two primary objectives of the analysis were to estimate (1) the measurable economic benefits to be derived from the eradication of PRV and (2) the costs of a program to eradicate PRV from the U.S. swine herd.

Many costs affecting producers were attributed to PRV. These costs varied due to the type of operation (farrow-to-finish, feeder-pig producer, seedstock producer), the number of swine composing the herd, and the density of swine herds within an area. In areas where PRV had been diagnosed, experience showed that the prevalence of infected herds increased as the density of herds increased. Furthermore, there was a positive correlation between within herd seroprevalence and larger-sized herds. The analysis itemized producer costs as follows: death loss, veterinary expense, diagnostic serology, reproductive losses, increased costs to market saleable animals, vaccine costs, and isolation and testing of new herd additions.

The analysis also described and listed—but did not specifically include—other costs, such as: death losses of cattle and sheep; death losses of dogs, cats, and wild animals; reduced gain; poor feed conversion; decreased live pigs weaned per litter; decreased pigs produced per sow per year; loss of sales of breeding stock and/or feeder pigs due to quarantines or movement restrictions; loss of export markets for live swine, swine products, and pork products; and, the herd owner's loss of satisfaction in raising swine and producing pork due to the herd's likelihood of becoming infected. The analysis also considered indirect costs from the under-utilization of fixed cost assets (i.e., finishing space or farrowing spaces) when livability or reproduction were adversely affected; however, these factors were difficult to quantify and, therefore, were not included in the analysis. Another cost that could not be quantified for the analysis was an increase in labor to deal with strategies that minimized the affects of the cost factors listed above.

In addition, the analysis identified costs involving both the public and private sectors of the community to implement a PRV eradication program. Public costs include paying accredited veterinarians on a fee-for-service basis or the salaries of Government veterinarians to collect blood samples and prepare and approve herd cleanup plans. Another expense was reimbursement to diagnostic laboratories for performing PRV assays. In some cases, State and Federal agencies may have provided partial funding for PRV vaccine to encourage its use. The public sector also covered overhead costs that provided clerical and supervisory support, such as recording program activities in databases. Indemnity payments were also a public expense.

The individual swine producer also had increased costs attributed to the initiation of a PRV eradication program. Depending on the PRV status of the producer's animals, the size and location of the herd, and the operation type, a producer may have been responsible for purchasing additional doses of vaccine and covering increased costs to implement biosecurity procedures on the farm. These bisosecurity procedures may have included restricting access to swine by certain individuals; increased cleaning and disinfection of trucks, machinery, and equipment; implementing isolation procedures for new herd additions; and, additional

labor involved with implementing herd cleanup plans and restraining animals selected for blood sampling. The increased costs involved in reducing the contamination of animal feed and ensuring the proper disposal of animal waste and carcasses was also an important consideration.

At the time of the benefit-cost analysis, several studies forecast that PRV would continue to spread among swine herds. Repeated blood sample surveys conducted at slaughter by the Federal Government demonstrated a steady increase in seroprevalence from 0.56 percent to 8.78 percent between 1974 and 1987. Another study, using computer modeling, predicted that the prevalence of PRV-infected herds may increase to 43 percent over a 20-year period in States identified as having the highest risk for herd-to-herd PRV transmission without an eradication program. Therefore, costs to the industry were expected to increase over time.

The analysis also considered and listed the benefits or cost savings to producers, the swine industry, and the public of having a PRV eradication program. Eradicating the virus would provide a continual, long-term cost savings to the industry. Swine producers would be assured of avoiding PRV infection in their herds and, therefore, reduce costs by preventing exposure to the disease. Deaths to other species of livestock and animals would also be avoided. Other benefits were that seedstock and feeder-pig producers would no longer be fearful of sales losses and movement restrictions, and they would avoid the costs involved with testing to prove the negative disease status of their herds. In addition, having a PRV eradication program could substantially reduce expenses to the public sector. The analysis assumed that the pork-consuming public would benefit from reduced food costs, which was estimated as a 1 percent increase in the Nation's pork supply that would result in a 1.83 percent decrease in price and make pork more competitive with other meats.

After successfully eliminating PRV from their herds, several producers commented anecdotally on other realized benefits of a PRV eradication program such as: increased pigs born alive; fewer mummified fetuses; fewer baby pig scours; heavier weaning weights; more pigs weaned per litter; less rhinitis; less pneumonia; fewer days to market; and, significant improvement in feed conversion. Some individuals also commented that following cleanup guidelines made the producer a better manager and that, for every dollar spent to clean up PRV, the operation realized a $4 return. Another producer, who depopulated his PRV-infected herd and repopulated with specific pathogen-free breeding stock, noticed the following benefits: inspections of carcasses at the slaughter plant confirmed no rhinitis, no ascarid migration lesions in the liver, and few lung lesions; feed efficiency improved by 0.5 lbs to 3.40 lbs feed per 1 lb of gain; average daily gain improved by 0.3 lbs to 1.76 lbs of gain per day; nursery mortality rates were reduced by 1.8 percent to 3.0 percent; grower pig mortality rates were reduced by 1.8 percent to 0.8 percent; finisher mortality rates were reduced by 2.3 percent to 0.5 percent; pigs weaned per litter improved by 1.5 to 9 pigs per litter; and, pigs per sow per year increased by an average of 3.4 pigs to 18.5 pigs per sow per year. Although all improvements cannot be attributed to the elimination of PRV from the herd, these producers' attestations to the benefits of participating in the eradication program cannot be overlooked.

In addition, the ISU analysis utilized information from a previous PRV-related study—the preliminary analysis of the pilot PRV eradication project in Marshall County, Iowa (see Chapter 6, "Iowa Pilot Project"). The pilot project had considered seven objectives: (1) determine the cost burden to the government; (2) determine direct costs to the producer by following one of three plans prescribed to eliminate PRV from the herd; (3) evaluate the success rate and length of time to eliminate PRV among the three cleanup plans; (4) determine benefits to the producer for eliminating the virus;

(5) determine costs to the producer for prevention; (6) determine how PRV prevalence affects the progress and success of the project; and, (7) estimate change in the producers' net income from maintaining a PRV-free area. Pilot project leaders gathered much of the information by administering a questionnaire to the producer. They used the responses to obtain a description of each operation, costs to maintain a PRV-negative herd, costs associated with a PRV outbreak, and costs to participate in various herd cleanup plans. ISU used this information, in part, as data points to include in the benefit-cost analysis. Information from the other four pilot projects was also included. Most of the herds studied in these projects had fewer than 100 sows. In addition, of the PRV-infected herds located in these 5 pilot project States, only 50 percent reported clinical signs. However, ISU recognized that each pilot project had data reflecting diversity among swine herds and production methods and that each herd was considered unique compared to the other herds.
The costs and benefits realized from the analysis of the PRV Eradication Program are based on 1986 dollars. At that time, the cost of disease ranged between $33 and $105 per sow. The higher cost involved seedstock herds. Larger herds had a 5.28 percent decrease in live pigs weaned per litter, accounting for an $11 cost per sow. Larger herds also experienced increased death loss in the farrowing phase, which caused unfilled animal spaces and added a cost of $16 per sow (or a total of $27 additional cost per sow in larger herds compared to the average-sized herds).

Approximately 8.18 percent seroprevalence was estimated among grow-finisher swine. Reduced performance among infected swine in this age group may account for between $0.06 and $0.88 per hundred pounds or between $1 and $12 million annually. Estimated losses to other species could account for $750,000. Losses of seedstock sales were estimated at $25 million.

In the benefit-cost analysis, ISU estimated measurable costs—totaling $21 million annually—for clinical outbreaks, diagnostic serology, and vaccine for prevention and disease control. This included estimated costs for clinical outbreaks at $9 million (see table 10.2), vaccine at $10 million, and serology tests at $2 million.

The type of operation influenced the costs. PRV cost farrow-to-finish herds on average $36 per sow, feeder-pig production herds $22 per sow, and seedstock herds $110 per sow. The analysis grouped States by pig and swine herd densities from greatest to least, identifying the States as groups A, B, and C, respectively. Infected herd prevalence varied among these groups: A = 11.4 percent, B = 4 percent, and C = 1 percent. The number of new PRV cases was an important consideration when estimating the effect of the eradication program on reducing the number of infected herds and preventing new cases.

Table 10.1 displays the differences in incidence, measured by the number of new cases, as related to swine densities and type of operation. Table 10.2 shows the estimated costs incurred due to clinical outbreaks in susceptible herds as related to swine densities and type of operation. In both tables, the abbreviations FTF and FP represent Farrow-to-Finish and Feeder-Pig Producer, respectively. Group A States included 5 States containing greater than 4 million swine per State; Group B States included 8 States containing between 1 and 4 million swine per State; and, the remaining 37 States were included in Group C States, all having less than 1 million swine each.

Therefore, during a 10-year time period, the total producer costs calculated in this benefit-cost analysis were $44.8 million in the Group A States, $16.6 million in the Group B States, and $6.2 million in the Group C States. This accounted for a total of $67.6 million in producer costs nationwide. The analysis estimated that it would cost the public $132.5 million to fund a PRV eradication program.

In summary, the economic results of this analysis provided a number of useful estimates that were utilized as part of the decisionmaking process on whether or not to eradicate PRV. The annual cost of PRV to producers was estimated to be a minimum of $21 million. Eliminating these costs by eradicating this disease has a present 10-year value of $136.4 million at a 10 percent discount rate and $271.5 million at a 6 percent discount rate. The present value of the total eradication program cost is $134.4 million at a 10 percent discount rate and $155.8 million at a 6 percent discount rate. These calculations suggest a benefit-cost ratio of between 1.02 and 1.74 at the 10 percent or 6 percent discount rate, respectively. In order to compute net present value, it is necessary to discount future benefits and costs. This discounting reflects the time value of money, as benefits and costs are worth more if they are experienced sooner. The higher the discount rate, the lower is the present value of future cash flows. Therefore, the benefit-cost ratio was reported in this manner.

**Table 10.1. Estimated new PRV cases by operation type and State grouping each year**

| Operation | A States | B States | C States | Total |
|---|---|---|---|---|
| FTF | 1,028 | 275 | 64 | 1,367 |
| FP | 225 | 60 | 42 | 327 |
| Seedstock | 32 | 9 | 3 | 44 |
| Total | 1,285 | 344 | 109 | 1,738 |

**Table 10.2. Annual costs due to clinical outbreaks (in millions of dollars)**

| Operation | A States | B States | C States | Total |
|---|---|---|---|---|
| FTF | 5.57 | 1.68 | 0.41 | 7.66 |
| FP | 0.74 | 0.22 | 0.16 | 1.12 |
| Seedstock | 0.20 | 0.04 | 0.01 | 0.25 |
| Total | 6.51 | 1.94 | 0.58 | 9.03 |

## The Ohio State University

Approximately 10 years after the ISU analysis, USDA conducted another benefit-cost analysis of the PRV Eradication Program through The Ohio State University. This analysis used an expert panel to project future herd-to-herd PRV transmission under various eradication mitigation strategies and funding levels. The modeling considered a 20-year period (1993-2012) and suggested that, at current funding levels, it was unlikely herd prevalence rates would decline to zero. The expert panel also estimated productivity and economic impacts on herds diagnosed with PRV. Factors used in this estimation included, among others: mortality rates among various phases of production; market weights; the number of pigs marketed; farrowing rates; the number of pigs weaned per litter; and, the number of pigs weaned per sow per year. These estimates and analyses predicted that producers with average-sized farrow-to-finish herds would experience $6 per hundredweight less profitability than producers operating herds that were not infected with PRV. This study incorporated producer and consumer supply and demand curves to evaluate the effect of increased pork production that was expected from a successful PRV eradication program. The results of this economic welfare analysis suggested that, due to decreased prices for pork and the expected increase in pork consumption, consumers were the major beneficiaries of the program. As part of the study, the expert panel used a parallel supply curve shift to estimate benefits versus costs. This showed that consumers gained $336.5 million and producers gained $35.9 million, while the government would spend $197.1 million to continue the eradication effort during the 20-year time period. The benefit-to-cost ratio, which included consideration for benefits to the pork-consuming public, was 1.89 to 1. This fact is especially significant, as it shows that consumers realize a benefit from a program their tax dollars are supporting.

The study also estimated that an increase of 25 percent above the current funding level would be needed to complete the PRV Eradication Program. Even with the most optimistic conditions, a State having the highest number of PRV-infected herds was not predicted to attain total PRV elimination by 2012. However, USDA's implementation of the APEP (see Chapter 8), in 1999 did change the general program's rate of progress. The substantial increase in funding enabled the depopulation of infected herds to occur as the predictor model in this study suggested. As a result, Government officials, industry, and producers achieved eradication more quickly than the study predicted.

# Chapter 11—Feral Swine

Infectious diseases do not recognize boundaries between domestic animals and wildlife—and PRV is no exception. Wild and feral swine have a global distribution. In fact, most populations of wild swine are endemically infected with PRV and represent a persistent reservoir of the virus. The spillover of PRV from acutely-infected farms frequently has caused the virus to move outside the premises. For example, sick or dead animals on a farm can be scavenged by any wild swine in the area, creating mixed infections. The release of domestic pigs and movement/contact between domestic and feral pigs at common markets has also caused—and can continue to cause—the transmission of PRV. This issue is now looming and considered a threat to the successful National PRV Eradication Program.

## Defining the Problem

Swine thrive in the United States, particularly in the wild. After their introduction into Florida in the 16th century and repeated population increases over time, the pigs established themselves during the next centuries along the southern coast through Texas all the way into California. The large expansion of the feral swine populations took place both on its own and with the help of human movements. During the 1980s, the feral swine population expanded north into the Central Plains, partially due to migration but also due to the release of domestic swine during the period of high grain prices. Millions of wild swine are now living permanently in all but a few northern States (see fig. 11.1). Some domestic hogs from the Midwest found their way south as far as Texas, sometimes carrying domestic strains of PRV and able to mix with what was already endemic in feral populations.

In most instances, feral pigs have been considered a nuisance species. Free-living swine are valued primarily because they are hunted. Twenty-five years ago,

Figure 11.1. Captured feral swine.
*(Photo by Kenton Lohraff, DPW Natural Resources)*

a survey in Florida estimated that hunters spent over 500,000 days killing or trapping, with a bag of more than 100,000 feral hogs. The value of the pigs then was $70 to $90 per head. Today, large boars can bring up to 10 times that price, making the nationwide value of wild-hog hunting well into the millions of dollars. No wonder wild hogs have been moved into almost all of the Central States to hunting preserves and backwoods. However, due to the absence of health checks, the movement of feral swine has been an uncontrolled means of disseminating PRV.

The discovery of multiple diseases in feral swine came as a result of widespread fear about the introduction of foreign animal diseases. For example, African swine fever (ASF) was found in Haiti and the Dominican Republic in 1978. Swine brucellosis was also known to exist in feral swine populations. Due to concern for domestic diseases of swine or other foreign animal diseases becoming established in wild swine, VS and State officials initiated surveillance for ASF, swine brucellosis, and PRV in Florida. They found brucellosis and PRV as a result of this survey.

The Southeastern Cooperative Wildlife Disease Study (SCWDS) continued a broad study of feral swine in 11

southeastern States and found that a high percentage of the pigs had been infected with PRV. Initial characterization of PRV in the feral host demonstrated that seroprevalence was age dependent. The virus-host dynamic in feral swine began to look different from the pathogenesis characteristic of the disease in domestic swine; however, most of the features of the disease were similar. Researchers initiated vaccine studies to integrate gene segments from the PRV genome into swine pox virus to be used to vaccinate feral swine. One group was also working on baiting techniques to deliver vaccines.

Concerns about the prospect of a national PRV eradication program and the unknown threat of reinfection of domestic swine prompted a series of small meetings in Florida and elsewhere. These meetings culminated in the first Feral Pig Symposium, which was held in Orlando in 1989. In the years that followed, other meetings were held at which the question of feral swine was discussed (see table 11.1). Additionally, a Feral Swine Subcommittee of the USAHA PRV Committee met each fall and reported to the parent committee.

**Table 11.1 Meetings held to discuss feral swine, 1989-2003**

| Date | Place | Meeting |
|---|---|---|
| April, 1989 | Orlando, Fl | Feral Pig Symposium |
| Oct., 1991 | San Diego, CA | Feral Swine Subcommittee |
| May, 1992 | Atlanta, GA | Feral Swine Pilot Project Planning |
| Sept., 1992 | Arlington, VA | APHIS Regional Swine Epidemiologists & Area Epidemiologists |
| Oct., 1992 | Columbia, MD | Feral Swine Technical Group |
| Nov., 16-18, 1994 | Baton Rouge, LA | Feral Swine Meeting |
| Jan. 23-25, 1996 | Athens, GA | Feral Swine Pilot Project Meeting |
| Sept. 23-26, 1997 | Orlando, FL | National Feral Swine Symposium |
| May 9-10, 2000 | Raleigh, NC | Outline for an APHIS Program on Feral Swine |
| June 27-28 | Riverdale, MD | Feral Swine - Development of a National Action Plan |
| Feb. 27-28, 2003 | Tampa, FL | NIAA Feral Swine Ad-hoc Committee |
| Sep. 22-23, 2003 | Des Moines, IA | National Pseudorabies Eradication Program - The National Plan for PRV Post-Eradication |

## Feral Swine Pilot Project

At a 1991 meeting in San Diego, California, the USAHA Feral Swine Subcommittee of the PRV Committee considered feral swine to be a significant problem for the ultimate success of the eradication program. The committee codified this concern into a resolution:

> "The Feral Swine Subcommittee recommends to APHIS, NPPC and the Southeast Wildlife Disease Research Center (SWDRC) [sic] that pilot studies be undertaken in states of high feral swine population with the objectives of developing effective, practical methods for prevention of transmission of pseudorabies and swine brucellosis between feral and domestic swine and for control/elimination of infection from feral swine. Suggested states for study are Florida, Georgia, Texas, and California."

Swine veterinarians with VS held three meetings during the following year and formed a Feral Swine Technical Group for final review of the proposed pilot project. The project included studying swine populations in the Southeast (Florida and Georgia), Texas, and California, with emphasis on descriptive epidemiology, analytical epidemiology, and intervention strategies of PRV in feral swine. The objectives of this comprehensive initiative set a pathway that PRV eradication efforts followed for a decade. As part of the feral swine pilot project, the Feral Swine Technical Group deemed it necessary to describe the distribution and density of feral swine in the United States and the area of overlap with commercial swine operations. The variables of disease prevalence in the feral populations and the extent to which domestic herds became infected completed the projects' analysis.

The first objective of the study's analytical epidemiology component was to characterize the mechanisms of excretion and PRV transmission from feral swine to domestic swine under various conditions. PRV is commonly isolated from nasal and throat swabs collected from recently PRV-infected, domestic swine. Therefore, this method was employed to detect virus secretions from feral swine. Thousands of nasal swabs collected from captured wild swine in several States failed to yield any infectious virus. Stressing captured wild swine by transporting them in trucks was tried, but again no virus was excreted from the nasal cavities.

A university researcher, working with trappers in Florida who shipped feral swine to slaughter in Texas, was able to document that feral swine with no detectible anti-viral antibody in Florida would seroconvert by the time they reached the slaughter plant in Texas. While no virus was shed from the nasal cavity, tonsillar swabs occasionally yielded infectious virus. Researchers from Illinois, Georgia, and Germany confirmed this shedding from the oral cavity in separate studies. Collaborators from the University of Illinois began to study the mechanisms of PRV transmission by commingling seropositive feral and naïve domestic pigs. Through these efforts, researchers discovered that direct contact between pigs was necessary for PRV transmission and venereal shedding was a definite mechanism. In addition, investigators at SCWDS and in Europe confirmed virus shedding from the prepuce of feral boars. With this information, it became clear that the PRV virus in wild swine had multiple mechanisms for perpetuation and transmission.

Although researchers were able to identify the major mechanisms of PRV's continued existence in the population (latency) and transmission (venereal), further studies suggested that other mechanisms are possible. Not only is the virus latent in ganglia near the genital region, but it has also been detected from conventional sites similar to those found in domestic swine (i.e., trigeminal ganglia, tonsil, and submandibular lymph nodes). This means that upper respiratory tract infection and oral transmission is also a likely mechanism for PRV spread. In fact, researchers have obtained many of the feral pig virus isolates from hunting dogs where venereal infection is unlikely. These

canine infections suggest that oral shedding is a viable mechanism for PRV transmission. In addition, animals have become infected with the PRV virus by ingesting infected tissues (such as through cannibalism). Researchers have also obtained virus isolates directly from vaginal swabs and tonsillar swabs, but never from nasal swabs. In this regard, it would appear that, although the PRV virus can use multiple routes of transmission, venereal and oral shedding are the predominant mechanisms for its spread.

The second objective of analytical epidemiology was to compare the virulence of PRV strains from feral swine with the virus isolates obtained earlier from domestic pigs. The original observations of PRV infection in wild swine (Italy, 1982) suggested that the wild pigs were very resistant to infection. In that situation, researchers observed no clinical signs of PRV infection. Further controlled studies, which were part of the feral swine pilot project, confirmed that virus from wild pigs is attenuated.

Studies at the University of Illinois and in Germany have compared the virulence of PRV strains from feral swine (wild boar) and domestic pig virus strains. Both independent studies described that the virus from wild swine was considerably more attenuated than the strains isolated from domestic swine. In both naïve wild-derived swine and naïve domestic swine, the virus strains isolated from wild pigs were more attenuated. In many instances, the attenuated wild pig strains did not produce any clinical signs in all but the youngest infected piglets. Seroconversion by wild pig strains was delayed several days or weeks after exposure compared with domestic pig virus administered at the same dose.

This attenuated behavior has several implications for the transmission of PRV virus from wild swine. If an attenuated wild pig strain was introduced into domestic swine, it would spread initially without showing characteristics of the highly lethal outbreaks that were the hallmark of the spreading domestic epidemic in the 1970s and 1980s. Without clear signs of PRV infection, the re-emergent virus could spread before being detected, thus impeding opportunities to identify the outbreak early and quickly eliminate the infection. The delayed seroconversion would also be a problem for herd cleanup, as negative pigs could be infected without exhibiting symptoms and later spread infection.

## A Case for Vertical Transmission

The attenuated nature of PRV from wild swine and the suggestion that a fraction of infected pigs may not have detectable levels of antibody have implications for one of the more widely believed concepts about the transmission biology of the virus in the wild pig population. Several groups of researchers have reported that the prevalence of infection in wild pig populations, as measured by anti-PRV antibody, is age dependent. The percentage of positive pigs declines after birth and then increases between ages 1 and 2 to approximately 50 percent seroprevalence. The fact that PRV is transmitted venereally is a mechanism that fits with the increase in seroprevalence at the time of sexual maturity, supporting this observation.

While venereal transmission was certainly a plausible factor, another research study about the wild pig strains suggested a different hypothesis. That is, the attenuated nature of the wild pig strains could be part of a mechanism of silent infection. PRV virus passed from sow to neonatal piglets at a time when they had maternal antibody could have initiated a latent infection. At a later time, latently infected pigs stressed by hunger or at the time of sexual maturity, would lead to viral reactivation and delayed seroconversion. This theory was supported by the fact that the prevalence of classic, age-dependent antibody in a population did not parallel age-dependency associated with viral infection, as determined by PCR for viral DNA. All age

groups of feral pigs were approximately 80 percent positive for the virus, regardless of whether the antibody was detectible.

## Characterization of Pseudorabies in Feral Swine

A number of studies reported about the characterization of virus isolates taken from both domestic and feral swine in order to understand the risks of PRV carried by feral swine. The virus isolates taken from domestic PRV outbreaks had reputations of above-average virulence and involved herds located in the Midwest. The isolates were compared in challenge experiments and at the molecular level. Studies demonstrated that the antibody response to feral pig PRV was readily detectible by all of the assays developed for domestic pig virus. It was therefore possible to use existing serological methods for PRV surveillance in feral swine. Seroconversion was slower after infection with feral pig virus than it was after infection with domestic pig virus. In addition, the feral pig virus isolates were consistently of much lower virulence than the strains that came from the domestic PRV outbreaks in the Midwest. Venereal transmission of PRV is more likely among feral swine, although oral transmission is also possible. Unlike what was seen with domestic PRV infection, the virus was never isolated with nasal swabs from infected feral pigs; however, the virus was isolated from vaginal, prepucial, and tonsillar swabs.

These characteristics of the virus in feral swine have important consequences for the PRV Eradication Program. Most significantly, the studies showed that PRV diagnostics were possible. The results also emphasized that, because oral transmission of PRV is possible, keeping domestic pigs from breeding with feral swine was not enough to prevent transmission of the virus. Lastly, the attenuated nature of PRV virus from feral swine suggested that initial infections may be quite silent, a particularly important issue to consider when conducting surveillance and testing for PRV.

## Regulatory Issues

The feral swine situation has impacted the PRV Eradication Program applied to domestic swine. During the 1990s, each State reported the likely source of new infections. Many of these cases were due to the movement of swine and contaminated trucks, but approximately 10 to 15 percent of new infections were attributed to feral swine each year. As the success of the eradication program reduced the number of PRV-infected domestic herds, new domestic infections decreased. By 2000, most States were declared free of PRV. There were a few outbreaks in Minnesota, Indiana, Nebraska, Pennsylvania, and Iowa due to domestic pig virus. However, as sources of domestic reinfection decreased, it became apparent that most of the flare-ups were occurring in States that had feral swine. One of the major causes of these infections was the inability to keep infected feral swine separate from commercial swine, especially at markets that dealt with both sources of pigs.

Florida understood this problem from the beginning and decided to pass laws that separated markets. The State restricted the movement of swine of unknown origin to be transported only to slaughter markets. Two strategies started to change the popular culture in this area. First, education programs that described the marketing channel separation created acceptance of this new way of marketing. Second, frequent inspections of markets, slaughter plants, and shipments of feral pigs out of state raised the general awareness about these issues and emphasized the seriousness of the State's intent. These efforts improved industry cooperation. In addition, the ability to move captured feral swine to specialty markets brought illegal activities into the realm of accepted practice.

After decades of discussing the threat from feral swine, problems arose with the very definition of the term "feral swine." For regulatory reasons it was especially important to know the source of PRV infection. Ac-

cordingly, different stakeholders began to argue over what and when a pig was considered feral or domestic. Terms such as "free-ranging" or "pigs with a documented history of ownership" did not help because, in some rural areas, pigs moved from free to captive status with variable frequency. These initial definitions allowed for a procedure that permitted feral swine to be redefined as domestic after time and testing proved them to be free of PRV. A third term, "transitional swine," was later born out of a need to describe pigs that were of undetermined origin. The definition of transitional swine took on importance from two perspectives—the origin of PRV infections and indemnification under the new regulations that paid for depopulation of the remaining PRV-positive herds. Feral or wild swine were defined as: "Swine that have lived all (wild) or any part (feral) of their lives as free-roaming animals," or according to the Pseudorabies Eradication State-Federal-Industry Program Standards, "Those swine that are free roaming." Transitional swine were: "Those feral swine that are captive or swine that have reasonable opportunities to be exposed to feral swine." The definition of commercial production swine was redefined in context to be: "Those swine that are continuously managed and have adequate facilities and practices to prevent exposure to either transitional or feral swine."

Because the United States is a major swine exporter, world trade is important and a strong factor in determining market prices and strategy. Criticism of the U.S. PRV Eradication Program centered around concerns that the reservoir of infection in feral swine could be a detriment to the future success of the eradication program.

A turning point came in 1990 at the Aujeszky's/PRRS Symposium in Copenhagen. Several scientists reported on studies that were well on their way to understanding the risk of reinfection to commercial swine posed by feral swine. Whereas some scientists from other countries were pointing to U.S. feral swine as a possible PRV reservoir, it was quite clear that the United States was making progress in understanding feral swine PRV infection. Across Europe, researchers initiated studies of European wild boar. In addition to widespread infection with PRV, other domestic pig diseases have been identified in wild boar, posing a potential threat to domestic livestock.

## Post-Eradication Issues

With the eradication of PRV from domestic livestock, the need to prevent reinfection from the feral swine reservoir became the paramount task. States were asked to prepare reports analyzing the presence of feral swine and a plan for dealing with the problem. At the spring 2006 NIAA meeting, it was recommended to VS that all swine premises be designated commercial production, transitional, or feral. NIAA members further resolved that the Government should evaluate and redesign surveillance programs for PRV and swine brucellosis, with the goal of evolving the programs into a comprehensive swine surveillance program based on risk assessments. USDA-APHIS' VS and Wildlife Services are now in the process of implementing this surveillance program. States with significant populations of feral swine in areas adjacent to commercial operations need to be constantly vigilant and continue educating producers, hunters, and trappers about the disease risks associated with this wildlife.

## Future Recommendations

States are now taking responsibility for the risks that feral swine pose to the health of their domestic livestock and public health. There is no doubt that the problems of feral swine are not going to disappear in the near future. The numbers of feral pigs are increasing in many regions. Surveillance will have to continue in regions where overlap between feral and domestic swine occurs. Continued study will be necessary to understand the risks of introducing PRV in domestic livestock from direct or indirect exposure to feral

swine. Government agencies must develop and tailor an appropriate response plan that focuses on the items of highest risk to our domestic swine populations.

Dr. Frank Mulhern, working with the NPPC, suggested the following point at the Feral Swine Technical Group Meeting in 1992:

> "The ultimate proof that the United States has permanently eradicated PRV from commercial production swine and dealt with the issue of feral swine as a PRV reservoir will come over time with continued effort to prevent transmission between the two populations. Neither feral swine nor the endemic PRV infection of feral swine will disappear soon. For this reason, adequate separation between the populations, surveillance efforts, education and understanding of the risks associated with feral swine, and the reduction of feral pig movement must all continue."

# Chapter 12—Emergency Response Plan

As of 2004, all 50 States, Puerto Rico, and the U.S. Virgin Islands have been recognized as qualifying for Stage V (Free) status according to the *Pseudorabies Eradication State-Federal-Industry Program Standards* (Program Standards) (see Appendix IV). Surveillance programs (see Chapter 8) remain active and are being utilized for two main reasons: to rapidly detect a reintroduction of PRV into the U.S. domestic swine population (U.S. swine) and to document freedom from this disease in U.S. swine. However, by maintaining this vigilance, the possibility exists that PRV may be detected. Therefore, it is imperative that stakeholders are informed and remain ready to respond to a confirmed diagnosis of PRV in any swine herd. This chapter explains the steps to consider and implement in order to respond to a PRV outbreak in a timely and efficient manner, thereby reducing the risks for exposing other U.S. swine herds to PRV should the disease be reintroduced. As part of emergency response planning, it is important to review procedures followed during an actual PRV outbreak. Accordingly, the following description details an example PRV case.

In this case, the affected State had its last PRV-infected swine herd depopulated in 1998 and had obtained Stage V status beginning in 2000. Since then, 10 to 12 slaughter reactors had been investigated annually. Follow-up herd testing had not disclosed infected herds during these past 7 years.

Reports of feral swine sightings in the State had circulated since 2003, and reports of hunter-killed feral swine also surfaced occasionally. With the cooperation of the State's department of natural resources, some hunter-killed swine were sampled for PRV and brucellosis. A few blood samples were collected, some of questionable quality, but all tested negative. Then, in late 2005, a deer hunter killed several feral swine in one county. Six of the swine tested were negative for PRV, and one reported as inconclusive.

On March 12, 2007, a swine producer in this State sold 19 cull sows and 1 boar through a market located in an adjacent State. A few days later, several of these sows were slaughtered at a packing plant located in the same State as this producer's operation. The other animals were slaughtered at a plant located over 500 miles away. Two sows were sampled at the first plant as part of routine PRV and swine brucellosis slaughter surveillance. These surveillance samples were submitted to a veterinary diagnostic laboratory and were classified suspect and positive for PRV, respectively. Both samples were then submitted to NVSL in Ames, Iowa, and were confirmed as PRV positive.

Regulatory officials located the herd of origin by tracing the sows back to the market that had applied the identification numbers retrieved from the animals during sample collection. The market provided the seller's name. This suspected case was assigned to a State regulatory veterinarian who contacted the seller, conducted an investigation, issued a quarantine, and completed herd testing. The veterinarian collected samples from 73 of the estimated 300 animals comprising the herd on April 11, 2007. On the same day, another laboratory reported that a sample collected at another slaughter plant from a cull sow was positive and was traced back to the same State where this case was being investigated. The sample had been collected from an animal that originated from this same suspect herd.

The owner of the index herd was interviewed and confirmed that clinical signs consistent with PRV were present on the farm during the January 2007 farrowing, and more than half of the neonatal pigs had died. The owner did not contact a veterinarian because he

thought the pigs had died from a "cold." He described clinical signs similar to "flu-like" symptoms. He also described clinical signs such as shaking and paddling among some piglets. Recent weaning rates had been reduced to approximately 20 percent of pigs born alive. The sows culled and sold in March were from this group that farrowed in January.

The State's veterinary diagnostic laboratory reported the results of testing the 73 animals and found 5 samples positive and 1 suspect. The samples were assayed by the PRV-ELISA-gE test and then forwarded to NVSL.

The herd owner also disclosed that he had previously loaned one of the seropositive animals, a boar, to another producer. The boar spent August to December 2006 at this farm located about 10 miles away, and it had returned in "bad shape." Testing of samples collected at this second contact farm confirmed that a second premises was also infected with PRV.

On April 17, 2007, NVSL confirmed that samples collected on these two farms were seropositive for PRV. The laboratory reported a total of seven PRV-positive animals from the samples submitted from the index case. This represented an estimated 10 percent seroprevalence among the swine tested.

Therefore, regulatory officials activated a response to this outbreak and notified appropriate State and Federal authorities. The Program Standards currently require specific procedures to be implemented. That is, in the event of a confirmed case of PRV in commercial production swine, the national program coordinator for VS shall be notified immediately, and the county or counties within a 2-mile radius of the new case will revert to Stage III status (except as noted below). All other counties in the State will revert to Stage IV status. Stage IV status for the affected county may be reinstated as outlined in the Program Standards (see Appendix IV).

The National PRV Coordinator and officials from the State where a confirmed case in commercial production swine occurs must notify all 50 States within 24 hours. Such notification is to include the location of the outbreak and the circumstances surrounding the case, including herd size, clinical signs, and type of herd.

Immediately after a confirmed case is identified in commercial production swine, all movement of swine from herds within a five-mile radius of the case and from other exposed herds must be stopped until such herds are tested and found to be negative using an official random-sample test (95/5) (See Appendix IV, Part I, Definitions). This testing must be completed within 15 days of identifying the infected herd.

If one or more counties revert to Stage III, officials from the State where a confirmed case occurs in commercial production swine must immediately notify producers and veterinarians that breeding swine from the affected counties must again be tested for PRV within 30 days prior to interstate shipment.

If the newly infected herd is isolated and disposed of within 15 days after test results are reported to the State animal health officials, and there is no spread to additional premises as determined by the testing of all exposed herds and all swine herds within 2 miles of the new case with an official random-sample test (95/5), Stage V status may be maintained. The testing of the above herds must be accomplished—with negative results—no earlier than 30 days and no later than 60 days after cleanup.

In this case, the State activated an Incident Command System (ICS) and sent an advance team to meet with the county's emergency management coordinator. Because the county emergency management organization had been cooperating with foot-and-mouth disease and avian influenza outbreak simulations and exercises with the State Veterinarian during the past 2

years, a working relationship had already been established. The county's role was limited to hosting a public information meeting and providing traffic control during the herd depopulations.

In addition to meeting with county officials on day one, teams of State and Federal livestock inspectors were dispatched to contact swine producers and schedule herd tests in the 5-mile diameter area surrounding the index herd. Survey questionnaires were administered and herd testing was scheduled, a process that had been developed previously when area testing was established as a PRV control strategy in 1986. Using these established methods saved valuable time. Regulatory officials used premises registration information and geographical information system mapping to delineate the five-mile testing area. Preliminary information from the State's premises registration database indicated that there were 16 premises with swine within five miles of the index herd. The survey teams found almost twice that many swine premises.

The second contact herd had been tested on April 20, 2007. Twelve of fourteen swine tested were seropositive. This small herd contained 2 domestic and 18 Eurasian-type pigs. The owner reported that he originally rescued two Eurasian-type pigs from an illegal hunting operation several years earlier, that pigs had escaped, and that he had seen feral swine in the area. Because of the presence of feral swine and unknown history of the PRV status of these Eurasian-type pigs, the State Veterinarian and VS officials resolved that the source of PRV originated in feral swine.

On April 24, 2007, area testing of 19 swine farms located around the index herd was completed. On April 25 through 26, survey teams visited premises within five miles of the second herd. Again, more than 50 percent of the swine premises found were not registered. By May 1, herd testing on these 35 farms was finished. All of these swine farms tested negative for PRV.

Both of the PRV-infected herds were depopulated on April 27. Initially, a plan to permit the owners to ship swine directly to slaughter was prepared; however, the slaughter plant had pre-established contracts to export pork products to the European Union. The plant management was reluctant to implement extraordinary steps to prevent cross contamination of products and risk jeopardizing these markets. Therefore, the plan to ship exposed animals to slaughter was eliminated from consideration.

A reefer type semi-trailer retrofitted to dispense CO2 gas was used to humanely euthanize animals from the first herd; this method was safer, faster, and much less labor-intensive than using alternative euthanasia methods (see fig. 12.1). Because the second herd was a pasture operation containing heavy brush, regulatory officials selected another method to capture and euthanize these swine.

Six seropositive swine were selected and submitted to the State's diagnostic laboratory for blood and tissue collection, virus isolation, and strain typing. Samples were collected in hopes of isolating the virus and determining genetic lineage relationships to provide insights on virulence and possibly the source of the virus. Intact heads and samples of blood, lung, spleen, liver, kidney, and ileum were collected. Latent virus tends to reside in the trigeminal ganglia and tonsil. Laboratory personnel harvested these tissues from the intact heads. Information obtained from the epidemiological investigation, including a description of clinical signs and history of feral hog exposure, was reviewed to determine the potential source of the virus. The results of virus isolation and strain typing were pending at the time this information was recorded.

When large groups of diseased animals require depopulation, several disposal options are considered since the carcasses are not slaughtered. Disposal of the carcasses by burial, rendering, composting, haul-

Figure 12.1. A reefer style semi-trailer has been modified to dispense CO2 gas to euthanize swine during a depopulation of a PRV-infected herd. *(APHIS photo by Doris Olander)*

ing to a landfill, and incineration are all considered as options. The options are analyzed with cost and safety being primary concerns. Depending on the time of day or week the animals are scheduled for euthanasia, the various disposal options may have different costs.

In this case, some disposal options were not available based on the method of euthanasia. Rendering companies do not accept animals containing chemical residues. On-farm burial required permission from the State's department of natural resources. Landfills considered not accepting animal carcasses or charging higher disposal fees for this service. Ultimately, the remaining carcasses were disposed of by hauling them to a rendering facility within the State. However, having written plans to describe sample collection, animal euthanasia, and carcass disposal methods prior to an animal disease outbreak could help expedite implementation of these processes when needed.

Through USDA-APHIS funding, VS provided indemnity to herd owners to compensate them for the value of the depopulated animals. Based upon fair market value, VS officials were able to calculate indemnity payment using formulas established during the APEP (see Chapter 8, "APEP"). An APEP calculator provided a rapid and accurate means of determining fair market value.

Herds located within two miles of the two infected herds were scheduled for retesting. Testing began between 30 and 60 days after the two PRV-infected herds had been depopulated and the facilities had been cleaned and disinfected.

When a rapid response to a disease outbreak is necessary, having adequate and sufficient personnel resources to accommodate the situation is vital. Even though this PRV outbreak was considered small, contacting and administering questionnaires to every premises owner with swine located within two, 5-mile buffer zones was time-consuming and required many staff hours to accomplish. State and Federal officials within the State quickly recognized the need for additional personnel. They made requests to an APHIS-VS regional office for assistance. Personnel from VS were dispatched from surrounding States to assist with the disease response.

The disclosure of PRV in this State quickly gained media attention. Headlines in local newspapers reported the new outbreak (e.g., "Pseudorabies Case Found in Area"). The story was reported on local television's nightly news and farm radio shows during the day. Magazines specializing in swine and pork production reported this news to their subscribers. Seeing and hearing the reporting of this local news caused concern among individuals residing in the area. While it was impossible to stop rumors about the situation, State officials and VS collaborated and printed an informational brochure to distribute during the premises owner survey to alleviate fears and misconceptions. This brochure explained the nature of PRV and its transmission and helped calm concerns among producers and other stakeholders. In addition, the regulatory officials organized a public meeting with local county officials. In this meeting, individuals could learn about PRV and ask questions about the disease response activities and plans animal health officials were implementing.

In summary, activating a rapid response is necessary to efficiently and effectively eliminate PRV if new cases are detected. APHIS recommends that each of the States have a written PRV response plan designed specifically for their area. The Program Standards provide guidance in these matters; however, each State may require different procedures to accomplish the objectives in a timely manner.

There are a number of procedures, strategies, and lessons learned from this State's experience in responding to a PRV outbreak. These items are summarized below:

(1) Work to reduce apathy about PRV among pork producers and regulatory officials. In this particular case, the State involved had not detected a PRV-infected herd for nearly 10 years. Previously, positive surveillance test results had not led officials to confirming an infected herd. Pork producers were no longer thinking of PRV as a threat and therefore, in this case, did not solicit professional help to diagnose disease problems. As a result, they missed an opportunity to report cases of PRV months earlier.

(2) Initiate a collaborative response to a PRV outbreak by establishing an ICS to manage the emergency. Initially, the ICS can be limited to a local level, but the system is also flexible enough to add more resources and responders if needed. This system will help to ensure that a coordinated response plan is designed and implemented.

(3) Hold public meetings and distribute educational materials during the PRV outbreak to inform the public about the history of the case. These efforts are also helpful in alerting pork producers and veterinarians to observe swine for clinical signs of PRV, warning pork producers to review and tighten biosecurity procedures, and describing the details of the disease response. States should pre-select a public information officer to provide accurate information to the media outlets that represent the majority of stakeholders involved with the response.

(4) Ensure that sufficient personnel resources are available or can be rapidly deployed from other States to respond to the disease situation. For example, the response can escalate quickly from an investigational phase, to depopulation, to planning disposal methods, to calculating fair market values and indemnity payments, to enhancing surveillance methodologies, to collecting tissue samples and information that will help analyze the outbreak and compare trends with future and past outbreaks long after the disease has been eliminated. In this regard, numerous personnel with a broad range of skills must be ready to assist with the disease response.

(5) Develop a plan to provide a communication system that keeps all stakeholders and responders connected and informed. This system should include individual communication devices issued to responders in the field (i.e., cell phones). Informing stakeholders through e-mail messages and frequently scheduled teleconferences is also necessary. In addition, tracking information about individual disease cases, test results, investigations, depopulations, herd cleanup, and other tasks in a database can assist in coordinating response efforts and providing reports that demonstrate progress.

(6) Develop plans in advance of the next outbreak that explain how to euthanize and dispose of a large number of swine. Contact stakeholders, and establish several workable methods in writing. Consider exercising this response by using several of the State's largest herds as examples in an outbreak simulation. After the exercise, develop estimates for the personnel, equipment, and financial resources needed to respond during an outbreak.

(7) Continue to maintain a group of individuals trained and educated about PRV. If necessary, continue to

convene meetings designed to update State, Federal, and local veterinarians about this disease. In addition, continue to remind State diagnostic laboratory personnel to remain vigilant and test for PRV whenever case histories suggest PRV should be included on the disease rule-out list.

(8) Producers should continue to register their swine premises with USDA's voluntary National Animal Identification System. This action will ensure that a current list of swine producers is available in the event of a PRV outbreak or other disease situation. Having this emergency contact list will help regulatory officials respond quickly and effectively to protect swine health.

(9) After the disease response has been completed, convene a meeting with the stakeholders involved and review the actions and results of the effort. Identify what procedures worked well, and determine if other procedures could be improved or updated. Ultimately, learn from the experience and be fully prepared to respond to any future PRV outbreak.

This chapter has described a PRV outbreak in a State that had not experienced this disease for nearly 10 years. The source of the disease—feral swine—was unexpected. However, the response, which included depopulating and disposing of animals from two infected herds, was both thorough and swift once the disease was confirmed. Regulatory officials and producers were able to contain the spread of disease, and therefore, the PRV-free status of the remaining herds within the State was unaffected. The experience taught animal health officials important lessons. Perhaps most importantly, the State learned that resources could become exhausted quickly if more than two herds or swine premises containing thousands of swine are found to be infected. With this in mind, other States may consider developing an exercise to respond to a hypothetical PRV outbreak scenario to ensure that they, too, are ready to respond.

# Chapter 13—Lessons Learned as Viewed by the Technical Coordinators

In this chapter, the Technical Coordinators have recorded items they believe were a significant aid to the PRV Eradication Program's success. A few additional comments emphasize the importance of remaining vigilant for PRV and being prepared to respond if the surveillance systems in place today detect the disease. This chapter also serves as a final summary of key points and lessons learned from the PRV Eradication Program and the information discussed in this booklet. These key points are not listed in any particular order of importance.

## Pork Producers

A major aspect of the eradication effort was the involvement of pork producers, the people who owned the hogs. The vast majority of them did not have PRV in their herds and did not want it to infect their animals. They were actively committed to keeping the disease out of their herds.

It was extremely important that the producers and their veterinarians be involved in the decisionmaking process. This was true not only for swine producers, but also for other livestock producers. At the beginning of discussions on how to approach the disease, many producers raised cattle as well as hogs.

With this vested interest in eradicating PRV, the producers took action. For example, they stimulated regulatory officials to quarantine infected herds and urged them to take other necessary actions, providing the cooperation and support they needed to implement tough measures when required. The producers spent countless hours attending meetings to learn about the disease and, with this knowledge, helped in determining what control and eradication methods to use in the program. In addition, they actively voiced their support for PRV eradication funding to State legislatures and the U.S. Congress. Producers also spent their own money for vaccination and cleanup measures when their herds became infected. Furthermore, they volunteered for leadership roles at the national, State, and local level, discussing and then voting to implement actions against the disease. And they advised the Government on the use and allocation of public funding.

## NPPC, NPB, and State Pork Producer Associations

The NPPC, the NPB, and State pork producer associations have been important in influencing the direction and progress of the PRV Eradication Program. Often, these associations have provided educational materials and held forums to disseminate information to their membership. They have provided information to their State and congressional representatives to express their support for program funding. They have been the feedback mechanism to Government officials, conveying what will or will not work with regard to implementing the program and the effects it will have on the membership. They have facilitated forums for assessing and reviewing current strategies, planning new strategies, and even providing a strategy for adjusting program activities in the post-eradication era.

## State Advisory Committees

The lesson of the value of State advisory committees made up mostly of producers had been learned in the hog cholera eradication campaign and was put to effective use in PRV eradication. Members of these advisory committees represented a conduit to send information between program officials and pork producers. They served, usually voluntarily, to provide advice on key issues and to deliver information about the program to those producers most affected by the program's activities. State advisory committees played an important role during this eradication program and

should be part of any other similar program involving the livestock industry in the future.

## State Animal Health Officials

The PRV Eradication Program moved more smoothly whenever the State animal health officials were able to provide a steady flow of information and direction about the program to veterinarians and producers. Despite a variety of sometimes conflicting influences, the State animal health officials were credited with enforcing State statutes regarding the program, preventing introduction of diseased animals into their States, and encouraging State legislatures to provide tools (through regulations) and funding to support the eradication effort. State animal health officials worked with APHIS representatives to ensure their State's interests were represented equally on a national basis.

## Veterinarians

Practicing veterinarians played another key role in the program. In the counties where veterinarians were supportive, the program progressed rapidly; where they were not, it took longer for producers to accept the program. In several States, practicing veterinarians collected blood samples and were instrumental in encouraging their clients to implement and follow herd cleanup plans. The United States relies on USDA-accredited veterinarians in private practice to perform a large portion of State and Federal regulatory veterinary medicine duties. The current demographics of food animal veterinarians suggest a critical short supply. The decline in numbers of these veterinarians is due to present and future retirements, less student interest in entering the profession, and a decrease in the number of new graduates electing to pursue the field of food animal medicine. Those in the animal health community should ascertain whether, without a reversal of these trends, the United States could meet the surge in demand for food animal veterinarians required to implement another eradication program in the future.

## The Committees

The USAHA and LCI (NIAA) PRV committees were important forums to discuss new research and adjust program policies. The two annual meetings, one held in the fall and the other in the spring, helped to provide frequent reevaluation of the program. The committees included a diversified list of members, representing State Government, the research community, academia, cooperative extension services, diagnostic laboratories, biological firms, identification device manufacturers, pork producer associations, and most importantly, producers. These groups gathered to discuss, develop, and refine the program. Their committee resolutions helped in providing guidance to Federal officials to implement and monitor the program in a consistent manner among all States.

## Working Together

Having a compatible working relationship between State and Federal animal health officials within the State was particularly important. Again, the program operated much better when the Federal authorities and their State counterparts had clearly-defined responsibilities and worked within a well-understood framework. One example of this cooperative work was the PRV program reviews of a State's program. Generally, APHIS initiated and coordinated this process. However, APHIS also included State regulatory officials and pork producers on the review team. The results of the review were made available to all other States. This collaborative effort determined whether general aspects of the program had been implemented successfully in that particular State. This helped to demonstrate to other States that the eradication effort was progressing in satisfactory manner.

## Vaccine and Diagnostic Tests

Effective vaccines with complementary differential diagnostic tests proved to be a tremendous aid to fur-

thering disease prevention and infected herd cleanup efforts. It became important to recognize that free enterprise among various biological firms encouraged research and the development of these new and novel products; however, constraints were necessary in selecting one gene-deletion so that uniformity existed in both the vaccine used and the application of the appropriate diagnostic test kit. Eventually, regulations were adopted to require the differentiation of infected from vaccinated animals, using vaccine products with at least gI (gE) gene-deletions; this requirement was established to avoid the incorrect interpretation of an animal's PRV status. Another important point regarding vaccines is that it was important for the swine industry to believe there was a need for a PRV eradication program. Without such leadership and support for the program, producers would settle for vaccinating their animals and living with the disease.

## Funding

The program's success was based on the amount of available funding from both State and Federal Government. At times, progress lagged because sufficient funding was not available. The producers' participation was influenced by the amount of money they felt they must contribute. Producer costs included restraining hogs for test, diagnostic laboratory fees, veterinary fees, premature culling, loss of marketing feeder pigs or breeding stock while quarantined, vaccines, and additional costs for implementing cleanup plans. Many States contributed State funds to offset some of these costs. State and Federal funds were used in procuring blood samples and reimbursing diagnostic laboratories to assay these samples. Finally, funding through the APEP made it possible to rapidly depopulate infected herds with fair market value compensation. Funding was also provided to enhance surveillance and subsidize vaccine costs, thereby serving to rapidly identify the remaining infected herds and prevent spread of the virus to susceptible swine.

## Pilot Projects

Whenever there was disagreement or skepticism among stakeholders involved with developing this program, it seemed that a common method to resolve the issue was to establish pilot projects or to encourage field research. Some examples of these situations include:

(1) The five pilot projects conducted in the mid-1980s that determined PRV eradication was feasible;

(2) The Large Herd Cleanup Study that began at a Technical Advisory Committee meeting held in conjunction with the LCI annual meeting in 1989. A panel composed of members of APHIS and the NPPC (now NPB) developed general guidelines and objectives for this study. Initially, five large herds from each of seven States were enrolled; several more States and herds were added later. The University of Minnesota's project coordinators maintained copies of most of the PRV testing records and copies of the herd cleanup plans and charted the study's progress. Several years later, at its conclusion, the study demonstrated that PRV could be eliminated from farrow-to-finish operations with greater than 400 sows; and,

(3) The field studies in Ohio in the 1990s documented the costs of a PRV outbreak and reported the economic hardships caused by PRV and the economic advantages to eliminate PRV from the swine population.

These science-based studies helped to convince those in doubt that the disease could be eradicated, and that its eradication would have a positive impact on the swine industry.

## Flexible Herd Plans to Fit the Producer's Situation

Being able to use herd plans other than depopulation encouraged producer cooperation and participation

in the program. Offspring segregation plans afforded producers the opportunity to maintain genetic lines and maintain cash flow. PRV vaccines, younger-aged weaning, and separation of offspring from their dams provided the ability to raise PRV-free swine originating from infected herds. Test-and-removal herd plans allowed the gradual depopulation of infected swine from these herds over time. These options worked well and provided the producer and the producer's veterinarian an opportunity to tailor a herd plan suited specifically for each herd owner's special set of circumstances.

## Market Operators

The feeder-pig program depended on cooperation from the feeder-pig market operators at the beginning of the program because this was the sales method used to pair up feeder-pig producers with pork producers. The market owners helped to disseminate information regarding the program, as they were trusted by many buyers and sellers. The owners also rearranged sale dates and modified facilities so that they could continue to maintain a flow of feeder pigs from seller to buyer. At the same time, they recognized the importance of not commingling pigs that originated from infected or unknown status herds with pigs from herds considered not infected. They also applied identification devices to the animals when necessary, which provided the opportunity to trace infected animals back to the herd of origin.

## Compliance Investigators

State and Federal compliance investigators worked hard to ensure that intrastate and interstate PRV regulations were enforced. This was necessary so that producers, truck drivers, market operators, and veterinarians all participated in the program by following a similar set of laws and rules. These regulatory guidelines were established to control the transmission of PRV by preventing the illegal movement of exposed or infected swine. Ensuring that swine being moved had proper identification, met testing requirements, and had been inspected and certified by an accredited veterinarian were the primary duties assigned to compliance investigators. Whenever there were alleged violations of State or Federal regulations, the investigators collected evidence and prepared cases to demonstrate to their supervisors and judicial authorities that punitive action may be needed.

## Don't Delay

While it was important for the industry to become supportive of PRV eradication, waiting too long to implement the program ultimately had a negative impact on the effort. Once the leadership and key producers were ready to move forward, it was imperative that the responsible parties be ready to proceed. Furthermore, administering the program expeditiously and uniformly in specific areas so that diseased herds could be detected and cleaned up together was important to reduce PRV from cycling among herds and causing reinfection. Pork producers came to expect a prompt response by program officials to any indication of PRV infection.

## Trained Professional Staff

Each year, APHIS convened a PRV Designated Epidemiology Training Course to train at least one regulatory individual in each State on the regulations, science, and procedures needed to implement a successful eradication program in the State he or she represented. This core group of highly-trained epidemiologists helped to provide uniform direction for the program. They were also authorized to use this training information to make sound, scientific decisions as State-specific issues arose.

## Mandatory Program

The PRV Eradication Program initially began as a voluntary program. This was necessary to assure producers that the disease could be eliminated and that the benefits of eliminating the virus outweighed the costs in both time and money. In its early years, the program imposed a few mandatory requirements designed to prevent further spread of PRV among the States. These requirements included negative tests or whole-herd testing for the sale and movement of breeding swine, or statistical sampling of the adult herd for the sale of feeder pigs. However, as the program progressed in the States through the various stages, it was apparent that stricter requirements were needed to achieve eradication. Therefore, the States added mandatory herd cleanup regulations and other regulations. The purpose was not to punish the last few remaining owners of infected herds, but to protect the many producers whose herds had never become infected or had successfully eliminated the virus and wanted the risk of exposure to be reduced.

## Provide Information

Distributing educational brochures to stakeholders and holding informational meetings added to the success of the eradication program. Providing accurate information was a key in gaining support from producers. University faculty and cooperative extension service staff were credited for developing and, in many cases, presenting and distributing this helpful information. In general, an informed public will not only participate in disease programs at a higher level, but will also provide information back to program managers to encourage improvement in program design. In responding to future outbreaks, informing the public and producers of current information and the response plan will continue to be important.

## Update Listings of Swine Premises and Continue Animal Identification

During the 1990s, many States collected blood samples from animals on the farm. First-Point Testing, Slaughter Testing, and Meat Juice Testing also detected positive samples requiring a traceback to swine farms. When PRV-infected herds were detected, neighboring herds were identified and also tested. The results were reported each time traceback and herd testing was completed. This activity ensured that information about swine herds was continually being collected, updated, and recorded. Most of this activity has been stopped or at least drastically reduced, and surveillance samples testing positive for PRV are now a rare event. Therefore, herd listings in most States are out-of-date and not accurate. Individual animal identification or group identification remains a requirement when swine move in interstate commerce. However, information about the herd of origin and the herd of destination associated with these movements is not available until either an alleged movement violation is investigated or a disease emergency occurs. Now, regulatory officials realize that the information taken for granted is no longer current and may affect future efforts to respond efficiently to an animal health issue. Methods should be developed that will ensure an accurate, up-to-date listing of all commercial swine herds that each State can maintain.

## Biosecurity

Biosecurity became a common term when discussing with herd owners methods to cleanup PRV-infected herds and practices to prevent introduction of the disease. This booklet has discussed characteristics of the virus, modes of transmission, and latent infection. Methods to test for the disease, immunize swine, and inactivate the virus by various means have also been

discussed, along with herd cleanup plans that were designed based on this information to eliminate PRV from the herds. Program officials developed strategies to keep a swine herd secure from initial PRV introduction or reintroduction during the course of the eradication effort. This information continues to be shared and applied today for preventing the introduction of PRV and other swine diseases into swine herds.

## Continued Research

Additional research projects about PRV and related issues are still needed. In particular, it is necessary to perfect surveillance strategies that are economical to producers and represent at-risk swine populations. The further development of accurate, low-cost, rapid, diagnostic tests is also needed for continued surveillance purposes. The Market Swine Surveillance Program is an example of innovative research. Surveillance can be conducted on several swine diseases at once by sampling a number of carcasses within a group, representing a herd by using meat juice as the sample. The continued sampling of lots and recording the owner's name provides a mechanism to maintain a current list of premises producing pork within the area.

## Feral Swine

Additional research is needed to further delineate the characteristics of the PRV strain currently infecting feral swine. More studies are also needed to determine the location and the risk posed by feral swine, the remaining reservoir of PRV in the United States. Since 2006, all PRV-infected herds have been traced to exposure by feral swine. Feral swine populations are moving northward in the United States either by natural migration, population increase, or human involvement. Potentially, there may be a disease risk to domestic swine if direct exposure to feral swine occurs.

## Surveillance

Continued sampling and testing of swine is necessary to assure the U.S. swine industry and our trading partners that PRV is not present in our swine population. Furthermore, monitoring the population for infected animals will ensure earlier detection of PRV and therefore reduce the potential for further disease transmission to other herds.

## Readiness for an Emergency Response

In case PRV is reintroduced into the commercial swine population in the United States, it is essential to have emergency plans in place for a quick response to the outbreak. State and Federal agencies must maintain a group of trained and motivated individuals who are not only experienced in recognizing signs of PRV, but also know about the epidemiology of the disease and the methods to quickly eliminate the virus from the swine population. In addition, it is important that these individuals have the authority to require depopulation of PRV-infected herds in a timely manner, and that they have the appropriate resources to euthanize large numbers of infected swine humanely and efficiently. Planning and developing suitable disposal strategies and options for such an event is equally important. Ensuring that there is a sufficient supply of PRV vaccine and complementary diagnostic test kits in reserve and available for rapid distribution should also be a component of emergency response readiness.

## Final Thoughts

This eradication program has been an adventure. It was successful because the program involved all affected stakeholders and respected all viewpoints prior to its start. The program encouraged new research and was flexible enough to permit modifications when better strategies became available. The program

remains successful because researchers are studying potential causes for the reintroduction of PRV into the commercial swine population.  They are also designing surveillance, prevention, and response strategies to protect this important industry.

## Chapter 14—Selected References

Editor's note: This listing of selected references is not intended to be an exhaustive list of all papers or information published or created regarding PRV, the disease, and the eradication effort. However, it is intended to provide readers with a source to obtain additional information about these subjects if they choose.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## Appendix I:

# LIVESTOCK CONSERVATION INSTITUTE

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# The Epidemiology Of Pseudorabies

*A Field Guide*

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**About the Authors:** The authors are both at the University of Minnesota. Dr. David G. Thawley is Dean of the College of Veterinary Medicine. Dr. Jerry Torrison is currently completing a Masters Degree in the College of Veterinary Medicine.

Dr. Thawley and Mr. Willard Korsmeyer, Beardstown, Illinois, are co-chairs of LCI's Pseudorabies Committee.


**About Livestock Conservation Institute:** Livestock Conservation Institute is a non-profit association organized in 1916 to address the problems and opportunities of controlling and eradicating livestock diseases and improving livestock handling procedures.

LCI's membership consists of over 180 highly respected companies and organizations from throughout the United States and Canada involved in the livestock industry. Its mission is to develop and achieve the implementation of industry directed solutions to the animal health and care needs of the livestock industry.


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Pseudorabies Committee.
Livestock Conservation Institute
6414 Copps Avenue, Suite 204
Madison, Wisconsin 53716
(608) 221-4848

# Epidemiology of PRV

## History

Pseudorabies (PR) emerged as a significant swine disease in the U.S. during the late 1960s and early 1970s. It had been described in the U.S. as early as the mid-1800's as "mad itch" in cattle and first appeared in the scientific literature in Hungary in a report by Aujeszky in 1902. Serological evidence suggesting prevalence in U.S. swine herds was noted by Shope in the 1930s,[1] but it wasn't until the mid-1970s that large-scale clinical outbreaks occurred. PR is now endemic in all countries with dense swine populations except Japan, Australia, and Canada, as well as Denmark and Great Britain where eradication programs have been completed.

A widely held belief is that PR is closely linked to the degree of intensity of swine management. This is based on observations of increased PR incidence associated with increased intensification throughout widespread regions of the world.[2] Similar patterns of association with changed husbandry practices have been observed with other swine pathogens such as *Actinobacillus pleuropneumoniae.*

There has also been speculation that a change in the pathogenicity of the virus may be responsible for the dramatic increase in the incidence and severity of clinical outbreaks.[3] This is supported by the current existence of numerous PR virus strains of varying pathogenicity and the low virulence of PR in early experimental studies in swine.[4] Other Reports of high piglet mortality in outbreaks during the mid-1930s, though, indicate that virulent strains of PR virus existed prior to the widespread problems of the 1970s. The absolute reason for the increased incidence and severity of PR most likely involves a measure of both explanations and remains open to discussion.

While the reasons may be unclear, the frequency of PR infection has markedly increased in U.S. swine herds. The prevalence of PR seropositive market hogs in the U.S. steadily increased from 0.56% to 8.18% from 1974 to 1983-84. [5] Due to concern over the rapid increase in PR infections, a pilot project to examine the feasibility of eliminating PR from herds and regions was initiated in 1983 in 119 PR infected herds in five states. Successful elimination was achieved in 116 (97.5%) of the herds. [6] After further discussion, the 1987 American Pork Congress passed a resolution for a 10 year national PR eradication program which began January 1, 1989.

## Virus characteristics

Pseudorabies is caused by a herpes virus. Important characteristics of the PR virus include:

1. Ability to infect a broad host range.
2. Ability to produce latent infection.
3. Poor survivability in the environment.
4. Immune response does not prevent infection

### 1. Host Range

While most herpes viruses are quite species specific, PR virus has a broad host range. The pig is the natural reservoir of the virus and is the main source of infection for other species. Non-porcine species that are susceptible to infection are considered "dead-end" hosts as the disease is, with few exceptions, rapidly fatal and is not transmitted. See Table API.1.[11,7]

Several domestic animals are susceptible to natural infection, including cattle, sheep, goats, dogs, and cats. Horses and birds are resistant to natural infection. A wide variety of wild-life are also susceptible to natural infection; cases have been reported in raccoons, skunks rats, mice, rabbits, porcupines, fox, badgers,

martens, ferrets, otters, deer, feral pigs, peccaries and others.[8] Additionally, there are reports of PR infections in captive species in zoos or on fur farms.[9]

## 2. Latency

An important characteristic of herpes viruses is their ability to persist in a latent state in infected swine. Pigs previously infected with PR may have a reactivation of latent virus and shed virus months after the original infection. Latent PR infections appear to be very common in pigs, approaching 100% based on evidence from experimentally infected animals.10,11 Because of this, any PR infected pig must be considered a potential source of infection.

Several means of artificially reactivating PR virus from the latent state have been developed using immunosuppressive agents.[12,13] It is assumed that "naturally" immunosuppressive conditions such as parturition or environmental extremes are involved in the reactivation of latent virus, but the mechanisms have not yet been completely determined. It is difficult to assess the importance of reactivation in PR transmission because the natural frequency of latency is unknown. However, observations of slow spread of infection within endemically infected breeding herds suggest reactivation is a rare event.

## 3. Environmental survivability

Herpes viruses, including PR virus, are unstable outside the body. Survival or PRV in the environment is a function of the combined effects of pH, temperature, and humidity.[14,15,16] The PR virus is very susceptible to pH levels below 4 and above 9. Temperatures slightly below freezing inactivate the virus more rapidly than temperatures slightly above. Survival times for PR virus on various environmental surfaces and fomites have been determined (see Table API.2). If optimal moisture, pH and temperature conditions exist, some virus may survive 40 days at 98.6°F and 120 days at 39°F. These conditions are unlikely to exist, and in fact the survival of virus in infectious dosages outside the animal host is likely to be very limited. Carcasses of pigs or wild animals may contain virus for at least one week under summer conditions.17 Experimental attempts in to infect pigs with milled feed containing infected tissue have indicated a survival time of less than 24 hours.[18] In most cases virus probably survives only a few days, but the length of survival under specific field conditions cannot be stated with absolute certainty.

Successful elimination of PR virus from environmental surfaces using disinfectant compounds requires that all organic matter be removed before disinfection. Orthophenyl phenol compounds inactivate 100% of the virus within five minutes at room temperature. Quaternary ammonium compounds, chlorhexidine diacetate, iodines, and 5% sodium hydroxide inactivate 90% of the virus within five minutes.[19]

## 4. Infection in the presence of neutralizing antibodies

Another characteristic of herpes viruses is their ability to infect and replicate in animals possessing antibodies specific for the virus. These antibodies can be passively obtained from colostrum or serum, or actively produced in response to vaccination or infection. Protective antibodies decrease the severity of clinical signs after PR infection in pigs and may increase the dose of virus required for infection. [20] Conflicting results have been reported regarding any reduction in the frequency of latent infections by vaccination.[13,21,22] No currently available vaccine has been shown to totally eliminate latency.

## Clinical Signs

The severity and type of clinical signs observed in PR infections are dependent on a number of factors. Species is the most important determinant as pigs are

affected differently than other animals. Non-porcine species typically show severe CNS signs similar to a rabies infection and may have intense pruritus to the extent of self-mutilation. With rare exceptions, death follows within a few days of onset of clinical signs.

In pigs, the severity and type of clinical signs are a function of age, specific and non-specific immune status and presence of other pathogens at the time of infection. Additionally, strain and dose of virus and route of infection are important. Herds with clinically inapparent infections are common, accounting for roughly half of the infected herds.[23,24]

Age of the pig at time of infection has a major impact on the type and severity of clinical signs produced. Younger animals are more severely affected than adults, with mortality as high as 100% in pigs less than two weeks of age. Sudden death without premonitory signs can occur at this age. Clinical signs commonly observed include high fever, progressive depression and loss of appetite, convulsions and paddling followed by death. Signs such as blindness, vomiting, diarrhea and others are occasionally observed. Piglets receiving colostral antibodies from previously vaccinated or infected dams are not as severely affected. Clinical severity decreases with age to the extent that adult animals may only experience fever and inappetence of a few days duration. Pregnant females may reabsorb their litters or deliver mummified, stillborn or weak piglets, depending on the stage of gestation when infected.

Virus characteristics such as dose,[25,26] route,[27,28] and strain,[29,30] of infective virus are major factors determining the severity and type of clinical manifestations present. Differences in the virulence and tissue tropism of different strains are responsible for a large portion of this variation. Strains vary dramatically in their virulence, with highly pathogenic strains at one extreme and attenuated strains that are used for vaccination of pigs at the other.[31] *In vitro* infectivity appears to correlate well with virulence *in vivo*.[32] One facet of strain variation affecting the type of clinical signs produced is tissue tropism of different strains. The highly virulent strains appear to preferentially infect nervous tissue, but some of the less virulent strains are more pneumotropic, infecting respiratory epithelial cells and causing respiratory rather than nervous disease.[33] Strain differences have been reported for the degree to which PR infection decreases bacteriocidal abilities of alveolar macrophages.[34] Intracellular killing of *Pasteurella multocida* is reduced in PR infected alveolar macrophages.[35] These and other effects of PR infection can result in severe respiratory disease in growing and finishing pigs when concurrent diseases such as *Actinobacillus (Haemophilus)* pneumonia or *Pasteurella* pneumonia are present.

## Transmission

The pig has the central role in maintaining the PR virus within the swine population and transmitting it to other species. Virus excretion from infected pigs is the primary source of new infections in pigs and other animals. Patterns of excretion in pigs following initial infection have been well characterized. See figure API.1.

Nose-to-nose contact with infected carrier pigs is considered the primary means of transmission in swine. Viral shedding via oropharyngeal secretions usually begins within 24 hours of infection and rises to a peak concentration in the three to six day post-infection period. Duration of shedding is a function of a number of factors including strain of virus, infective dose and vaccination status. Shedding usually stops in the 14 to 21 day post infection period, but intermittent shedding over longer periods has been reported. It appears that shedding after reactivation of latent infection is of shorter duration and lower concentration than during the initial phase of infection.[14]

Infection by fomites, transplacental transfer,[36] breeding,[37] artificial insemination and embryo transfer[38] or ingestion of infected tissue or milk,[39] are all possible, but less common routes of infection. Wind-borne aerosol transfer over distances of up to several miles has been suggested as a means of virus transmission,[40] but is based only on circumstantial evidence. Aerosol transfer of virus from infected pigs to cattle[41] and pigs[42] over distances of up to 20 yards has been documented. Transmission under these circumstances requires closely confined pigs that are shedding large quantities of the virus at the same time, ideal virus survival conditions and appropriate winds. Windborne spread is considered to be only a rare mechanism for virus spread over relatively short distances.

Various non-porcine species have been implicated as occasional sources of PR infection on swine farms. Particular attention has been drawn to the role of dogs, cats, rats, and raccoons as carriers of PR between farms. These animals can become infected by ingesting tissues from infected pigs, such as carcasses or placentas. Rats[43] and raccoons[44] are highly resistant to PR infection, requiring high virus titers in the tissues consumed for infection to result. Horizontal transfer by contact within these species does not occur, and it appears that pigs most likely become infected by ingesting the carcasses of these animals. The likelihood of these animals carrying PR infection between farms is thus a function of distance between herds, sanitation (prompt disposal of carcasses) and barriers to contact with pigs. As PR infection is almost always rapidly fatal in non-porcine species, transmission by this method is likely to be restricted to a single farm or small area.

In some parts of the U.S., feral pigs also can be sources of infection. Feral pigs are capable of maintaining PR in their population long-term and could transmit the virus to domestic herds if interaction is allowed.

## Vaccines

Vaccines against PR have become widely used since they first became available in 1976. Ideally, a PR vaccine should stop clinical losses in acute outbreaks, prevent infection, virus excretion and development of latency in uninfected swine, prevent reactivation and shedding in infected swine and allow for differentiation between infected and vaccinated individuals. Currently available vaccines accomplish some of these objectives but not all. In general, vaccination has been shown to reduce the severity of clinical signs produced by new infections. Currently available commercial vaccines do not totally prevent infection, but the amount of virus required for infection may well be increased. Excretion of virus from vaccinated animals is reduced and the frequency of latency formation may also be reduced by vaccination. It is unproven but is likely that vaccines may reduce the rate of reactivation of latent virus.

Several vaccines are available that make differentiation between infected and vaccinated animals possible. The basis for this differentiation is a deletion of specific non-essential genetic material from the vaccine virus strain by natural attenuation or by genetic engineering. An accompanying serological test is used to detect the presence of antibodies to the deleted region. When present, antibodies against the deleted region indicate infection with a field strain of PR virus (or vaccination using products without the specific deletion). Several different vaccines having different deletions have been produced, all having their own specific serological tests. The advent of differentiable vaccines allows greater flexibility in the use of programs to control and eradicate PR from herds and regions. The number of vaccines available and the exclusivity of accompanying diagnostic tests, however, requires careful record keeping to use the vaccines to their full potential. (See LCI bulletin, “Swine Pseudorabies Eradication Guidelines”)

## Diagnosis

Identification of the virus, by isolation from infected tissues or by tests using fluorescent antibody or immunoperoxidase labeling is the absolute confirmation of infection. Characteristic histologic lesions are supportive evidence, but the most widely used method of identifying infected animals is serologically testing for the presence of antibodies against PR. Many tests have been developed and several are commonly used to identify infected animals:

1. The serum neutralization (SN) test has been the standard of comparison for new tests and is still considered the definitive serological test. Because of problems related to contaminated serum, the long time required for results and the labor intensity of the procedure, the SN test has been supplanted in many labs by the enzyme linked immunosorbant assay (ELISA).

2. The enzyme linked immunosorbant assay is rapid, sensitive, can be automated, and is used as the companion test method for differentiable vaccines. It is often used as an initial screening test to be followed by SN confirmation.

3. The latex agglutination test is also rapid and very sensitive and used by a number of diagnostic laboratories. It is also a field tet that can be conducted "on farm" and can be read without special equipment. Other rapid field tests that will be able to differentiate vaccinated and infected pigs are likely to become available.

## Control programs

Methods of eliminating PR from swine herds are detailed in LCI bulletin, "Swine Pseudorabies Eradication Guidelines" and will only be briefly mentioned here. The best way to achieve a negative PR status in a herd is not to become infected in the first place. As infected carrier pigs are known to be the principle disseminates of PR between herds, minimal herd security warrants testing of all additions to the herd prior to introduction. Additionally, a 30-day isolation period and a second negative test before mixing with the herd increases the probability of preventing virus entry. Other security measures such as restricted personnel movement, vermin control and disinfection of equipment will decrease the probability of PR entry into a herd.

Cleanup methods described for herds include test and removal of infected animals, depopulation and repopulation, and offspring segregation.[45] Differentiable vaccines add the option of a vaccination program in conjunction with these cleanup procedures. In deciding the appropriate method of use in a given herd many factors must be considered including herd size, herd type (farrow to finish vs producer, etc.) desirability of maintaining existing genetic stock, availability of facilities, cash flow, management ability and the history of concurrent diseases.

## Surveillance and Case Finding

As the national eradication program progresses it will eventually be necessary to identify all PR infected herds to control continued spread and develop head cleanup plans. Several means identifying infected herds are currently in use with variations between programs in different states. These are fully defined in the Program Standards for Pseudorabies Eradication[46] and can only briefly be discussed in this bulletin. Measures to stop continued spread include feeder pig monitoring programs, qualified negative herd programs, controlled vaccinated herd programs and the requirement of PR serological testing of breeding stock before movement. These are intended to limit the spread of PR by infected pig movement.

Additionally several programs are in place to detect infected herds. These include the market slaughter surveillance programs, first point testing programs, circle testing around infected and qualified negative

herds, tracing movement of animals to and from infected herds and the reporting of clinical outbreaks by producers, veterinarians and diagnostic laboratories.

**Figure API.1. Overview of pseudorabies transmission.**

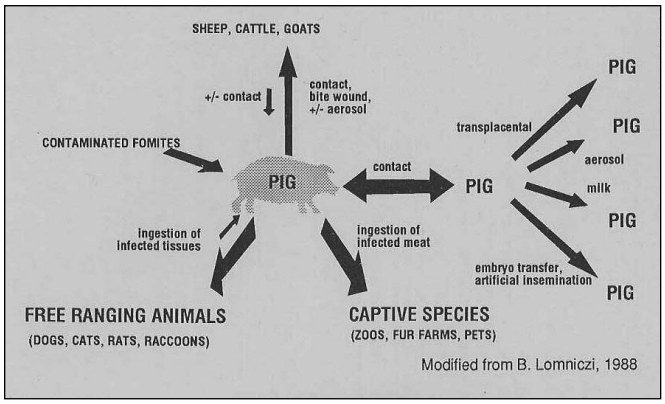


**Table API.1–Resistance to PR infection by species**

| Species | Resistance to natural infection | Outcome of Infection |
|---|---|---|
| Pig | low | Variable |
| Cattle | moderate | usually fatal |
| Sheep | moderate | fatal |
| Raccoon | moderate | usually fatal |
| Dog | high | fatal |
| Cat | high | fatal |
| Rat | high | usually fatal |
| Mouse | high | fatal |
| Skunk | high | fatal |
| Opossum | high | fatal |

**Table API.2–Survival of PRV Virus on Various Fomites** [7,8,9,47]

| Fomite | Maximum survival time (days) in saliva, nasal washings or mucus at 25°C (77°) |
|---|---|
| Loam soil | 7 |
| Non-chlorinated water | 7 |
| Steel | 4 |
| Whole corn | 4 |
| Straw | 4 |
| Concrete | 4 |
| Plastic | 3 |
| Pelleted feed | 3 |
| Manure/lagoon water | 2 |
| Meat and bone meal | 2 |
| Rubber | 2 |
| Green grass | 2 |
| Housefly | <2 |
| Chlorinated water | <1 |
| Alfalfa hay | <1 |
| Denim cloth | <1 |
| Ground corn | <1 |
| Aerosol suspension | 50% inact. in 1 hr. (4°C) |

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## Other Pseudorabies Information Available from Livestock Conservation Institute

*Swine Pseudorabies Eradication Guidelines*
(Second Edition)
12 page booklet

*Pseudorabies Progress Report*
Monthly Newsletter (no charge for subscription)
General information about national and international progress in eradicating pseudorabies

*Pseudorabies Epidemiology Report*
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Technical information of interest to swine practitioners and researchers

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**Appendix II:**

# LIVESTOCK CONSERVATION INSTITUTE

## Swine Pseudorabies

## Eradication Guidelines

# Plans for Elimination of PRV from a Swine Herd

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## Table Of Contents




**About the Authors:** The author, Dr. David G. Thawley, is Dean of the College of Veterinary Medicine, University of Minnesota.

Dr. Thawley and Mr. Willard Korsmeyer, Beardstown, Illinois, are co-chairs of LCI's Pseudorabies Committee.


**About Livestock Conservation Institute:** Livestock Conservation Institute is a non-profit association organized in 1916 to address the problems and opportunities of controlling and eradicating livestock diseases and improving livestock handling procedures.

LCI's membership consists of over 180 highly respected companies and organizations from throughout the United States and Canada involved in the livestock industry. Its mission is to develop and achieve the implementation of industry directed solutions to the animal health and care needs of the livestock industry.


A Publication of the
Pseudorabies Committee.
Livestock Conservation Institute
6414 Copps Avenue, Suite 204
Madison, Wisconsin 53716
(608) 221-4848

## Guidelines for Eradicating Pseudorabies from a Swine Herd

Swine herds and/or premises can be freed of pseudorabies (PR). When PR is diagnosed in a herd, all factors must be considered and a plan chosen and rigidly adhered to. Alterations to the basic plan can be made to take advantage of the particular premises; however, the basis principles must be scrupulously followed.

Included here are broad outlines and specific recommendations involved in Depopulation and Repopulation, and in programs designed to retain bloodlines in a herd, either by Testing and Removal Programs, which is intended for rebuilding a herd from seronegative adults, or Offspring Segregation, which is intended for development of a herd using the offspring of seropositive adults.

These guidelines have been developed through consultation with authorities on PR including epidemiologists, research scientists, diagnosticians, regulatory veterinarians, extension veterinarians and practicing veterinarians.

These guidelines may be used as a basis for developing a specific plan for an individual herd, but it must be emphasized that the details of a formula for a given herd must be adjusted to fit the situation.

Preliminary considerations in deciding how to proceed, should include:

1. Evaluation of laboratory data and, if necessary, reconfirmation of the diagnosis;

2. Consideration of type of management, housing, size of breeding herd, other domestic animals with direct contact with pigs, personnel and vehicle traffic, herd additions and source of replacements, presence of wild animals, dead animal disposal, and

3. Presence or Absence of PR in the neighborhood.

### Factors to consider

- The main source of PR virus is the infected pig.
- The virus is primarily transferred by the pig or its secretions, but dogs, cats, and rodents and wildlife have been incriminated as sources of infection in a number of outbreaks. People and agents capable of harboring the virus, such as boots, bedding, manure or trucks may carry the virus in isolated instances. The virus is not present in significant amounts in feces or urine.
- In establishing a new, PRV-free herd, consideration must be given to the factors involved in the first herd infection. They must be corrected, to prevent re-infection. Dedicated management and a positive attitude are vital to success of any program to eliminate the virus from a herd.
- Latent virus may exist within a herd without any current or previously recognized clinical evidence. Periodically, particularly at times of stress, virus may be shed from latent carriers and may infect other herd members.
- Virus survival in the environment is important in the effort to establish a PRV-free herd. Virus can survive for 140 days at 39°F under ideal conditions, such as in damp, cool bedding, especially straw. Maximum virus survival times in other conditions include 24 hours at 99°F, 10 days at 75°F, 30 days at 65°F, up to 7 weeks on wood boards, 6 months at refrigerator temperatures, up to 2 weeks in swine urine, 5 weeks in shelled corn, and 3 weeks on moist metal. The virus has a very short survival time on clean concrete, green plants or well-cured hay.
- Time of year is important in any eradication at tempt, since virus survival is very dependent on temperature and dryness. Heat, direct sunlight and dry conditions inactivate the virus quickly.

- All commonly used serological tests are accurate and valid, but false positives or negatives can occur. Samples which have been mishandled can result in false negatives, or an invalid test. Care must be taken to avoid microbial or chemical contamination. A positive serological test provides an indication of infection that occurred at least 5 to 14 days previous to the test therefore, these facts should be used in evaluation of herd status. A negative test indicates that infection had not occurred 12 to 14 days earlier, but nothing about the interim period. Testing should be considered a device to monitor the presence of infection. Retesting is important to monitor progress of the program.
- Frequent testing of a representative sample of swine in a herd is more valuable than 100% testing at infrequent intervals.
- For eradication plan in a herd to be successful, strict isolation must be achieved. As the number of infected herds in an area increases, so does the chance of re-exposure.
- A plan which includes moving infected hogs off the farm should not be undertaken unless permission is obtained from the proper regulatory agency.
- Vaccination – Vaccination for PRV will neither totally prevent infection nor latency, nor also will not eliminate viral shedding after infection. However, vaccination may inhibit spread within a herd. "Differentiable" vaccines combined with their appropriate serologic tests permit vaccinated animals to be distinguished from those infected with "field" strains of virus. It is advisable to con sult your veterinarian regarding the most appropriate vaccine to use.

## Selecting a strategy to eliminate herd infection

There are three basic plans to eliminate PRV from herds of swine: test and removal, offspring segregation, and depopulation-repopulation. Each plan has its advantages and appropriate applications. A number of considerations influence the decision on which plan to choose:

**1. Type of operation –** different implications are presented by different types of operations – farrow-to-finish, seedstock, feeder pig producer, feeder pig finisher.

**2. Prevalence –** Infection rate in the herd should be determined by serological test. In large herds (more than 200 sows), a satisfactory estimate can usually be obtained by testing 30 representative hogs and pigs (10% of the herd in large herds with a minimum of 30 head in small herds). Obviously, immediate test and removal is not a valid consideration if most desirable adults are seropositive. If more than 60% of the herd is positive on blood test, or if additional positive pigs are found on retest, phased test and removal, depopulation or segregation of off-spring might be the wise choice.

**3. Facilities –** Evaluate the facilities for the probability of maintaining separation. Multiple premises with different personnel are ideal, but are not necessary. The more separation that can be achieved the less the chance of cross contamination, but cleanup of herds with no more than 12 feet of separation between individual single-litter units have been reported.

Total confinement of all ages in a single building is probably not compatible with any plan except depopulation. The ventilation system is critical, as would be expected with an airborne disease. Great distances outside are not necessary. However, there is ample documentation of PRV transmission by air currents within buildings.

The most powerful management change to prevent transmission within a herd is to move pigs in an all in/all out flow. This change alone will usually stop the spread of PRV and coincidentally improve performance. In practice, all in/all out management is a

matter of degree. Ideally, each group of pigs should have less than 400 pigs with a 1-2 weeks age spread, 4 weeks maximum. Additionally, rooms should be cleaned before introducing pigs and contact (physical or aerosol) between groups should be eliminated.

**4. Value of bloodlines –** To preserve valuable bloodlines consider test and removal or offspring segregation, but if prevalence of the virus is high in the herd, it may be difficult to carry out either plan successfully.

**5. Commitment and management ability of personnel –** Details must be carefully planned and followed. Re-infection has occurred in herds because the owner couldn't part with a "foundation sow."

**6. Financial considerations –** The plan must be realistic in terms of the financial resources of the owner. Contracting for bred gilts, purchasing temporary facilities for the "back forty," or other, non-routine efforts may represent solutions to "unsolvable" problems. It may be necessary to consult lenders.

**7. Availability of suitable replacements –** From both a genetic and disease standpoint.

**8. Disease profile of herd –** The status of the herd with regard to diseases other than PRV could well be a major consideration, since the presence of other diseases might make depopulation the most practical choice. Effects of some chronic diseases are cumulative and freeing a herd of such disease problems along with PR could justify depopulation economically, provided clean stock can be found for repopulation.

**9. The area PRV status –** Whether the disease regularly occurs in the area or there are only a few infected herds, herd size and swine density in the area will be factors in the ability to keep the herd free once it is cleaned up.

## Plans for Elimination

### Plans for Removal from the Grow-Finish Herd

The first step in choosing an elimination program is to determine if any growing-finishing pigs present are infected, and to estimate the PRV seroprevalence in the breeding herd. If growing pigs are moved in a continuous flow, then only a single group needs to be tested. If pigs move in all in/all out groups, then each group should be tested. Testing only pigs over 4 months of age will avoid misinterpretation due to passive antibodies.

### Stop Spread in Grow-Finish

During a PRV epidemic, virus usually spreads rapidly throughout the herd such that the seroprevalence approaches 100%. Subsequently, virus spontaneously stops spreading within the grow-finish section in the majority of herds, however virus usually spreads continuously among growing pigs in large herds. This tendency reflects the increased likelihood of being completely confined and the increased number of susceptible pigs being continuously introduced. Considering these associated factors, one can formulate a program to stop spread in growing-finishing pigs.

The most powerful management change which will inhibit spread is to move pigs in an all in/all out flow. This change alone will usually stop the spread of PRV and coincidentally improve performance. In practice, all in/all out management is a matter of degree. Ideally, each group of pigs should have less than 400 pigs with a 1-2 weeks age spread, 4 weeks maximum. Additionally, rooms should be cleaned before introducing pigs, and contact (physical or aerosol) between groups should be eliminated.

The decision whether to vaccinate growing/finishing pigs must consider the anticipated economic benefit if vaccinating versus the cost of the vaccina-

tion program. At present, there is no consensus on a specific age at which to vaccinate. Ideally, pigs should be vaccination delayed until 2-4 weeks prior to when infection usually takes place. This age appears to vary among herds. Therefore, the age of vaccination should to be a herd specific decision.

## Plans for Removal from the Breeding Herd

Following the initial sampling of the breeding and finishing herds, a plan must be developed which will provide the most cost-effective means to clear the herd of PRV infection. Each plan will fall into one of three categories:

- **Test and removal of positive animals-**rebuilds a herd with seronegative adults.
- **Offspring segregation,** followed by phased repopulation rebuilds a herd using offspring of seropositive adults.
- **Depopulation/repopulation**

Vaccination programs are often important components of these plans. The vaccination program in the breeding herd is critical since it is the main method to control any spread that may exist. The goal of vaccination is: (1) to inhibit shedding if reactivation of latent PRV occurs and (2) to decrease new infections if a gilt/sow is exposed to virus. The frequency of administration has an effect on the immune response but no data exist on the optimum interval. Currently, most herds are vaccinated biannually or pre-farrowing. A more intensive vaccination program would be quarterly, or pre-farrowing and again at weaning. It is important to use a vaccine which will permit the differentiation between vaccinated pigs and those infected with a “field type” virus. Most herd-owners should use the same type of vaccine in the breeding herd as in the growing pigs. This will avoid the possibility of false positive reactions on serology if gilts are selected from within the herd.

An additional general recommendation is to reduce stress whenever possible. Stressed sows have lower productivity, but more importantly in the case of PRV their immune response is suppressed. This is thought to predispose these individuals to recrudescence of latent PRV and possible reshedding of virus. Known stressors include fighting, extreme environmental temperatures, housing changes, and rough handling. Although it will be exceedingly difficult to document, the manager’s attitude towards the pigs and his/her husbandry skills may have critical effect on the sow’s immune system, and consequently, may be the most important determinant in a herd’s chance of eliminating PRV.

## PLAN A
## Test and Removal

**Test and Removal-**Under favorable conditions this option may be least disruptive to management and least costly. It is very successful in herds with a stable or declining prevalence rate and no current clinical signs. In many herds it may be combined with a vaccination program. It probably will not be successful in a herd with total confinement and all ages in a single building. It should not be attempted in a herd in such a confinement system or in herds with current clinical signs or evidence of continuing spread. The lower the prevalence, the more likely it is to succeed.

Two options available:

**1. Immediate Test and Removal** (with or without Vaccination)-Use this option when less than 20-25% of the breeding herds is seropositive and there is no evidence of infection in the growing or finishing pens. Test the entire breeding herd every 30 days and immediately remove all positive animals. Remaining sows may then be vaccinated with a “differentiable” vaccine. All positive swine must be considered potential sources of infection. If, after three tests, seropositive animals continue to be found, this method should be

re-evaluated. Positive animals must be moved immediately to slaughter or to quarantined feeding facility. Retention of one infected animal to save a bloodline could result in failure of the program. Following two whole herd negative tests, the herd may be considered free of PRV.

**2. Phased Test and Removal** (with vaccination)-To minimize the interruption to pig flow and financial costs, a phased test and removal plan may be used. Inherent in this plan is increased risk of failure to eliminate PRV from the herd because positive swine remain in the herd for longer periods of time; however, the risk is reduced by vaccination and may be more than offset by the reduced cost of the program. All sows and boars are tested and then vaccinated with a "differential" vaccine. The original positive sows are removed from the herd at their next weaning or if necessary over two weanings. All positive boars are immediate removed from the herd. Positive sows are replaced after weaning, with vaccinated gilts. Replacement of the original infected sows may take up to three breeding cycles, but should occur as rapidly as possible.

## PLAN B

## Offspring Segregation

Offspring Segregation-This plan is most applicable when at least 6 months have passed since clinical outbreak, or in herds experiencing only subclinical infections. It may be used in herds with any percentage of seropositive breeding or finishing swine. It is applicable only to herds with breeding stock.

It is usual practice in using this plan to vaccinate all open sows and gilts, using vaccine of the herd veterinarian's choice. Vaccinated breeding stock should be boostered 2-4 weeks before farrowing to provide maximum levels of colostral antibodies to protect suckling pigs.

**Procedure**

**Wean** baby pigs early (2-3 weeks of age) and select at least 1 _ times as many gilt offspring as may be desired as replacement gilts. Immediately move these gilts into a facility as far from all other swine as possible.

**Raise** the segregated gilts as protected as possible from exposure to PRV. Separate caretakers, changing of boots and coveralls, prevention of any contact with other swine and disinfection of transport vehicles or trailers are all appropriate.

**Serologically** test 14 randomly selected gilts per segregated group at 4-5 months of age by ELISA screening test. If any of the gilts are positive, test all of each segregated group. If fewer than 10% are seropositive, promptly remove them and repeat a 100% test after 30 days. If more than 10% are seropositive, the entire replacement gilt group should be sold and the segregation procedure started over.

**If possible,** the replacement gilts should be vaccinated with a "differential" type vaccine, then bred and gestated in the segregated facilities. Be certain that infected boars are used to breed them. If breeding in segregation is not possible, the portion of the breeding/gestation unit where they will be placed should be emptied and disinfected 30 days previous and at least one empty pen should be maintained between the new and old breeding stock. These gilts may be booster vaccinated 2-4 weeks before farrowing.

**Remove** old breeding stock from the infected herd as litters are weaned. Empty the farrowing unit, or an isolatable section of the farrowing unit, and disinfect 30 days before the bred replacement gilts are moved in.

**Maintain** a 30-day open space through the nursery, grower and finisher units, cleaning and disinfecting

each as progeny of the old, infected herd are moved through.

**During** and following cleanup, the new herd should be serologically monitored every 3 months. Prior to declaration of free status, 2 clean tests of 14 breeders and 9 finishers should be obtained.

## PLAN C

## Depopulation-Repopulation

**Considerations, planning**

Recommended for, and plan most likely to succeed, in a confinement operation with a high level of chronic infection. Consider this choice if:

1. High percentage of seropositives (over 75%), especially if an increasing seropositive rate, seropositive rates in different pens, or appearance of new seropositive pigs in repeated tests, indicate an actively progressing disease.
2. Existing genetic strains one of little value.
3. The farm has multiple health problems.
4. There is confinement housing, with common air source, or where separation is difficult to maintain.

A significant advantage of this choice is the opportunity to repopulate with healthier, genetically superior swine. Other diseases may be causing as much, or more loss, as PR.

The plan should include:

**Hogs:** schedule for depopulation—trucking, personnel, release papers; repopulation—dates, location in facilities; blood testing and retesting to monitor success of restocking.

**Facilities:** alternate facilities for finishing light-weight pigs, feed, water, manure handling.
**People:** commitment from management to complete job; acquaint farm workers with the plan and their role and the need to maintain clean and dirty areas, arrange for paper work, quarantine release, permits, extra help, etc.

**Equipment and supplies:** for cleaning and disinfecting, manure handling, feed handling, dead pig disposal.

**Monitoring progress:** set up blood testing schedule with veterinarian and laboratory.

**Budget:** estimate cost for veterinarian and laboratory services, disinfectant, extra help if needed, and any extraordinary expense.

**Timing**

Choose warm, dry months, when possible. Sunlight and drying very quickly inactivate the virus. During cold months, in empty facilities, the virus is inactivated by alternate freezing and thawing.

**Depopulation**

Most common and economical plan is depopulation over a period of months as hogs reach market weight. In a commercial herd, don't be in too big a hurry to depopulate lightweight hogs. Sell hogs as they reach market weight, but don't retain slow growing pigs.

**Other options include:**

1. Sell for slaughter all breeding swine and market weight hogs, and sell to a quarantined feedlot all other pigs. A quarantined feedlot is a unit which has no breeding stock and sells only to slaughter. With proper planning this option could result in minimal downtime, if bred gilts are available.

With adequate approval and safeguards to neighboring herds, growing-finishing hogs are kept during cleaning and disinfection could be moved to a neighboring farm or a separate, isolated feeding lot. Precautions must be taken to prevent recontamination of cleaned buildings by human, animal or mechanical means.

2. Sell sows as soon as pigs are weaned. Remove weaned pigs and/or market animals in finishing house to another location as soon as possible. Pigs may be moved to quarantined feedlot for finishing.

**Cleanup**

Clean thoroughly, removing all foreign material, manure, straw, and trash. Cleanup of outside lots should include removal of feeding equipment from the lot, removal of all manure and debris, thorough cleaning and disinfecting of feeding floors (repeat after one week), allowing lot to stand empty a minimum of 30 days. Scrape dirt lots down to clean soil, till soil to expose it to sunlight, and leave idle for 30 days. Any material that cannot be thoroughly cleaned should be removed and burned.

Cleanup of feeders and other equipment should include hosing down thoroughly and scraping off all collected feed and debris, followed by disinfection.

Cleanup of buildings should include removal of all manure and feed, scraping floors and walls of accumulations and scrubbing thoroughly with high pressure sprayer and a good detergent to remove all organic material, followed by spraying walls and floors with disinfectant. Repeat cleaning and allow to dry out thoroughly.

Pits should be pumped and cleaned out as part of building cleanup. After cleaning and disinfecting building, pump pits again.

If a lagoon waste handling system is in use, it is recommended that a recycling flush system not be used during a PRV outbreak and cleanup period. PRV is inactivated so quickly (experimentally less than 3 days even at high concentrations) that it is best not to pump out a lagoon. Attempts to disinfect a lagoon during cleanup definitely are not recommended. Manure pits are a much closer source to pigs, but experimentally PRV has not survived over 3 days in pits, and the amount of virus which might be excreted into a pit by shedding pigs would be small. Good cleanup should include pumping out pits, allowing the disinfectant used in the building to run into the pit, then pumping out the pit again and allowing it to dry. This is probably even more important for preventing exposure of a new herd to pathogenic organisms which are hardier than PRV.

Cleaning and disinfection should be conducted in conjunction with phased depopulation and a second cleaning and disinfection after all swine are gone.

Clean or replace all plastic ventilation bags used as air distributors.

All manure and organic material removed from pens, buildings, etc., should be buried or placed on fields to be plowed under immediately, not pastured. At least one week should elapse after removal of pigs from contact with such material before it is taken to the fields, to minimize exposure of wild animals and roaming cats and dogs.

**Disinfection**

Recommended disinfectants: orthophenolphenate compounds, such as “One Stroke Environ”; Phenol 5%, Na hypochlorite, Ca hypochlorite, 2% Na hydroxide, TriNaPO4, quarternary ammonia, chlorhexidine. All disinfectants are less effective in the presence of organic matter.

Fumigation may also be used, with extreme care. It is dangerous. It cannot be substituted for thorough cleaning, however.

**Rodents**

Exterminate rodents. Prevent wildlife and other domestic animal exposure to swine and feed sources.

**Repopulation**

Wait a minimum of 30 days after disinfection before repopulating. Wait longer if there is any question about effectiveness of cleanup and disinfection procedures. The period between cleanup-disinfection and repopulation can vary greatly, depending on weather and individual farm conditions. This is a subject, along with the testing and retesting of animals used to repopulate, which should be considered in the planning stage and decisions made after consultation with your veterinarian.

Repopulate from a PR-qualified negative herd, isolate on premises and retest 30 days later.

**Security**

Keep groups of replacement gilts and boars separate from the remainder of the herd until retested.

Any isolation units should be clean, sanitary and comfortable to reduce stress as much as possible. They should be sufficiently separated from other facilities to prevent aerosol transmission. They must be secure from contact by wildlife, dogs, other pet animals or escaped pigs. Separate coveralls and boots must be put on and taken off at the isolation units. Disinfectant foot baths should be placed at entrances **and used.** Unfortunately, isolation units are often the least secure facilities on the hog farm. Isolation is essential, not only to provide time for diseases or antibodies to appear, but also to allow newly introduced carrier animals with a variety of infectious agents, to recover from stress-induced shedding before being mingled into the herd. In many cases it may be advisable to vaccinate the new breeding herd with a "differentiable" vaccine.

As soon as possible, establishment of a closed herd will offer the best security.

## Other Pseudorabies Information Available from Livestock Conservation Institute

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20 page booklet

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## Appendix III:

**United States Department of Agriculture**

Animal and Plant Health Inspection Service

APHIS 91-55-005

# Pseudorabies Eradication

## State—Federal—Industry Program Standards, Effective January 1, 1992

# Contents

## Introduction

These Program Standards were adopted for the eradication of pseudorabies virus from all domestic swine in the United States. These are the minimum standards adopted by the United States Animal Health Association as amended in October 1991 and approved by the Veterinary Services division of the Animal and Plant Health Inspection Service (APHIS), an agency of the U.S. Department of Agriculture (USDA).

The following list highlights changes adopted in this version of the Program Standards.

1. Feeder pig movement into Stage IV areas was modified to encourage the progress of States into the later Stages of the Cooperative State-Federal-Industry Pseudorabies Eradication Program (p. 179).
2. Use of vaccine in Stage IV and Stage V is now permitted if approved by the State Veterinarian (p.179-180).
3. Guidelines for movement of animals from infected multiple-site production facilities were included but for intrastate movement only (p. 179-180).
4. Circle-testing requirements are now in effect for Stage II States (p. 176).
5. Release of quarantine in Stage III is now permitted by representative sample testing (p. 177).

The minimum standards described in this publication do not preclude the adoption of more stringent standards by any geographic or political subdivision of the United States.

## Part I-Definitions

**Accredited veterinarian**
A veterinarian approved by the Administrator of APHIS, USDA, to perform functions required by cooperative State-Federal-Industry animal disease-control and -eradication programs.

**Administrator**
The Administrator of APHIS, USDA, or any other official of APHIS to whom authority has been delegated or may be delegated to act in his or her stead.

**Approved all-class market**
A livestock market approved by the Administrator where breeding, feeding, and slaughter swine are sold in accordance with Federal interstate regulations and applicable provisions of these Program Standards.

**Approved differential pseudorabies test**
Any test for the diagnosis of pseudorabies that:

1. Can distinguish vaccinated swine from infected swine; and
2. Is produced under license from the Secretary of Agriculture with indications for use in the Cooperative State-Federal-Industry Pseudorabies Eradication Program; and
3. Is conducted in a laboratory approved by the Administrator

**Approved feeder-pig market**
A livestock market approved by the Administrator where only feeder pigs that meet the following criteria are accepted for sale, in accordance with Federal interstate regulations and applicable provisions of these Program Standards:

1. All swine must originate in a qualified pseudorabies-negative herd; or
2. All swine must originate from a State that has achieved Pseudorabies Eradication Program status of Stage III, IV, or V; or
3. All swine must originate in a pseudorabies-monitored feeder-pig herd; or
4. All swine are found negative to an official pseudorabies test conducted 30 days or less prior to presentation at the market.

**Approved slaughter market**
A livestock market approved by the Administrator that accepts and releases only shipments of slaughter swine, in accordance with applicable State and Federal regulations. No swine may be released from an approved slaughter market unless consigned directly to another approved slaughter market, a recognized slaughtering establishment for immediate slaughter, or a quarantined feedlot.

**Breeding herd**
All swine over 6 months of age.

**Certificate**
An official document issued for and prior to interstate movement of swine not known to be infected with or exposed to pseudorabies by a Veterinary Services representative, a State representative, or an accredited veterinarian, which states: (1) the number and description of the swine to be moved; (2) the swine to be moved are not known to be infected with or exposed to pseudorabies; (3) the purpose for which the swine are to be moved; (4) the points of origin and destination; (5) the consignor and consignee; and (6) additional information as required by applicable State and Federal laws and regulations.

**Common ground**
The ground, areas, buildings, and equipment commonly shared by any specific group or groups of livestock.

**Deputy Administrator**
The Deputy Administrator, Veterinary Services, APHIS, USDA, or any other Veterinary Services official to whom authority has been delegated to act in his or her stead.

**Direct shipment**
Movement without unloading en route, without contact with swine of lesser pseudorabies status, and without contact with infected or exposed livestock.

**Exposed livestock**
Any livestock that have been in contact with an animal infected with pseudorabies, including all livestock in a known infected herd. (Livestock other than swine that have not been exposed to a clinical case of pseudorabies for a period of 10 consecutive days shall no longer be considered to be exposed.)

**Exposed swine**
Any swine that have been in contact with an animal infected with pseudorabies, including all swine in a known infected herd.

**Farm of origin**
A farm where swine were born or on which they have resided for at least 90 consecutive days immediately prior to movement.

**Infected livestock**
Any livestock determined to be infected with pseudorabies by an official pseudorabies epidemiologist.

**Interstate**
From any State into or through any other State.

**Intrastate**
Within a State.

**Isolation**
Separation of swine by a physical barrier in such a manner that one pig does not have access to the body, excrement, or discharges of another pig; does not share a building with a common ventilation system; and is not within 10 feet of another pig.

**Known infected herd**
Any herd in which any swine have been determined to be infected with pseudorabies by an official pseudorabies epidemiologist.

**Licensed pseudorabies vaccine**
Any pseudorabies virus vaccine produced under license from the Secretary of Agriculture under the Virus-Serum-Toxin Act of March 4, 1913, and any legislation amendatory thereof (21 U.S.C. 151 et seq.).

**Livestock**
Swine, cattle, sheep, and goats.

**Moved**
Shipped, transported, or otherwise moved; or delivered or received for movement by land, water, or air.

**National Pseudorabies Control Board**
A board which reviews requests by States for pseudorabies eradication program status according to the Program Standards and makes recommendations to the APHIS, Veterinary Services, for program stage designation. Currently, this is a six-member board composed of two representatives each from the United States Animal Health Association, the National Pork Producers Council, and the Livestock Conservation Institute, appointed by the respective presidents of those organizations.

**Official pseudorabies epidemiologist**
A State or Federal veterinarian designated by the State animal health official and veterinarian in charge to investigate and diagnose suspected pseudorabies in livestock. The official pseudorabies epidemiologist is expected to have had special training in the diagnosis and epidemiology of pseudorabies which will provide the unique qualifications demanded by the position.

**Official pseudorabies herd-cleanup plan**
A written plan to eliminate pseudorabies from a swine herd. This plan is (1) developed by an official pseudorabies epidemiologist in consultation with the herd owner and his or her veterinary practitioner, when applicable; (2) mutually acceptable to those parties; and (3) approved by the State animal health official.

**Official pseudorabies serological test**
Any test approved by the Administrator for diagnosis of pseudorabies in nonvaccinated swine, conducted in a laboratory approved by the A Administrator, and listed in Section 9 of the Code of Federal Regulations (CFR), Part 85.1, to determine the presence or absence of pseudorabies antibodies.

**Official pseudorabies test**
Any test for the diagnosis of pseudorabies approved by the Administrator, conducted in a laboratory approved by the Administrator, and listed in 9 CFR, Part 85.1.

**Official random-sample test (95/10)**
A sampling procedure utilizing official pseudorabies serologic tests which provides a 95-percent probability of detecting infection in a herd in which at least 10 percent of the swineare seropositive for pseudorabies. Eachsegregated group of swine on an individual premises must be considered a separate herd and sampled as follows:

Less than 100 head-test 25
100-200 head-test 27
201-999 head-test 28
1,000 and over-test 29

**Official random-sample (95/5)**
A sampling procedure utilizing official test pseudorabies serologic tests which provides a 95-percent probability of detecting infection in a herd in which at least 5 percent of the swine are seropositive for pseudorabies. Each segregated group of swine on an individual premises must be considered a separate herd and sampled as follows:

Less than 100 head-test 45
100-200 head-test 51
201-999 head-test 57
1,000 and over-test 59

**Oversight Committee, National Pork Producers Council**
A committee of pork producers, constituted as determined by the National Pork Producers Council and calling on such scientific experts as needed, which shall review the national Pseudorabies Eradication Program and the expenditure of Federal funds for the Program at least annually. The committee will also review, in advance, allocations of Federal funds for any national surveillance program to the various States and make recommendations to the Deputy Administrator of Veterinary Services, APHIS, as it deems appropriate.

**Permit**
An official document issued for and prior to the interstate shipment of pseudorabies-infected or -exposed swine by a Veterinary Services representative, State representative, or accredited veterinarian, stating: (1) the number of swine to be moved, (2) the purpose for which the swine are to be moved, (3) the points of origin and destination, (4) the consignor and consignee, and (5) additional information required by applicable State and Federal regulations.

**Prevalence**
The number of known infected herds in the State as of the date of the application for Stage III status, divided by the number of swine herds in the State as determined by the National Agricultural Statistics Service (NASS). When a State has conducted a down-the-road survey of all swine producers, the swine population data so developed may be used rather than the NASS data.

**Pseudorabies**
The contagious, infectious, and communicable disease of livestock and other animals also known as Aujeszky's disease.

**Pseudorabies-monitored feeder-pig herd**
A swine breeding herd that has been sampled and tested negative by an official pseudorabies serological test during the last 12 months at the following rate:

10 head-test all
11-35 head-test 10
36 or more-test 30 percent or 30, whichever is less

Tested breeding swine are to be selected at random from all age groups, including herd boars; all groups are to be proportionately represented.

**Pseudorabies-restricted feeder-pig market**
A market especially designated by the State animal health official to handle shipments of feeder pigs from premises under pseudorabies quarantine. Sales are limited to quarantined feedlots. Pseudorabies-restricted feeder-pig markets are restricted to handling intrastate shipments of pseudorabies-quarantined swine only.

**Pseudorabies vaccinates**
Any swine that have been vaccinated with a USDA-licensed pseudorabies vaccine.

**Quarantined feedlot**
A premises where pseudorabies-infected or -exposed swine are fed under the supervision and control of the State animal health official and from which such swine are moved directly to a recognized slaughtering establishment or directly through no more than one slaughter market and then directly to a recognized slaughtering establishment.

**Quarantined herd**
A herd in which pseudorabies-infected or -exposed swine are bred, reared, or fed under the supervision and control of the State animal health official and from which swine are moved directly to a recognized slaughtering establishment, pseudorabies-restricted feeder-pig market, quarantined feedlot, or directly through no more than two slaughter markets and then directly to a recognized slaughtering establishment or quarantined feedlot.

**Recognized slaughtering establishment**
A slaughtering establishment operated under the provisions of the Federal Meat Inspection Act (21 U.S.C. 601 et seq.) or a State-inspected slaughtering establishment.

**State/Area**
Any State or Territory of the United States, the District of Columbia, Puerto Rico, Guam, or the Northern Mariana Islands, or any portion of a State which meets the following criteria:

1. All counties whose pseudorabies eradication status is in the same Stage must be contiguous.
2. There shall be no more than two Stages in any State.
3. Only the following combinations of status will be permitted within a State: Stages II and III, Stages III and IV.
4. The surveillance system required for Stages III and IV must differentiate between animals and/or herds from areas with different status.

**State animal health official**
The State official who is responsible for the livestock and poultry disease control and eradication programs in the official's State/Area, or that person's designated representative.

**State pseudorabies committee**
An appointed advisory committee composed of swine producers, animal scientists, State and Federal regulatory officials, and other representatives of the swine industry.

The responsibilities of the committee include:

A. Informing and educating all segments of the State/Area swine industry regarding pseudorabies eradication activities.
B. Reviewing the State/Area pseudorabies eradication program and making recommendations to State and Federal animal health officials and, as appropriate, consulting with State officials in the areas of:
    1. Budgeting;
    2. Intrastate and interstate regulations, including use of vaccine;

3. Progress through the Program Stages.

C. Maintaining liaison with other States and with the national pseudorabies eradication program through the National Pork Producers Council, Livestock Conservation Institute, and APHIS.

**State representative**
A person regularly employed in animal health work by a State and authorized by the State to perform the functions involved or under a cooperative agreement with USDA.

**Surveillance index**
Refers to the percentage of a population of sows and boars sampled, multiplied by the percentage of positive swine traced to the farm of origin. When no positive swine are found, then the surveillance index will be the percentage of a population of sows and boars sampled.

Only three specific forms of surveillance testing may be included in the surveillance index calculations:

1. Samples collected at slaughter.
2. Samples collected at markets (first point).
3. Samples collected on farms as part of down-the-road (area) surveillance.

Data of the following types may not be included in surveillance index calculations:

1. Data from samples collected for epidemiologic purposes (e.g., circle testing, tracing into or out of infected herds);
2. Data from status testing (e.g., tests to establish qualified-negative herd status, qualified-negative vaccinated herd status, or feeder-pig-monitored herd status; or testing for sale and show).

The percentages of the breeding population in a State/area to be tested annually to meet the surveillance requirements for Stages III, IV, and V apply regardless of whether the surveillance is conducted at slaughter, at first point, or as part of a down-the-road (area) testing program. Whichever system is used must be random and must be representative of all herds of unknown status in the State/Area.

A random system for onfarm testing, using the official random-sample (95/10) test or the pseudorabies feeder-pig-monitored herd test procedures as defined previously, may involve selection of herds for testing on the basis of simple random or stratified random sampling, excluding herds of known status. Randomness of slaughter, first-point, or on-farm (area) surveillance testing must be documented in applications for status.

**Swine not known to be infected with or exposed to pseudorabies**
All swine except those which are part of a known infected herd or are known to have been exposed to pseudorabies.

**Veterinarian-in-Charge**
The veterinary official of Veterinary Services, APHIS, USDA, who is assigned by the Administrator to supervise and perform APHIS' official animal health work in the State/Area concerned.

**Veterinary Services**
The Veterinary Services branch of APHIS, USDA.

**Veterinary Services representative**
A person employed by Veterinary Services, APHIS, USDA, who is authorized to perform official pseudorabies eradication activities.

## Part II-Administrative Procedures

### A. Supervision of the Cooperative State-Federal-Industry Pseudorabies Eradication Program

The Cooperative State-Federal-Industry Pseudorabies Eradication Program (hereafter called "the Program") must be supervised by full-time animal health veterinarians employed by the State or Federal Government.

### B. Entering premises

Persons working for the Program must be authorized by the State to enter premises to carry out Program policy. While on such premises, they must use commonly accepted sanitary procedures to minimize the risk of physically transmitting diseases among groups of livestock on the farm being investigated, as well as to other premises.

### C. Providing services to livestock owners

Owners are responsible for handling their animals. Program administrators may contract with accredited veterinarians, paraprofessionals, other State and Federal agencies, or with the management of privately owned firms as needed, to assist State and Federal animal health personnel in collecting blood or tissue samples, in identifying animals, and in performing other Program activities.

### D. Notifying the community of pseudorabies-infected herds and quarantined feedlots

State or Federal Program officials should notify swine owners in the immediate community within 30 days after a swine herd has been quarantined for pseudorabies. Program officials should also notify herd owners in the immediate community when they grant approval for a quarantined feedlot. Notification may be by an educational letter emphasizing the importance of taking appropriate actions to protect swine against pseudorabies. When the herd quarantine is released or the approval of the quarantined feedlot is terminated, herd owners should be notified within 30 days by an informational letter.

### E. Dealers-Registration and Recordkeeping

The following dealers (individuals or other legal entities) of swine must be registered or licensed with the appropriate State agency:

- Dealers who purchase, deal in, or sell swine;
- Dealers who act as commission representatives or brokers;
- Dealers who operate and conduct an auction where swine are sold.

These dealers must maintain records required by the licensing agency to make it possible for State authorities to trace swine to their herds of origin or destination.

1. Registering dealers—After giving due notice and opportunity for a hearing to the dealer involved, the State agency must have the authority to deny an application for registration, or to suspend or cancel the registration, when the agency is satisfied of either or both of the following:

    a. There is adequate evidence to establish that the dealer had the intent to violate or circumvent recordkeeping requirements of this section and/or other animal health regulations;
    b. The dealer has repeatedly demonstrated failure to keep records adequate to trace his swine sales and purchases.

2. Keeping records—Each registered or licensed swine dealer must keep sufficient records of all swine purchased for resale to enable the State agency to trace back those animals satisfactorily to their herds of origin and destination. The records must be kept for a minimum of 2 years.
3. Dealing with violations—Provisions must exist so that State animal health officials can institute any action at law or in equity that appears necessary to enforce compliance with dealer registration and recordkeeping requirements. This includes the authority to subpoena appropriate records and/or persons who allegedly violate these minimum standards. The appropriate State officials must also have authority to petition the local court that has venue for an order to enforce these subpoenas.

**F. Administrative review of Program activities**

Appropriate Veterinary Services personnel will review the progress of State/Area pseudorabies programs on an ongoing basis to ensure compliance with the Program Standards.

Each State will prepare a quarterly report of pseudorabies eradication activities and submit it to Veterinary Services for tabulation and distribution of a national Program progress report. Veterinary Services shall make reports as requested and at least annually to the Oversight Committee, National Pork Producers Council, on Program progress, Program operation, and use of Federal funds, including, but not limited to, the operation of any national slaughter surveillance program.

**G. Application for Program status**

Application for Program entry and advancement in status will be jointly signed by the State animal health official and veterinarian in charge, and be submitted to the Deputy Administrator. The application shall be reviewed by the National Pseudorabies Control Board prior to a final decision by the Deputy Administrator.

## Part III-Program Stages and Requirements

**Stage I-Preparation**

This is the initial Program stage in which the basic procedures to control and eradicate pseudorabies are developed.

**A. To qualify for Stage I recognition, the application for Program status shall provide documentation that the following standards are met:**

1. A State pseudorabies committee has been formed and is functioning;
2. Plans are formulated for a reliable system of determining pseudorabies prevalence in the State/Area swine population, which may include:

    a. Mandatory reporting of suspected pseudorabies by producers, veterinarians, and laboratories;
    b. Change-of-ownership test requirements;
    c. Collection of blood samples from sows and boars at swine markets, slaughter establishments, or farms. Emphasis is given to pseudorabies testing of blood samples that are collected for other purposes, e.g., brucellosis validation, disease diagnosis, exhibition requirements, etc.

3. State officials and/or industry representatives have, or are actively seeking, legislative and regulatory authority to:

a. Participate in the Cooperative State-Federal-Industry Pseudorabies Eradication Program;
b. Require reporting of suspected pseudorabies by producers, veterinarians, and laboratories to the State animal health official;
c. Conduct diagnostic and epidemiologic investigations of suspected pseudorabies;
d. Quarantine premises on which pseudorabies is confirmed;
e. Trace purchases and sales of swine to and from quarantined premises and inspect and collect diagnostic specimens from such swine;
f. Regulate shipments of breeding swine, feeder pigs, and slaughter swine within and into the State;
g. Control the use of pseudorabies vaccines;
h. Control disposal of dead animals.

4. A system for distribution of Program literature to producers and other interested groups is developed and functioning.
5. Applicable Federal pseudorabies regulations are enforced
6. A State progress report (VS Form 7-1, Pseudorabies Quarterly Report) is produced quarterly.

**B. Duration of status**

A State will retain its Stage I status indefinitely, provided it continues to meet the requirements of Stage I or until it meets the requirements of a subsequent stage.

**Stage II-Control**

In this stage, a State will continue to participate with Veterinary Services on a cooperative basis. The goals of this stage are to determine which herds are infected with pseudorabies and to begin herd cleanup.

**A. To qualify for Stage II recognition, the application for Program status shall provide documentation that the following standards are met:**

1. Stage I standards have been implemented.
2. A surveillance program plus circle-testing 1.5 miles (2.4 kilometers) around all newly identified infected herds has been implemented to find additional infected herds. This surveillance should be based on testing sows and boars at slaughter, on the farm, or at first point of concentration. *This circle-test requirement takes effect immediately for new States entering Stage II and on January 1, 1993, for all States currently in Stage I.*
3. Swine movements into the State/Area are controlled as follows:

   a. Breeding swine not known to be infected or exposed to pseudorabies must:

      (1) Pass a negative official pseudorabies serologic test within 30 days prior to interstate shipment; or
      (2) Originate in a qualified pseudorabies-negative herd; or
      (3) Originate in a qualified pseudorabies-negative gene-altered vaccinated herd; or
      (4) Be shipped directly from the farm of origin in a Stage IV or Free State; or
      (5) Originate in a qualified pseudorabies-negative herd or have passed a negative official pseudorabies serologic test within 30 days prior to sale at an approved all-class market and be released under State quarantine for isolation and retest in 30-60 days at the importer's expense.

b. Feeder pigs not known to be infected with or exposed to pseudorabies and not mingled with or exposed to swine of lesser or unknown status must:

(1) Pass a negative official pseudorabies serologic test within 30 days prior to interstate shipment; or
(2) Originate in a qualified pseudorabies-negative herd; or
(3) Originate in a qualified pseudorabies-negative gene-altered vaccinated herd; or
(4) Originate in a pseudorabies-monitored feeder-pig herd; or
(5) Be shipped directly from the farm of origin in a Stage III, IV, or Free State; or
(6) Be sold at an approved all-class market or approved slaughter market and imported for feeding in a quarantined feedlot; or
(7) Be sold at an approved feeder-pig market and imported for feeding with out restriction.

c. Slaughter hogs:

(1) Swine not known to be infected with or exposed to pseudorabies may move as follows:

(a) Directly to a recognized slaughter establishment; or
(b) Directly to an approved slaughter market or approved all-class market and then directly to another approved slaughter market or a recognized slaughter establishment or quarantined feedlot; or
(c) Directly to an approved slaughter market and then to a quarantined feedlot.

(2) Infected or exposed swine may move directly to a recognized slaughter establishment or directly to no more than two approved slaughter markets and then directly to a recognized slaughter establishment when:

(a) The carrier transporting pseudorabies-infected or –exposed slaughter swine is cleaned and disinfected before it is used to transport non-slaughter swine or feedstuffs within the following 30 days; and
(b) Additional State-of-destination swine-identification requirements and regulations are followed.

4. Intrastate movements are controlled as necessary to meet State needs.

**B. Voluntary herd cleanup**

Owners desiring to eliminate herd infections may utilize one of the basic strategies as published by Livestock Conservation Institute (Swine Pseudorabies Eradication Guidelines, appendix II).

**C. Duration of status**

A State will retain its Stage II status indefinitely, provided it continues to meet the requirements of Stage II or until it meets the requirements of a subsequent stage.

**Stage III—Mandatory Herd Cleanup**

In this stage, the cleanup of infected herds becomes mandatory. The State pseudorabies committee shall provide time limits for developing and completing official pseudorabies herd-cleanup plans. An official

pseudorabies epidemiologist will consult with the herd owner and his or her veterinary practitioner, when applicable, to develop a mutually acceptable official pseudorabies herd-cleanup plan based on the strategies outlined in the Livestock Conservation Institute's Swine Pseudorabies Eradication Guidelines. The attending accredited veterinarian should play a major role in selecting and implementing herd-cleanup plans. Pseudorabies prevalence in the affected community must be determined for all groups of swine, including swine in feedlots.

**A. To qualify for Stage III recognition, the application for Program status shall provide documentation as follows:**

1. The standards of Stage II are implemented and, with the endorsement of the State pseudorabies committee, the State animal health official is implementing mandatory herd-cleanup procedures.

2. Epidemiology

    a. Swine movements into and out of infected premises or premises suspected of being infected are traced, and the status of receiving and source herds is appropriately established by either a test of all breeding swine or an official random-sample test.
    b. All swine units, including feedlots within a 1.5-mile (2.4 kilometer) radius of infected premises, are monitored either by a test of all breeding swine or by an official random-sample test.
    c. The State demonstrates a prevalence of not more than 1 percent, based on surveillance testing that meets the requirements of section 3, below.

3. Surveillance

    At least 10 percent of the breeding swine population is surveyed annually using an official pseudorabies serologic test with at least 80-percent successful traceback of seropositives to the farm of origin, or testing and traceback to achieve a surveillance index of 0.08. Current statistics of the National Agricultural Statistics Service, USDA, on breeding swine populations will be used to calculate surveillance data. The surveillance program must be random and must be representative of all herds in the State. Tests of swine from premises currently known to be infected may not be included in totals to meet the requirements of this section.

    Only three specific forms of surveillance testing may be included in the surveillance index calculation:

    A. Samples collected at slaughter.
    B. Samples collected at markets (first point).
    C. Samples collected on farms as part of down-the-road (area) surveillance.

Data from samples collected for epidemiologic purposes (e.g., circle testing, tracing into and out of infected herds) may not be included. Neither may status test data (e.g., testing in qualified-negative herds as well as tests for sale and show, etc.)

4. Vaccination

    Vaccination may be permitted by the State animal health official as part of an approved herd-cleanup plan and in area control programs.

**B. During Stage III:**

1. Information and education efforts are intensified.
2. The effectiveness of regulations is monitored, and enforcement is strengthened as necessary.
3. Industry commitment for Program advancement is secured.
4. Epidemiologic evaluation of Program activities is utilized.

**C. Disposition of herds**

When only a few known infected herds remain in the State, mandatory depopulation of herds whose owners have been unable or unwilling to eliminate pseudorabies infection may be considered by responsible State-Federal-Industry Program personnel.

**D. Duration of status**

A State will retain its Stage III status indefinitely provided it continues to meet the requirements of Stage III or until it meets the requirements of a subsequent stage.

**Stage IV—Surveillance**

To qualify for Stage IV recognition, the following requirements shall be met:

**A. The application for Program status shall demon strate that the standards of Stage III are in effect and shall document that:**

1. There is no known infection in the State/Area and the surveillance program required for Stage III has been in effect for at least 2 years.
2. The State/Area has and enforces regulatory authority requiring farm-of-origin identification of cull sows and boars.
3. No new cases of pseudorabies were confirmed during the year prior to application for Stage IV status, except those that resulted from out-of-State importation with no spread to additional premises.

**B. The surveillance program required for Stage III must be continued at the same rate.**

**C. A slaughter-hog surveillance program that includes feedlots must be conducted.**

**D. Vaccination is prohibited except by permission of the State animal health official in high-risk herds or as part of an approved herd-cleanup plan.**

**E. Swine import requirements are as follows:**

1. Slaughter swine

    a. Infected or exposed swine may only be shipped into a Stage IV State/Area on permit directly to a recognized slaughter establishment or to an approved slaughter market.
    b. Imports of slaughter swine from States or Areas with a Program status up to and including Stage III are permitted to a recognized slaughter establishment or an Approved slaughter market only.

2. Breeding swine

    a. Direct shipment from a Stage IV or V State/Area, or
    b. Direct shipment from a qualified pseudorabies-negative herd in any State/Area, or
    c. Negative official pseudorabies serologic test within 30 days prior to shipment with quarantine, isolation, and retest at destination in 30-60 days following importation.

3. Feeder pigs

    a. Direct shipment from a farm of origin or a market in a Stage IV or V State/Area, or
    b. Direct shipment from a qualified pseudorabies-negative herd, or
    c. Entry is allowed into Stage IV States from Stage III States/Areas or from feeder-pig-monitored herds in Stage II States on the following conditions:

        (1) That the swine enter on permit directly to a designated feedlot and not through an all-class market;
        (2) That the swine originate from an approved feeder-pig market or direct from a qualified-negative (QN) herd, a qualified-negative vaccinated (QNV) herd, a feeder-pig-monitored (FPM) herd, or a feeder-pig-monitored vaccinated herd (FPMV);
        (3) That the swine be quarantined to slaughter only;
        (4) That the designated feedlot have no breeding swine on the premises and no breeding herds within 1.5 miles;
        (5) That the feeding herd must be part of the feeder-pig surveillance system required for Stage IV with testing of a sample of pigs from the feedlot, using the official random-sample test (95/10) as defined in these Program Standards, and that the test be conducted in each such feedlot at least every 6 months.

**F. Intrastate swine movements-no restrictions.**

**G. Duration of status**

A State/Area will retain its Stage IV status indefinitely provided it continues to meet the requirements of Stage IV or until it meets the requirements of Stage V. In the event of a confirmed case of pseudorabies, the State/Area will revert to Stage III status until 60 days following cleanup of the last known infected herd.

**Stage V—Free**

This is the stage in which a State is declared pseudorabies free.

**A. To qualify for this final surveillance stage, the application for Program status shall provide evidence that the State is implementing the standards of Stage IV.**

**B. In addition, the State must document that:**

1. The State has been free of pseudorabies for 1 year since recognition of Stage IV status.
2. Surveillance of breeding herds continues at a rate sufficient to provide a surveillance index of at least 0.04.
3. Swine imports are controlled as follows:

    a. Slaughter swine--same as Stage IV;
    b. Breeding swine-same as Stage IV;
    c. Feeder pigs-same as Stage IV.

4. Vaccination is not permitted except by permit from the State Veterinarian in certain high-risk herds.
5. Intrastate swine movements-no restrictions.

**C. Duration of status**

A State will retain its Stage V status indefinitely provided it continues to meet the requirements of Stage V. In the event of a confirmed outbreak of pseudorabies, the State will revert to Stage IV status until 1 year following cleanup of the last known infected herd.

## Part IV-Participation in Herd Plans and Release of Quarantines

### Subpart I-The Qualified Pseudorabies-Negative Herd

**A. Establishment of a qualified pseudorabies-negative (QN) breeding herd:**

1. For breeding herds, QN status is attained by (1) subjecting to an official pseudorabies serologic test all swine over 6 months of age plus a number of progeny equal to 20 percent of the breeding swine population of the herd, and finding that all swine test negative. Progeny shall be randomly selected from the oldest swine in the herd less than 6 months of age. The herd must not have been a known infected herd within the past 30 days. A minimum of 90 percent of the swine in the herd must have been on the premises and a part of the herd for at least 60 days prior to the qualifying official pseudorabies serologic test or have entered by direct shipment from another QN herd.
2. When all swine are shipped directly from existing QN herds, a new QN breeding herd may be established if, within 30 days of arrival, all swine in the initial shipment (up to 50 animals) are tested and found negative to an official pseudorabies serologic test.

**B. QN breeding herd status may be maintained by annual pseudorabies testing as follows:**

1. Conduct an official pseudorabies serologic test of 80 percent of all swine 6 months of age and older.
2. Conduct an official pseudorabies serologic test of a number of progeny equal to 20 percent of the breeding swine population of the herd. Progeny selected shall be the oldest in the herd less than 6 months of age.
3. All swine tested shall be randomly selected and, in the case of the adult swine, representative of all age groups on the premises.

The required annual testing must be accomplished by testing 25 percent of the required breeding swine and progeny every 80-1 05 days and finding all swine tested to be negative or by testing 10 percent of the required breeding swine and progeny monthly and finding all swine tested to be negative.

All swine intended to be added to a QN herd shall be isolated until they are found negative to an official pseudorabies serologic test conducted 30 days or more following their placement in isolation except:

a. Swine from a herd of unknown status must be tested negative by an official pseudorabies serologic test not more than 30 days prior to movement, with a second test in isolation at least 30 days after movement.
b. Swine intended to be added to a QN herd directly from another QN herd may be added without isolation or testing.
c. Swine intended to be added to a QN herd from another QN herd, but with interim contact with swine other than those from a QN herd, shall be isolated until they have been found negative to an official pseudorabies serologic test, conducted 30 days or more after the swine have been placed in isolation.

C. Reestablishment of QN breeding herd status following confirmation of infection in the herd

1. A QN herd which has been determined to be pseudorabies infected may qualify for rein statement as a QN herd if:

    a. All swine in the herd 6 months of age and over are found negative to an official pseudorabies serologic test, and
    b. An official random-sample (95-10) test of progeny 2-6 months of age is conducted and all swine tested are negative, and
    c. In 30 or more days, the testing described in a and b above is repeated.

2. If on a qualifying official pseudorabies serologic test or any subsequent official pseudorabies test, any swine are tested positive, qualified pseudorabies-negative herd status is suspended until the infection status of the herd is determined by an investigation of the suspected pseudorabies conducted by an official pseudorabies epidemiologist.
3. The official pseudorabies epidemiologist will consider the following factors in determining the presence or absence of pseudorabies in the herd:

    a. The specific titers of positive swine;
    b. The percentage and number of titered swine;
    c. The vaccination history of titered swine;
    d. Proximity and pseudorabies infection status of neighboring herds;
    e. The possibility of laboratory or sample identification error;
    f. Other pertinent herd history and clinical signs.

4. Based on the above information obtained by the official pseudorabies epidemiologist, a final determination of infection status will be made; however, before qualified pseudorabies-negative herd status may be attained or maintained, all seropositive swine must either:

    a. Be sold for slaughter, and a complete herd test conducted at least 30 days later must be negative; or
    b. Pass a negative official pseudorabies serologic test.

**D. Establishment and maintenance of QN growout premises on which no adult breeding swine are maintained:**

Situation 1

Herd A ----------→Herd B ----------→Herd C
QN breeding herd(s) Growout Sales Point

Situation 2

Herd A ----------→Herd C
QN breeding herd(s) Sales Point

Pigs moved from herd(s) A within 1 week of weaning are not required to be pseudorabies tested; for pigs moved later, a negative official random-sample test (95-10) of the group being moved is required.

Herd B

QN status is attained by a negative official pseudorabies serologic test of the entire initial shipment or 50 head selected at random, whichever is less. QN status may be maintained by monthly negative official random-sample tests (95-5).

Herd C

QN status is attained by a negative official pseudorabies serologic test of the entire initial shipment or 50 head selected at random, whichever is less.

QN status may be maintained by a monthly negative official pseudorabies serologic test of 50 swine selected at random from those that have been in the herd at least 30 days.

**Subpart II—The Qualified-Negative Gene-Altered Vaccinated (QNV) Herd**

**A. Establishment of a QNV herd from a non-pseudorabies-vaccinated breeding herd of un known pseudorabies status**

1. For breeding herds, QNV status is attained by (1) subjecting to an official pseudorabies serologic test all swine over 6 months of age plus a number of progeny equal to 20 percent of the breeding swine population of the herd, and (2) finding that all swine test negative. Progeny shall be randomly selected from the oldest swine in the herd less than 6 months of age.
2. The herd must not have been a known infected herd within the past 30 days. A minimum of 90 percent of the swine in the herd must have been on the premises and part of the herd for at least 60 days prior to the qualifying official pseudorabies test, or have entered directly from a QN herd.
3. Not more than 30 days after test results show the herd to be pseudorabies negative; all swine over 6 months of age must be vaccinated with a single official gene-altered pseudorabies vaccine.

**B. Any qualified pseudorabies-negative herd may achieve QNV status if all swine in the herd over 6 months of age are vaccinated with a single official gene altered pseudorabies vaccine.**

**C. Establishment of a QNV herd from a pseudorabies-vaccinated breeding herd**

1. QNV status may be granted if (1) no swine in the herd are known to be infected with or exposed to pseudorabies and (2) the only swine vaccinated for pseudorabies have been vaccinated with a single official gene-altered pseudorabies vaccine. The owner must subject to an approved differential pseudorabies test all swine over 6 months of age plus a number of progeny equal to 20 percent of the breeding swine population of the herd and find that all swine test negative. Progeny shall be randomly selected from the oldest swine in the herd less than 6 months of age.
2. The herd must not have been a known infected herd within the past 60 days. A minimum of 90 percent of the swine in the herd must have been on the premises and part of the herd for at least 60 days prior to the qualifying approved differential pseudorabies test or have entered directly from a QN herd or a QNV herd.

**D. QNV breeding herd status may be maintained by annual pseudorabies testing as follows:**

1. Conduct an approved differential pseudorabies test of 80 percent of all swine 6 months of age and older.

2. Conduct an approved differential pseudorabies test of a number of progeny equal to 20 percent of the breeding swine population of the herd. Progeny selected shall be the oldest in the herd less than 6 months of age.
3. All swine tested shall be randomly selected and, in the case of the adult swine, representative of all age groups on the premises.

   The required annual testing must be accomplished by testing 25 percent of the required breeding swine and progeny every 80-105 days and finding that all swine test negative, or by testing 10 percent of the required breeding swine and progeny monthly and finding that all swine test negative.

4. All swine intended to be added to a QNV herd shall be isolated until they are found negative to an approved differential pseudorabies test conducted 30 days or more following their placement in isolation except:

   a. Swine from a herd of unknown status must be tested negative by an official pseudorabies serologic test not more than 30 days prior to movement, with a second test in isolation at least 30 days after movement.
   b. Swine intended to be added to a QNV herd directly from another QNV or QN herd may be added without isolation or testing.
   c. Swine intended to be added to a QNV herd from another QNV herd or QN herd, but with interim contact with swine other than those from a QN or QNV herd, shall be isolated until they have been found negative to an official pseudorabies serologic test or approved differential pseudorabies test, as appropriate, conducted 30 days or more after the swine have been placed in isolation.

**Subpart III The Pseudorabies-Monitored Feeder-Pig Herd**

A**. This is a swine breeding herd that has been sampled and tested negative by an official pseudorabies serologic test during the last 11-13 months at the following rate:**

10 head—test all
11-35 head—test 10
36 or more—test 30 percent or 30, whichever is less

**B. Tested breeding swine are to be selected at random from all age groups, including herd boars, with proportional representation of all ages.**

**C. A remote growout nursery to which pigs have been moved within 1 week of weaning from a pseudorabies-monitored feeder-pig herd may qualify as a pseudorabies-monitored feeder-pig herd on the basis of a negative official test of 30 pigs. The required tests must be conducted within 30 days of movement from the remote growout nursery and must be conducted at random.**

**D. Testing must be conducted on each group of pigs moving through the remote growout nursery or, in the case of a continuous-flow facility, 30 head may be tested monthly with tests conducted at random.**

**E. All pigs from a pseudorabies-monitored feeder-pig herd that are transported to a remote growout nursery must be progeny of sows that have not been vaccinated with any pseudorabies vaccine.**

**Subpart IV-The Pseudorabies-Monitored Vaccinated Feeder-Pig Herd**

**A. A swine breeding herd, not known to be infected, that has been vaccinated with an official gene-deleted pseudorabies vaccine and tested negative with an approved differential pseudorabies test during the last 11-13 months at the following rate:**

10 head-test all
11-35 head-test 10
36 or more-test 30 percent or 30, whichever is less

**B. Breeding swine to be tested shall be selected at random from all age groups, including herd boars, with proportional representation of all ages.**

**C. A remote growout nursery to which pigs have been moved within 1 week of weaning from a pseudorabies-monitored vaccinated feeder-pig herd may qualify as a pseudorabies-monitored vaccinated feeder-pig herd on the basis of a negative approved differential pseudorabies test of 30 pigs. The required tests must be conducted within 30 days of movement to the remote growout nursery. Testing must be conducted on each group of pigs moving through the remote growout nursery or, in the case of a continuous-flow facility, 30 head may be tested monthly.**

**D. All pigs from a pseudorabies-monitored vaccinated feeder-pig herd that are transported to a remote growout nursery must be progeny of sows which have been vaccinated with a single official gene-altered pseudorabies vaccine.**

**Subpart V-Multiple-Site Production Guidelines**

If a State wishes to approve swine movements between multiple-site productions within its borders, these guidelines are suggested: (1) The breeding herds must be vaccinated at least twice a year with a differentiable vaccine; (2) Movement of breeding stock, either from one site to another or from the final site, shall be instate only; (3) The plan shall be part of a State-approved cleanup plan for the breeding herd which will provide a maximum of 18 months for elimination of the virus from the infected breeding herd; (4) Progeny shall be tested monthly; (5) Before movement of progeny as breeding stock, 100 percent of the progeny must be tested.

**Subpart VI—Quarantine Release Procedures**

A herd of swine shall no longer be classified as a known infected herd when no livestock or other animals on the premises show clinical signs of pseudorabies after removal of the positive swine, and at least one of the four following conditions has been met. Additionally, if the herd is vaccinated, all vaccinates must be vaccinated with the same official gene-altered pseudorabies vaccine.

1. All swine have been removed from the premises; the premises were cleaned and disinfected under official supervision with a disinfectant approved by Veterinary Services for such use; and the premises have been maintained free of swine for

30 days or a period of time determined ad equate by an official pseudorabies epidemiologist.

2. All swine positive to an official pseudorabies serologic test or an approved differential pseudorabies test have been removed from the premises and all remaining swine, except suckling pigs, were subjected to an official (or approved differential) pseudorabies serologic test and found negative 30 days or more after removal of all positive swine.
3. All swine positive to an official pseudorabies serologic test or an approved differential pseudorabies test have been removed from the premises; all breeding swine that remain in the herd and an official random sample (95-10) of grower-finishing swine over 2 months of age are subjected to an official (or approved differential) pseudorabies serologic test and found negative 30 days or more after removal of positive swine. A second test of grower-finishing swine at least 30 days after the first is required if the State is in Stage III or IV of the Program.
4. (Stage I, II, and III only) All swine present on the date the quarantine was imposed have been removed, and there have been no clinical signs in the herd for at least 6 months. Two successive official (or approved differential) random-sample (95-10) tests of the breeding herd [95-5 for Stage III States], conducted at least 90 days apart, have been determined by the official pseudorabies epidemiologist to reveal no infection, and two successive official (or approved differential) random-sample (95-10) tests of progeny at least 4 months of age, conducted at least 90 days apart, are negative. Herds removed from quarantine by this provision are required to be tested negative by an official (or approved differential) random-sample (95-10) test 1 year after quarantine release.

**References**

Livestock Conservation Institute. 1990. Pseudorabies Herd Plan Manual (rev). Madison, WI: Livestock Conservation Institute. 36 p.



Revised February 1992

# Appendix IV:

**United States Department of Agriculture**

Animal and Plant Health Inspection Service

APHIS 91-55-071

# Pseudorabies Eradication

State–Federal–Industry

# Program Standards

Effective November 1, 2003

Issued November 2003

This publication supersedes APHIS 91–55–071, under the same title, which was effective August 1, 2003.

# Pseudorabies Eradication Program Standards

## Contents



The minimum standards described in this publication do not preclude the adoption of more stringent standards by any geographic or political subdivision of the United States.

## Introduction

These Program Standards were adopted for the eradication of pseudorabies from all domestic swine in the United States. These are the minimum standards developed by the Veterinary Services division of the Animal and Plant Health Inspection Service (APHIS), an agency of the U.S. Department of Agriculture (USDA), and endorsed by swine health practitioners and State animal health officials at the annual meeting of the United States Animal Health Association in October 2003.

The following list highlights changes adopted in this version of the Program Standards.

Throughout the document, "National Pork Board" has replaced "National Pork Producers Council."

***Part I, Definitions***

*Definitions have been added for commercial production swine, confirmed case, feral or wild swine, and transitional production swine.*

***Part II, Administrative Procedures***

*Sec. B., when entering and while on a premises, biosecurity procedures must be used by Program personnel.*

*Sec. G., only the original Application for Program entry and advancement in status is required to be sent to the National Center for Animal Health Programs staff for approval. No additional copies are necessary.*

*Sec. I., a new section is added about the procedure for changing the Program Standards.*

***Part III, Stage I (Preparation)***

*Sec. A.6., State progress and activity reports are now required to be produced monthly.*

***Part III, Stage IV (Surveillance)***

*Sec. A.4., a new subsection is added that requires states to develop and adopt a management plan that adequately separates and controls the interface of feral and transitional production swine with commercial production swine.*

*Sec. G., now requires that only confirmed cases of pseudorabies in commercial production swine be reported immediately to Veterinary Services for action. Additionally, after a confirmed case is identified in commercial production swine, all movement of swine from herds within a five-mile radius of the case and from exposed herds must be stopped until such herds are tested and found to be negative using an official random sample test (95/5); and this testing must be completed within 15 days of identifying the infected herd.*

***Part III, Stage V (Free)***

*Sec.B.6. now requires states to develop and adopt a management plan that adequately separates and controls the interface of feral and transitional production swine with commercial production swine.*

*Sec. C., now requires that only confirmed cases of pseudorabies in commercial production swine be reported immediately to Veterinary Services for action. Additionally, after a confirmed case is identified in commercial production swine, all movement of swine from herds within a five-mile radius of the case and from exposed herds must be stopped until such herds are tested and found to be negative using an official random sample test (95/5); and this testing must be completed within 15 days of identifying the infected herd.*

## Part I—Definitions

**Accredited veterinarian**
A veterinarian approved by the Administrator of APHIS, USDA, to perform functions required by cooperative State–Federal–Industry animal disease-control and -eradication programs.

**Administrator**
The Administrator of APHIS, USDA, or any other official of APHIS to whom authority has been delegated or may be delegated to act in his or her stead.

**Approved all-class market**
A livestock market approved by the Administrator where breeding, feeding, and slaughter swine are sold in accordance with Federal interstate regulations and applicable provisions of these Program Standards.

**Approved differential pseudorabies test**
Any test for the diagnosis of pseudorabies that:

1. Can distinguish vaccinated swine from infected swine; and
2. Is produced under license from the Secretary of Agriculture with indications for use in the Cooperative State–Federal–Industry Pseudorabies Eradication Program; and
3. Is conducted in a laboratory approved by the Administrator.

**Approved feeder-pig market**
A livestock market selling feeder pigs in which no animals from known infected herds are accepted for sale on the same day, in accordance with Federal interstate regulations and applicable provisions of these Program Standards:

1. All swine must originate in a qualified pseudorabies-negative herd; or
2. All swine must originate from a State that has achieved Pseudorabies Eradication Program status of Stage III, IV, or V; or
3. All swine must originate in a pseudorabies-monitored feeder-pig herd; or
4. All swine are found negative to an official pseudorabies test conducted 30 days or less prior to presentation at the market. In a herd of single-source pigs in which no sows remain, the State Veterinarian may require a negative test of an official random sample (95/5) of the remaining pigs before sale.
5. Cleaning and disinfection must be done after all other classes of swine have been removed and before feeder pigs are offered for sale.
6. Additional requirements may be imposed as deemed necessary by the State Veterinarian to limit the possibility of disease spread through the market.

**Approved slaughter market**
A livestock market approved by the Administrator that accepts and releases only shipments of slaughter swine, in accordance with applicable State and Federal regulations. No swine may be released from an approved slaughter market unless consigned directly to another approved slaughter market, a recognized slaughtering establishment for immediate slaughter, or a quarantined feedlot.

**Breeding herd**
All swine on a premises that are 6 months of age or older, and that are used or intended to be used for breeding.

**Certificate**
An official document issued for and prior to interstate movement of swine not known to be infected with or exposed to pseudorabies by a Veterinary Services representative, a State representative, or an accredited veterinarian, which states: (1) the number and de-

scription of the swine to be moved; (2) the swine to be moved are not known to be infected with or exposed to pseudorabies virus; (3) the purpose for which the swine are to be moved; (4) the points of origin and destination; (5) the consignor and consignee; and (6) additional information as required by applicable State and Federal laws and regulations.

**Commercial production swine**
Those swine that are continuously managed and have adequate facilities and practices to prevent exposure to either transitional production or feral swine.

**Common ground**
The ground, areas, buildings, and equipment commonly shared by any specific group or groups of livestock.

**Confirmed case**
Any animal determined to be infected with pseudorabies virus by an official pseudorabies epidemiologist whose diagnosis is supported by official pseudorabies test results.

**Deputy Administrator**
The Deputy Administrator, Veterinary Services, APHIS, USDA, or any other Veterinary Services official to whom authority has been delegated to act in his or her stead.

**Direct shipment**
Movement without unloading en route, without contact with swine of lesser pseudorabies status, and without contact with infected or exposed livestock.

**Exposed livestock**
Any livestock that have been in contact with an animal infected with pseudorabies virus, including all livestock in a known infected herd. (Livestock other than swine that have not been exposed to a clinical case of pseudorabies for the last 10 consecutive days shall no longer be considered to be exposed.)

**Exposed swine**
Any swine that have been in contact with an animal infected with pseudorabies virus, including all swine in a known infected herd.

**Farm of origin**
A farm where swine were born or on which they have resided for at least 90 consecutive days immediately prior to movement.

**Feral or wild swine**
Those swine that are free roaming.

**Infected livestock**
Any livestock determined to be infected with pseudorabies virus by an official pseudorabies epidemiologist whose diagnosis is supported by official pseudorabies test results.

**Interstate**
From any State into or through any other State.

**Intrastate**
Within a State.

**Isolation**
Separation of swine by a physical barrier in such a manner that one pig does not have access to the isolated pig's body, excrement, or discharges of another pig; does not share a building with a common ventilation system; and is not within 10 feet of another pig.

**Known infected herd**
Any herd in which any swine have been determined to be infected with pseudorabies virus by an official pseudorabies epidemiologist.

**Licensed pseudorabies virus vaccine**
Any pseudorabies virus vaccine produced under license from the Secretary of Agriculture under the Virus–Serum–Toxin Act of March 4, 1913, and any legislation amendatory thereof (21 U.S.C. 151 et seq.).

**Livestock**
Swine, cattle, sheep, and goats.

**Monitored negative feral swine population**
Feral swine originating from areas that have been geographically defined and under continuous surveillance with no evidence of infection and classified by the pseudorabies epidemiologist as a monitored negative feral swine population.

**Moved**
Shipped, transported, or otherwise moved; or delivered or received for movement by land, water, or air.

**National Pseudorabies Control Board**
A board that reviews requests by States for pseudorabies eradication program status according to the Program Standards and makes recommendations to the APHIS, Veterinary Services, for program stage designation. Currently, this is a six-member board composed of two representatives each from the United States Animal Health Association, the National Pork Board, and the National Institute for Animal Agriculture (formerly the Livestock Conservation Institute), appointed by the respective presidents of those organizations.

**Official pseudorabies epidemiologist**
A State or Federal veterinarian designated by the State animal health official and veterinarian in charge to investigate and diagnose suspected pseudorabies in livestock. The official pseudorabies epidemiologist is expected to have had special training in the diagnosis and epidemiology of pseudorabies which will provide the unique qualifications demanded by the position.

**Official pseudorabies herd-cleanup plan**
A written plan to eliminate pseudorabies virus from a swine herd. This plan is (1) developed by an official pseudorabies epidemiologist in consultation with the herd owner and his or her veterinary practitioner, when applicable; (2) mutually acceptable to those parties; and (3) approved by the State animal health official.

**Official pseudorabies serologic test**
Any official test approved by the Administrator for diagnosis of pseudorabies in swine, conducted in a laboratory approved by the Administrator, and listed in Section 9 of the Code of Federal Regulations (CFR), Part 85.1, to determine the presence or absence of pseudorabies antibodies.

**Official pseudorabies test**
Any test for the diagnosis of pseudorabies approved by the Administrator, conducted in a laboratory approved by the Administrator, and listed in 9 CFR, Part 85.1.

**Official random-sample test (95/20)**
A sampling procedure utilizing official pseudorabies serologic tests which provides a 95-percent probability of detecting infection in a herd in which at least 20 percent of the swine are seropositive for pseudorabies. Each segregated group of swine on an individual premises must be considered a separate herd and sampled as follows:

Up to 14 head—test all
Over 14 head—test 14

**Official random-sample test (95/10)**
A sampling procedure utilizing official pseudorabies serologic tests which provides a 95-percent probability of detecting infection in a herd in which at least 10 percent of the swine are seropositive for pseudorabies. Each segregated group of swine on an individual premises must be considered a separate herd and sampled as follows:

Less than 100 head—test 25
100–200 head—test 27
201–999 head—test 28
1,000 and over—test 29

**Official random-sample test (95/5)**
A sampling procedure utilizing official pseudorabies serologic tests which provides a 95-percent probability of detecting infection in a herd in which at least 5 percent of the swine are seropositive for pseudorabies. Each segregated group of swine on an individual premises must be considered a separate herd and sampled as follows:

Less than 100 head—test 45
100–200 head—test 51
201–999 head—test 57
1,000 and over—test 59

**Permit**
An official document issued for and prior to the interstate shipment of pseudorabies-virus-infected or -exposed swine by a Veterinary Services representative, State representative, or accredited veterinarian, stating: (1) the number of swine to be moved, (2) the purpose for which the swine are to be moved, (3) the points of origin and destination, (4) the consignor and consignee, and (5) additional information required by applicable State and Federal regulations.

**Prevalence**
The number of known infected herds in the State as of the date of the application for Stage III status, divided by the number of swine herds in the State as determined by the National Agricultural Statistics Service (NASS). When a State has conducted a down-the-road survey of all swine producers, the swine population data so developed may be used rather than the NASS data.

**Pseudorabies**
The contagious, infectious, and communicable disease of livestock and other animals also known as Aujeszky's disease.

**Pseudorabies-monitored feeder-pig herd**
For the purpose of this document, "pseudorabies-monitored feeder-pig herd," "pseudorabies-monitored vaccinated feeder-pig herd," "pseudorabies-monitored herd," and "monitored herd" are interchangeable, and all refer to a swine herd that is in compliance with Part IV, Subpart III, of this document.

**Pseudorabies-restricted feeder-pig market**
A market specifically designated by the State animal health official to handle shipments of feeder pigs from premises under pseudorabies quarantine. Sales are limited to quarantined feedlots. Pseudorabies-restricted feeder-pig markets are restricted to handling intrastate shipments of pseudorabies-quarantined swine only.

**Pseudorabies virus vaccinates**
Any swine that have been vaccinated with a USDA-licensed pseudorabies vaccine.

**Quarantined feedlot**
A premises where pseudorabies-virus-infected or -exposed swine are fed under the supervision and control of the State animal health official and from which swine are moved directly to a recognized slaughtering establishment or directly through no more than one slaughter market and then directly to a recognized slaughtering establishment.

**Quarantined herd**
A herd in which pseudorabies-virus-infected or -exposed swine are bred, reared, or fed under the supervision and control of the State animal health official and from which swine are moved directly to a recognized slaughtering establishment, pseudorabies-restricted feeder-pig market, quarantined feedlot, or directly through no more than two slaughter markets and then directly to a recognized slaughtering establishment or quarantined feedlot.

**Recognized slaughtering establishment**
A slaughtering establishment operated under the provisions of the Federal Meat Inspection Act (21 U.S.C. 601 et seq.) or a State-inspected slaughtering establishment.

**State/Area**
Any State or Territory of the United States, the District of Columbia, Puerto Rico, Guam, or the Northern Mariana Islands, or any portion of a State which meets the following criteria:

1. All counties whose pseudorabies eradication status is in the same Stage must be contiguous.
2. There shall be no more than two Stages in any State.
3. Only the following combinations of status will be permitted within a State: Stages II and III, Stages III and IV.
4. The surveillance system required for Stages III and IV must differentiate between animals and/or herds from areas with different status.

**State animal health official**
The State official who is responsible for the livestock and poultry disease control and eradication programs in the official's State/Area, or that person's designated representative.

**State pseudorabies committee**
An appointed advisory committee composed of swine producers, animal scientists, State and Federal regulatory officials, and other representatives of the swine industry. The responsibilities of the committee include:

A. Informing and educating all segments of the State/Area swine industry regarding pseudorabies eradication activities.
B. Reviewing the State/Area pseudorabies eradication program and making recommendations to State and Federal animal health officials and, as appropriate, consulting with State officials in the areas of:
    1. Budgeting;
    2. Intrastate and interstate regulations, including use of vaccine;
    3. Progress through the Program Stages.
C. Maintaining liaison with other States and with the national pseudorabies eradication program through the National Pork Board, the United States Animal Health Association, the National Institute for Animal Agriculture, and APHIS.

**State representative**
A person regularly employed in animal health work by a State and authorized by the State to perform the functions involved or under a cooperative agreement with USDA.

**Surveillance index**
Refers to the percentage of a population of sows and boars sampled, multiplied by the percentage of positive swine traced to the farm of origin. When no positive swine are found, then the surveillance index will be the percentage of a population of sows and boars sampled.

Only two specific forms of surveillance testing may be included in the surveillance index calculations:

1. Samples collected at slaughter.
2. Samples collected at markets (first point).

Unless cull sows and boars from herds tested for other purposes (e.g., feeder-pig monitoring, circle testing, etc.) can be eliminated from the population being tested at slaughter or first point—in which case the number of sows in such herds can be deducted from the population to be used for surveillance—data of the following types may not be included in surveillance index calculations:

1. Data from samples collected for epidemiologic purposes (e.g., circle testing, tracing into or out of infected herds);
2. Data from status testing (e.g., tests to establish qualified-negative herd status, qualified-negative vaccinated herd status, or feeder-pig-monitored herd status; or testing for sale and show).

The percentages of the breeding population in a State/Area to be tested annually to meet the surveillance requirements for Stages III, IV, and V apply regardless of whether the surveillance is conducted at slaughter, at first point, or as part of a down-the-road (area) testing program. Whichever system is used must be random and must be representative of all herds of unknown status in the State/Area.

Randomness of slaughter, first-point, or on-farm (area) surveillance testing must be documented in applications for status.

**Swine Health Committee, National Pork Board**
A committee of pork producers, constituted as determined by the National Pork Board and calling on such scientific experts as needed, which shall review the national Pseudorabies Eradication Program and the expenditure of Federal funds for the Program at least annually. The committee will also review, in advance, allocations of Federal funds for any national surveillance program to the various States and make recommendations to the Deputy Administrator of Veterinary Services, APHIS, as it deems appropriate.

**Swine not known to be infected with or exposed to pseudorabies virus**
All swine except those which are part of a known infected herd or are known to have been exposed to pseudorabies virus.

**Transitional production swine**
Those feral swine that are captive or swine that have reasonable opportunities to be exposed to feral swine.

**Veterinarian-in-Charge**
The veterinary official of Veterinary Services, APHIS, USDA, who is assigned by the Administrator to supervise and perform APHIS' official animal health work in the State/Area concerned.

**Veterinary Services**
The Veterinary Services branch of APHIS, USDA.

**Veterinary Services representative**
A person employed by Veterinary Services, APHIS, USDA, who is authorized to perform official pseudorabies eradication activities.

## Part II—Administrative Procedures

### A. Supervision of the Cooperative State–Federal–Industry Pseudorabies Eradication Program

The Cooperative State–Federal–Industry Pseudorabies Eradication Program (hereafter called "the Program") must be supervised by full-time animal health veterinarians employed by the State or Federal Government.

### B. Entering premises

Persons working for the Program must be authorized by the State to enter premises to carry out Program

policy. While on such premises, they must use commonly accepted sanitary and biosecurity procedures to minimize the risk of physically transmitting diseases among groups of livestock on the farm being investigated, as well as to other premises.

**C. Providing services to livestock owners**

Owners are responsible for handling their animals. Program administrators may contract with accredited veterinarians, paraprofessionals, other State and Federal agencies, or with the management of privately owned firms as needed, to assist State and Federal animal health personnel in collecting blood or tissue samples, in identifying animals, and in performing other Program activities.

**D. Notifying the community of pseudorabies-virus-infected herds and quarantined feedlots**

State or Federal Program officials should notify swine owners in the immediate community within 30 days after a swine herd has been quarantined for pseudorabies. Program officials should also notify herd owners in the immediate community when they grant approval for a quarantined feedlot. Notification may be by an educational letter emphasizing the importance of taking appropriate actions to protect swine against pseudorabies. When the herd quarantine is released or the approval of the quarantined feedlot is terminated, herd owners should be notified within 30 days by an informational letter.

**E. Dealers—Registration and Recordkeeping**

The following dealers (individuals or other legal entities) of swine must be registered or licensed with the appropriate State agency:

- Dealers who purchase, deal in, or sell swine;
- Dealers who act as commission representatives or brokers;
- Dealers who operate and conduct an auction where swine are sold.

These dealers must maintain records required by the licensing agency to make it possible for State authorities to trace swine to their herds of origin or destination.

1. Registering dealers—After giving due notice and opportunity for a hearing to the dealer involved, the State agency must have the authority to deny an application for registration, or to suspend or cancel the registration, when the agency is satis fied of either or both of the following:
   a. There is adequate evidence to establish that the dealer had the intent to violate or circumvent recordkeeping requirements of this section and/or other animal health regulations;
   b. The dealer has repeatedly demonstrated failure to keep records adequate to trace his swine sales and purchases.
2. Keeping records—Each registered or licensed swine dealer must keep sufficient records of all swine purchased for resale to enable the State agency to trace purchased animals satisfactorily to their herds of origin and destination. The records must be kept for a minimum of 2 years.
3. Dealing with violations—State animal health officials must have the authority to enforce compliance with dealer registration and record keeping requirements. This includes the authority to subpoena appropriate records and/or persons who allegedly violate these minimum standards. The appropriate State officials must also have authority to petition the local court that has venue for an order to enforce these subpoenas.

**F. Administrative review of Program activities**

Appropriate Veterinary Services personnel will review the progress of State/Area pseudorabies programs

on an ongoing basis to ensure compliance with the Program Standards.

**G. Application for Program status**

Application for Program entry and advancement in status, jointly signed by the State animal health official and Veterinarian-in-Charge, along with required documentation, must be submitted to the Veterinary Services National Center for Animal Health Programs, Pseudorabies Eradication Program staff for approval. The application shall be reviewed by the National Pseudorabies Control Board prior to a final decision by the Deputy Administrator.

**H. Other movements**

The State Veterinarian may, upon request in specific cases, permit the movement of livestock not otherwise provided for in these Program Standards to prevent the spread of pseudorabies virus. It is the intention of these Standards that such authority be used only in situations and under circumstances that could not have been reasonably anticipated in advance. It is not the intention that such authority be used repeatedly to cover the same problem, but that the Program Standards be amended to conform with needed changes as they come to light.

**I. Changes to the Program Standards**

All proposed changes to Program Standards must first be reviewed and approved by the Pseudorabies Program Standards Committee, a subcommittee of the United States Animal Health Association (USAHA) Pseudorabies Committee. Proposed changes must then be reviewed and approved by the full USAHA Pseudorabies Committee during the annual USAHA meeting. Proposed changes that are approved by the USAHA Pseudorabies Committee and included in the Pseudorabies Committee report will be forwarded as a recommendation for final approval to Veterinary Services, National Center for Animal Health Programs staff.

## Part III—Program Stages and Requirements

**Stage I—Preparation**

This is the initial Program stage in which the basic procedures to control and eradicate pseudorabies are developed.

**A. To qualify for Stage I recognition, the application for Program status shall provide documentation that the following standards are met:**

1. A State pseudorabies committee has been formed and is functioning;
2. Plans are formulated for a reliable system of determining pseudorabies prevalence in the State/Area swine population, which may include:
   a. Mandatory reporting of suspected pseudorabies by producers, veterinarians, and laboratories;
   b. Change-of-ownership test requirements;
   c. Collection of blood samples from sows and boars at swine markets, slaughter establishments, or farms. Emphasis is given to pseudorabies testing of blood samples that are collected for other purposes, e.g., brucellosis validation, disease diagnosis, exhibition requirements, etc.
3. State officials and/or industry representatives have, or are actively seeking, legislative and regulatory authority to:
   a. Participate in the Cooperative State–Federal–Industry Pseudorabies Eradication Program;

b. Require reporting of suspected pseudorabies by producers, veterinarians, and laboratories to the State animal health official;
c. Conduct diagnostic and epidemiologic investigations of suspected pseudorabies;
d. Quarantine premises on which pseudorabies is confirmed;
e. Trace purchases and sales of swine to and from quarantined premises and inspect and collect diagnostic specimens from such swine;
f. Regulate shipments of breeding swine, feeder pigs, and slaughter swine within and into the State;
g. Control the use of pseudorabies virus vaccines;
h. Control disposal of dead animals.

4. A system for distribution of Program literature to producers and other interested groups is developed and functioning.

5. Applicable Federal pseudorabies regulations are enforced.

6. A State progress report will be produced monthly.

The States will prepare a monthly report of pseudorabies eradication activities and submit it to Veterinary Services for tabulation and distribution in a national Program progress report. Veterinary Services shall make reports as requested and at least annually to the Oversight Committee, National Pork Board, on Program progress, Program operation, and use of Federal funds, including, but not limited to, the operation of any national slaughter surveillance program.

**B. Duration of status**

Twenty-four to 28 months following assignment of Stage I status by Veterinary Services, a State must (1) indicate that it continues to meet the Stage I requirements, utilizing the same certification procedures as followed initially, or (2) certify that it meets the requirements of a subsequent Program Stage. States failing to recertify as required will automatically lose their Stage I status.

**Stage II—Control**

In this stage, a State will continue to participate with Veterinary Services on a cooperative basis. The goals of this stage are to determine which herds are infected with pseudorabies virus and to begin herd cleanup.

**A. To qualify for Stage II recognition, the application for Program status shall provide documentation that the following standards are met:**

1. Stage I standards have been implemented.
2. A surveillance program plus circle-testing 1.5 miles around all newly identified infected herds has been implemented to find additional infected herds. This surveillance should be based on testing sows and boars at slaughter, on the farm, or at first point of concentration.
3. States/Areas must have acquired the authority to require herd-cleanup plans on all known infected herds before the States/Areas can apply for a subsequent Program Stage or reapply for status in Stage II.
4. Swine movements into the State/Area are controlled as follows:
   a. Breeding swine not known to be infected or exposed to pseudorabies virus must:
      (1) Be negative to an official pseudorabies serologic test within 30 days prior to interstate shipment; or
      (2) Originate in a qualified pseudorabies-negative herd; or

(3) Originate in a qualified pseudorabies-negative gene-altered vaccinated herd; or
(4) Be shipped directly from the farm of origin in a Stage IV or Free State; or
(5) Originate in a qualified pseudorabies-negative herd or be negative to an official pseudorabies serologic test within 30 days prior to sale at an approved all-class market and be released under State quarantine for isolation and retest in 30–60 days at the importer's expense.

b. Feeder pigs not known to be infected with or exposed to pseudorabies virus and not mingled with or exposed to swine of lesser or unknown status must:
(1) Be negative to an official pseudorabies serologic test within 30 days prior to interstate shipment; or
(2) Originate in a qualified pseudorabies-negative herd; or
(3) Originate in a qualified pseudorabies-negative gene-altered vaccinated herd; or
(4) Originate in a pseudorabies-monitored feeder-pig herd; or
(5) Be shipped directly from the farm of origin in a Stage III, IV, or Free State; or
(6) Be sold at an approved all-class market or approved slaughter market and imported for feeding in a quarantined feedlot; or
(7) Be sold at an approved feeder-pig market and imported for feeding without restriction.

c. Slaughter hogs:
(1) Swine not known to be infected with or exposed to pseudorabies may move as follows:
(a) Directly to a recognized slaughter establishment; or
(b) Directly to an approved slaughter market or approved all-class market and then directly to another approved slaughter market or a recognized slaughter establishment or quarantined feedlot; or
(c) Directly to an approved slaughter market and then to a quarantined feedlot.

(2) Virus-infected or -exposed swine may move directly to a recognized slaughter establishment or directly to no more than two approved slaughter markets and then directly to a recognized slaughter establishment when
(a) The carrier transporting pseudorabies-virus-infected or -exposed slaughter swine is cleaned and disinfected before it is used to transport nonslaughter swine or feedstuffs within the following 30 days; and
(b) Additional State-of-destination swine-identification requirements and regulations are followed; and
(c) Quarantined swine are accompanied by a shipping permit (VS Form 1–27) and are conveyed in sealed vehicles.

d. Interstate movements of swine from infected herds in multisite production systems must be made as part of a herd-cleanup plan approved by the State Veterinarians of the originating and recipient States.

5. Intrastate movements are controlled as necessary to meet State needs.

   Movement of quarantined swine between multiple-site production units may be approved under the following guidelines: (1) The breeding herds must be vaccinated at least twice a year with a differentiable virus vaccine; (2) Movement of breeding stock, either from one site to another or from the final site, shall be intrastate only; (3) Such movement shall be part of a State-approved cleanup plan that will provide a maximum of 18 months for elimination of the virus from the infected breeding herd; (4) Progeny shall be tested monthly; (5) Before movement of progeny as breeding stock, 100 percent of the progeny must be tested.

6. Transmission of pseudorabies virus from wild or feral swine shall be controlled as follows:

   a. Any swine that have had known exposure to wild or feral swine must be separated from wild or feral swine and quarantined until released in accordance with Part IV, subpart IV.
   b. Wild or feral swine may be moved to immediate slaughter. Movement to hunting preserves or game farms is not classified as shipment to slaughter.
   c. Wild or feral swine moved to hunting preserves or game farms, or for exhibition, or feeding, must test negative on an official pseudorabies test conducted within 30 days prior to shipment under permit of the State animal health official.
   d. Wild or feral swine moved for breeding purposes must be held separate and apart from all swine for 90 days and must test negative on two official pseudorabies tests conducted at least 60 days apart.

**B. Disposition of quarantined herds**

Owners of quarantined herds must complete their cleanup plans and fulfill the requirements for quarantine release as follows:

Quarantines issued before January 1, 1997, must be released by January 1, 1999.

Quarantines issued during 1997 must be released within 24 months from the quarantine date.

Quarantines issued after January 1, 1998, must be released by January 1, 2000.

These time frames must be included in all herd-cleanup plans.

**C. Duration of status**

Twelve to 14 months following assignment of Stage II status by Veterinary Services, a State/Area must (1) certify that it meets the requirements of a higher Program Stage; or (2) indicate that it continues to meet Stage II requirements, utilizing the same certification procedure as followed initially; and (3) demonstrate progress in herd cleanup consistent with the goal of eradication by the year 2000 by, at a minimum, meeting the following provisions: (A) herd-cleanup plans written on all herds within 30 days of quarantine; (B) all herd plans reviewed semiannually and revised as necessary; (C) all quarantined breeding herds must be tested by a whole-herd test every 30 days. All sows

and boars testing positive for pseudorabies virus must be removed for slaughter or isolation for slaughter within 15 days after test results are reported; (D) all quarantined continuous-flow finishing sites must be tested every 45 days with an official random sample test (95/10). If two consecutive tests detect pigs positive for pseudorabies virus, no additions of swine may be made to the premises until the quarantine is released; (E) unless otherwise determined by the State Veterinarian and the pseudorabies epidemiologist, all swine in quarantined herds and all swine in herds located within 2 miles of a quarantined herd must be vaccinated for pseudorabies. States failing to recertify as required will be reviewed by the National Pseudorabies Control Board and may lose their Stage II status.

**Stage III—Mandatory Herd Cleanup**

In this stage, the cleanup of infected herds becomes mandatory. The State pseudorabies committee shall provide time limits for developing and completing official pseudorabies herd-cleanup plans in conformity with Section C. An official pseudorabies epidemiologist will consult with the herd owner and his or her veterinary practitioner, when applicable, to develop a mutually acceptable official pseudorabies herd-cleanup. This plan should be based on the strategies outlined in the Livestock Conservation Institute's Swine Pseudorabies Eradication Guidelines. The attending accredited veterinarian should play a major role in selecting and implementing herd-cleanup plans. Pseudorabies prevalence in the affected community must be determined for all groups of swine, including swine in feedlots.

**A. To qualify for Stage III recognition, the application for Program status shall provide documentation as follows:**

1. The standards of Stage II are implemented and, with the endorsement of the State pseudorabies committee, the State animal health official is implementing mandatory herd-cleanup procedures.

2. Epidemiology
   a. Swine movements into and out of infected premises or premises suspected of being infected are traced, and the status of receiving and source herds is appropriately established by either a test of all breeding swine or an official random-sample test.
   b. All swine units, including feedlots within a 1.5-mile (2.4-kilometer) radius of infected premises, are monitored either by a test of all breeding swine or by an official random-sample test.
   c. The State prevalence of infected herds is 1 percent or less, based on surveillance testing that meets the requirements of section 3, below.

3. Surveillance

   a. Surveillance by slaughter or first-point testing:

      At least 10 percent of the breeding swine population is surveyed annually using an official pseudorabies serologic test with at least 80-percent successful traceback of seropositives to the farm of origin, or testing and traceback to achieve a surveillance index of 0.08. Current data from the National Agricultural Statistics Service, USDA, on breeding swine populations will be used to calculate surveillance data. The surveillance program must be random and must be representative of all herds in the State. Tests of swine from premises currently known to be infected may not be included in totals to meet the requirements of this section.

Only two specific forms of surveillance testing may be included in the surveillance index calculation: (1) samples collected at slaughter, and (2) samples collected at markets (first point).

If sows and boars from herds tested for other purposes (e.g., feeder-pig monitoring, circle testing, etc.) can be eliminated from the population being tested at slaughter or first point, then the number of sows in such herds can be deducted from the population to be sampled for surveillance. Applications for status for States/Areas taking advantage of this provision must explain how this is being accomplished.

b. Surveillance by herd testing:

If an official random sample test (95/10) or a monitored herd test is used, 25 percent of the herds or 10 percent of the breeding swine in the Stage III area must be tested annually.

If an official random-sample test (95/20) is used, 33 percent of the herds in the Stage III area must be tested annually.

Herds to be tested must be selected randomly during the surveillance period. Herds are eligible for selection when more than 12 months have elapsed since the last herd test. Quarantined herds are not eligible for selection.

4. Vaccination

Vaccination may be permitted by the State animal health official as part of an approved herd-cleanup plan and in area control programs.

5. Transmission of pseudorabies virus from wild or feral swine shall be controlled as follows:

Regulations to prevent virus transmission from wild or feral to domestic swine within the State are implemented.

**B. During Stage III:**

1. Information and education efforts are intensified.
2. The effectiveness of regulations is monitored, and enforcement is strengthened as necessary.
3. Industry commitment for Program advancement is secured.
4. Epidemiologic evaluation of Program activities is utilized.
5. Swine may not be moved from a quarantined herd to ~~any~~ location within a ~~Stage~~ III area unless part of the herd was at this location when the original herd quarantine was issued or such movement is required as part of an approved herd-cleanup plan.

**C. Disposition of quarantined herd~~s~~**

Owners of quarantined herds must complete their cleanup plans and fulfill the requirements for quarantine release as follows:

Quarantines issued before January 1, 1997, must be released by January 1, 1999.

Quarantines issued during 1997 must be released within 24 months from the quarantine date.

Quarantines issued after January 1, 1998, must be released by January 1, 2000.

These time frames must be included in all herd-cleanup plans.

**D. Duration of status**

Twelve to 14 months following assignment of Stage III status by Veterinary Services, a State/Area must (1) certify that it meets the requirements of a higher program stage, or (2) indicate that it continues to meet Stage III requirements, utilizing the same certification procedure as followed initially, and demonstrate progress in herd cleanup consistent with the goal of eradication by the year 2000, by, at a minimum, meeting the following provisions: (A) herd-cleanup plans written on all herds within 30 days of quarantine; (B) all herd plans reviewed semiannually and revised as necessary; (C) all quarantined breeding herds must be tested by a whole-herd test every 30 days. All sows and boars testing positive for pseudorabies virus must be removed for slaughter or isolation for slaughter within 15 days after test results are reported; (D) all quarantined continuous-flow finishing sites must be tested every 45 days with an official random sample test (95/10). If two consecutive tests detect pigs positive for pseudorabies virus, no additions of swine may be made to the premises until the quarantine is released; (E) unless otherwise determined by the State Veterinarian and the pseudorabies epidemiologist, all swine in quarantined herds and all swine in herds located within 2 miles of a quarantined herd must be vaccinated for pseudorabies. States failing to recertify as required will be reviewed by the National Pseudorabies Control Board and may lose their Stage III status.

In the event that the prevalence of infected herds exceeds 1 percent at any time during the recertification period, the national coordinator for Veterinary Services shall be notified immediately. Such notification shall be followed by a written explanation for review and consideration by the National Pseudorabies Control Board.

**Stage IV—Surveillance**

To qualify for Stage IV recognition, the following requirements shall be met:

**A. The application for Program status shall demonstrate that the standards of Stage III are in effect and shall document that:**

1. There is no known infection in the State/Area and the surveillance program required for Stage III has been in effect for at least 2 years.
2. The State/Area has and enforces regulatory authority requiring farm-of-origin identification of cull sows and boars.
3. No new cases of pseudorabies were confirmed during the year prior to application for Stage IV status, except as follows: In the event of an isolated case, application for Stage IV status may be made if the affected herd was disposed of within 15 days after test results were reported with no spread to additional premises as determined by testing of all exposed herds and all swine herds within 2 miles of the new case with an official random sample test (95/5). Testing of the above herds must be accomplished, with negative results, no earlier than 30 days and no later than 60 days after cleanup.
4. States must develop and adopt a management plan that adequately separates and addresses controls of the interface of feral and transitional production swine with commercial production swine. The plan is to be reviewed by the Control Board and Veterinary Services, National Center for Animal Health Programs staff.

**B. Surveillance of breeding herds must be continued at the same rate required for Stage III.**

**C. Certification, with respect to feedlots on premises on which there are no breeding animals, must show that:**

1. Such feedlots have been included in a down-the-road herd-testing program, or
2. Such herds will be monitored by slaughter or first-point surveillance of butcher hogs, or
3. During the period since the last case in a State/Area has been cleaned up, such herds
   a. Have been negative to an official random-sample test (95/10) as defined in these Standards, or
   b. Have undergone a 30-day depopulation with appropriate cleaning and disinfection.
4. Any feedlots not tested under the provisions of this part must be operated all-in and all-out by premises.

**D. Vaccination is prohibited except by permission of the State animal health official in high-risk herds or as part of an approved herd-cleanup plan.**

**E. Swine import requirements shall be as follows:**

1. Slaughter swine
   a. Infected or exposed swine may be shipped through or into a Stage IV State/Area with prior written approval from the State Veterinarian and must move directly to a recognized slaughter establishment. Such swine must be accompanied by a shipping permit (VS Form 1–27), be conveyed in sealed vehicles, and be unloaded under the supervision of State or Federal officials to ensure that biosecurity measures are observed.
   b. Imports of slaughter swine from States or Areas with a Program status up to and including Stage III are permitted to a recognized slaughter establishment or an approved slaughter market only.

2. Breeding swine
   a. Direct shipment from a Stage IV or V State/Area, or
   b. Direct shipment from a qualified pseudorabies-negative herd in any State/Area, or
   c. Negative official pseudorabies serologic test within 30 days prior to shipment with quarantine, isolation, and retest at destination in 30–60 days following importation.

3. Feeder pigs
   a. Direct shipment from a farm of origin or a market in a Stage IV or V State/Area, or
   b. Direct shipment from a farm of origin in a Stage III State/Area, or
   c. Direct shipment from a qualified pseudorabies-negative herd or qualified-negative gene-altered vaccinated herd, or
   d. Entry is allowed into Stage IV States/Areas from feeder-pig-monitored herds in Stage II States or from approved feeder-pig markets under the following conditions:
      (1) That the swine enter on permit directly to a designated feedlot;
      (2) That the swine be restricted to the designated feedlot until they are sent to slaughter.

**F. Intrastate swine movements—no restrictions.**

**G. Duration of status**

Twelve to 14 months following assignment of Stage IV status by Veterinary Services, a State/Area must (1) indicate that it continues to meet the Stage IV requirements, utilizing the same certification procedures as followed initially, or (2) certify that it meets the requirements of another Program Stage. States/Areas failing to recertify as required will automatically lose their Stage IV status.

In the event of a confirmed case of pseudorabies in commercial production swine, the national program coordinator for Veterinary Services shall be notified immediately, and the county or counties within a 2-mile radius of the new case will revert to Stage III status (except as noted below) until 60 days following cleanup and quarantine release. During the 60 days following quarantine release, and before Stage IV status is reinstated, all exposed herds and all swine herds within 2 miles of the new case must be tested with an official random sample test (95/5) and be found negative.

The national pseudorabies coordinator and officials from the State where a confirmed case in commercial production swine occurs must notify all 50 states within 24 hours. Such notification is to include the location of the break and the circumstances surrounding the case, including herd size, clinical signs, and type of herd.

Immediately after a confirmed case is identified in commercial production swine, all movement of swine from herds within a five-mile radius of the case and from exposed herds must be stopped until such herds are tested and found to be negative using an official random sample test (95/5). Testing must be completed within 15 days of identifying the infected herd.

If one or more counties revert to Stage III, animal health officials from the State where a confirmed case occurs in commercial production swine must immediately notify producers and veterinarians that breeding swine from the affected counties must again be tested for pseudorabies within 30 days prior to interstate shipment.

If the newly infected herd is isolated and disposed of within 15 days after test results are reported to State animal health officials, and there is no spread to additional premises as determined by testing of all exposed herds and all swine herds within 2 miles of the new case with an official random sample test (95/5), Stage IV status may be maintained. Testing of the above herds must be accomplished, with negative results, no earlier than 30 days and no later than 60 days after cleanup.

**Stage V—Free**

This is the stage in which a State is declared pseudorabies free.

**A. To qualify for this final surveillance stage, the application for Program status shall provide evidence that the State is implementing the standards of Stage IV.**

**B. In addition, the State must document that:**

1. The State has been free of pseudorabies for 1 year since recognition of Stage IV status.
2. Surveillance of breeding herds has been continued at one-half the rate required for Stage III and Stage IV. Once all States have achieved Stage IV or V status, surveillance will no longer be required to maintain Stage V status in states that have maintained Stage V status for five consecutive years, have had no confirmed cases of pseudorabies during the same period, and have demonstrated that no feral swine exist in the state.

3. Swine imports are controlled as follows:
   a. Slaughter swine—same as Stage IV;
   b. Breeding swine—same as Stage IV;
   c. Feeder pigs—same as Stage IV.
4. Vaccination is not permitted except by permit from the State Veterinarian in certain high-risk herds.
5. Intrastate swine movements—no restrictions.

6. States must develop and adopt a management plan that adequately separates and addresses controls of the interface of feral and transitional production swine with commercial production swine. The plan is to be reviewed by the Control Board and Veterinary Services, National Center for Animal Health Programs staff.

**C. Duration of status**

Twelve to 14 months following assignment of Stage V status by Veterinary Services, a State/Area must indicate that it continues to meet Stage V requirements, utilizing the same certification as followed initially. States/Areas failing to recertify as required will automatically lose their Stage V status.

In the event of a confirmed case of pseudorabies in commercial production swine, the national program coordinator for Veterinary Services shall be notified immediately, and the county or counties within a 2-mile radius of the new case will revert to Stage III status (except as noted below) and all other counties in the State will revert to Stage IV status. Stage IV status for the affected county may be reinstated as outlined under Stage IV requirements.

The national pseudorabies coordinator and officials from the State where a confirmed case in commercial production swine occurs must notify all 50 States within 24 hours. Such notification is to include the location of the break and the circumstances surrounding the case, including herd size, clinical signs, and type of herd.

Immediately after a confirmed case is identified in commercial production swine, all movement of swine from herds within a five-mile radius of the case and from exposed herds must be stopped until such herds are tested and found to be negative using an official random sample test (95/5). Testing must be completed within 15 days of identifying the infected herd.

If one or more counties revert to Stage III, officials from the state where a confirmed case occurs in commercial production swine must immediately notify producers and veterinarians that breeding swine from the affected counties must again be tested for pseudorabies within 30 days prior to interstate shipment.

If the newly infected herd is isolated and disposed of within 15 days after test results are reported to the State animal health officials, and there is no spread to additional premises as determined by testing of all exposed herds and all swine herds within 2 miles of the new case with an official random sample test (95/5), Stage V status may be maintained. Testing of the above herds must be accomplished, with negative results no earlier than 30 days and no later than 60 days after cleanup.

# Part IV—Participation in Herd Plans and Release of Quarantines

## Subpart I—The Qualified Pseudorabies-Negative Herd

**A. Establishment of a qualified pseudorabies-negative (QN) breeding herd:**

1. For breeding herds, QN status is attained by (1) subjecting to an official pseudorabies serologic test all swine over 6 months of age plus a number of progeny equal to 20 percent of the breeding swine population of the herd, and (2) finding that all swine are negative to the test. Progeny shall be randomly selected from swine between 4 and 6 months of age. The herd must not have been a known infected herd within the 30 days prior to the qualifying test. A minimum of 90 percent of the swine in the herd must have been on the premises and a part of the herd for at least 60 days prior to the qualifying official pseudorabies serologic test or have entered by direct shipment from another QN herd.
2. When all swine are shipped directly from existing QN herds, a new QN breeding herd may be established if, within 30 days of arrival, all swine in the initial shipment (up to 50 animals) are tested and found negative to an official pseudorabies serologic test.
3. Any breeding herd in a Stage IV or V State/Area is recognized as a QN herd.

**B. QN breeding herd status may be maintained by monthly or quarterly pseudorabies testing as follows:**

1. Monthly testing:
   a. Every 30 days, conduct an official pseudorabies serologic test of 7 percent of all breeding swine 6 months of age or older, and test a number of offspring 4 to 6 months of age located on the same premises as the breeding herd equal to 2 percent of the breeding animals in the herd, or
   b. On approval of the State Veterinarian, herds in Stage III, IV, or V States/Areas may maintain status on the basis of a monthly negative official random sample test (95/5) in each separate population of breeding swine on a premises, and a monthly test of 50 offspring 4 to 6 months of age located on the same premises as the breeding herd. Sampling in the population must be random and the testing protocol in the herd must be a part of the approval. Progeny must be selected at random from all groups on the premises.
   c. Progeny testing on multisite herds is covered in item D. on pages 25–26 regarding establishment and maintenance of QN growout premises on which no adult breeding swine are maintained.

2. Quarterly testing:
   a. Every 80 to 105 days, conduct an official pseudorabies serologic test of 20 percent of all breeding swine 6 months of age or older, and test a number of offspring 4 to 6 months of age located on the same premises as the breeding herd equal to 6 percent of the breeding animals in the herd.
   b. Progeny testing on multisite herds is covered in item D. on pages 25–26 regarding establishment and maintenance of QN growout premises on which no adult breeding swine are maintained.

3. All swine tested shall be randomly selected and, in the case of the adult swine, representative of all age groups on the premises.

4. All swine intended to be added to a QN herd shall be isolated until they are negative to an official pseudorabies serologic test conducted 30 days or more following their placement in isolation except:
    a. Swine from a herd of unknown status must be negative to an official pseudorabies serologic test not more than 30 days prior to movement, with a second test in isolation at least 30 days after movement.
    b. Swine intended to augment a QN herd and coming directly from another QN herd may be added without isolation or testing.
    c. Swine intended to be added to a QN herd from another QN herd, but with interim contact with swine other than those from a QN herd, shall be isolated until they have been found negative to an official pseudorabies serologic test, conducted 30 days or more after the swine have been placed in isolation.

**C. Reestablishment of QN breeding herd status following confirmation of infection in the herd**

1. A QN herd that has been determined to be infected with pseudorabies virus may qualify for reinstatement as a QN herd if:

    a. All swine in the herd 6 months of age and over are negative to an official pseudorabies serologic test, and

    b. An official random-sample (95/10) test of progeny 2–6 months of age is conducted and all swine tested are negative, and

    c. In 30 or more days, the testing described in a and b above is repeated.

2. If on a qualifying official pseudorabies serologic test or any subsequent official pseudorabies test, any swine test positive, QN herd status is suspended until the infection status of the herd is determined by an investigation conducted by an official pseudorabies epidemiologist.

3. The official pseudorabies epidemiologist will consider the following factors in determining the presence or absence of pseudorabies in the herd:
    a. The specific titers of titered swine;
    b. The percentage and number of titered swine;
    c. The vaccination history of titered swine;
    d. Proximity and pseudorabies virus infection status of neighboring herds;
    e. The possibility of laboratory or sample identification error;
    f. Other pertinent herd history and clinical signs.

4. Based on the above information obtained by the official pseudorabies epidemiologist, a final determination of infection status will be made; however, before QN herd status may be attained or maintained, all seropositive swine must either:
    a. Be sold for slaughter, and a complete herd test conducted at least 30 days later must be negative; or
    b. Be negative to an official pseudorabies serologic test.

**D. Establishment and maintenance of QN growout premises on which no adult breeding swine are maintained:**

Situation 1

Herd A ----------> Herd B ----------> Herd C
QN breeding herd(s) Growout Sales Point

Situation 2

Herd A ----------> Herd C
QN breeding herd(s) Sales Point

Pigs moved from herd(s) A within 1 week of weaning are not required to be pseudorabies tested.

Herd B

QN status may be attained and maintained by monthly negative official random sample tests (95/5) beginning within 30 days after establishment of the herd, except that in all-in/all-out units, 1 test of 50 head is required of each group. If herds A, B, and C are in the same State and program stage, this testing is not required.

Herd C

QN status is attained by a negative official pseudorabies serologic test of the entire initial shipment or 50 head selected at random, whichever is less.

QN status may be maintained by a monthly negative official pseudorabies serologic test of 50 swine selected at random from those that have been in the herd at least 30 days, except that in all-in/all-out units, 1 test of 50 head is required of each group. Each segregated group of swine on an individual premises must be considered a separate herd.

**Subpart II—The Qualified-Negative Gene-Altered Vaccinated (QNV) Herd**

Qualified-negative gene-altered vaccinated (QNV) herd status is attained and maintained under the same guidelines as for qualified pseudorabies-negative (QN) herd status, except that swine may be vaccinated with an approved gene-deleted pseudorabies virus vaccine, and testing may be completed using an official pseudorabies serologic test.

**Subpart III—The Pseudorabies-Monitored Feeder-Pig Herd**

**A. Monitored status in Stage II States or Areas**

1. For breeding herds, pseudorabies-monitored feeder-pig status is attained when the herd has been sampled and was negative to an official pseudorabies serologic test during the last 12 months at the following rate:

   10 head—test all
   11–35 head—test 10
   36 or more—test 30 percent or 30, whichever is less

   Tested breeding swine are to be selected at random from all age groups, including herd boars, and all age groups are to be proportionately represented.

2. An offsite nursery that is not otherwise part of a pseudorabies-monitored herd, to which pigs have been moved within 1 week of weaning from pseudorabies-monitored feeder-pig herds, may be recognized as a pseudorabies-monitored feeder-pig herd on the basis of a negative official random sample test (95/10) as determined by an official pseudorabies epidemiologist. The required tests must be conducted within 30 days prior to movement out of the offsite nursery.

   An official random sample test (95/10) as determined by an official pseudorabies epidemiologist must be conducted on each group of pigs moving through the offsite nursery. In the case of a continuous-flow facility, monthly tests (95/10) must be conducted.

B. Monitored status in Stage III, IV, or V States or Areas

   1. Any breeding herd in a Stage III, IV, or V State or Area not known to be infected is recognized as a pseudorabies-monitored feeder-pig herd.

   2. Offsite nurseries in Stage III, IV, or V States or Areas shall be recognized as pseudorabies-monitored feeder-pig herds if all pigs in the nurseries come from breeding herds in Stage III, IV, or V States or Areas. If part of the pigs in the offsite nursery originate from a Stage II area, the nursery must be tested as outlined in Part A of this section.

**C. Monitored status in the vaccinated swine breeding herd is attained and maintained as outlined in parts A and B of this section.**

**Subpart IV—Quarantine Release Procedures**

A herd of swine shall no longer be classified as a known infected herd when no livestock or other animals on the premises show clinical signs of pseudorabies after removal of the positive swine, and at least one of the four following conditions has been met. Additionally, if the herd is vaccinated, all vaccinates must be vaccinated with the same official gene-altered pseudorabies virus vaccine.

**A. All swine were removed from the premises; the premises were cleaned and disinfected under official supervision with a disinfectant approved by Veterinary Services for such use; and the premises have been maintained free of swine for 30 days or a period of time determined adequate by an official pseudorabies epidemiologist.**

**B. All swine positive to an official pseudorabies serologic test or an approved differential pseudorabies test have been removed from the premises and all remaining swine, except suckling pigs, were subjected to an official (or approved differential) pseudorabies serologic test and found negative 30 days or more after removal of all positive swine.**

**C. All swine positive to an official pseudorabies serologic test or an approved differential pseudorabies test have been removed from the premises; all breeding swine that remain in the herd and an official random sample (95/10) of grower-finishing swine over 2 months of age are subjected to an official (or approved differential) pseudorabies serologic test and found negative 30 days or more after removal of positive swine. A second test of grower-finishing swine at least 30 days after the first is required if the State is in Stage III or IV of the Program.**

**D. (Stage I, II, and III only) All swine present on the date the quarantine was imposed have been removed, and there have been no clinical signs in the herd for at least 6 months. Two successive official (or approved differential) random-sample (95/10) tests of the breeding herd [95/5 for Stage III States], conducted at least 90 days apart, have been determined by the official pseudorabies epidemiologist to reveal no infection, and two successive official (or approved differential) random-sample (95/10) tests of progeny at least 4 months of age, conducted at least 90 days apart, are negative. Herds removed from quarantine by this provision are required to be negative by an official (or approved differential) random-sample (95/10) test 1 year after quarantine release.**

**E. In nurseries or finishing herds without any breeding swine and where no pigs are received from quarantined premises, quarantines may be released as follows:**

(1) A negative official random sample test (95/10), conducted at least 30 days following depopulation with cleaning and disinfection (C&D) of the premises and 7 days' down time, must be determined by the official pseudorabies epidemiologist to reveal no infection; or

(2) A negative official random sample test (95/5), conducted at least 30 days following a negative official random sample test (95/10), must be determined by the official pseudorabies epidemiologist to reveal no infection.

An official random sample test (95/10) must then be conducted between 60 and 90 days following quarantine release.

## References

Livestock Conservation Institute. 1990. Pseudorabies Herd Plan Manual (rev). Madison, WI: Livestock Conservation Institute. 36 p.

## Appendix V:

# The Seventh Draft PRV Eradication Plan

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# PRV CONTROL/ERADICATION PLAN (9/11/86)

**H. Schroeder**
**Sauk City, Wisconsin**

## Introduction

This proposed four-stage program leading to Free status is an opportunity for producers to be actively involved in solving a serious problem. It is based on the conviction that (1) technical knowledge is available to eradicate pseudorabies from the domestic U.S. swine population, (2) given the commitment and leadership of pork producers eradication is attainable, and (3) eradication is in the best interest of the swine industry. As states progress in the program, freer interstate movement will be possible.

It should be remembered that (1) this is a proposed plan for review by the industry, (2) any plan must be submitted to legislative bodies for consideration in obtaining authorities and funding, (3) the plan assumes that there will be a public commitment to eradicate PRV, and (4) to the extent that federal funding is contemplated, the plan is based on cooperative agreements between the federal and state governments.

Entry into the program would be voluntary on the part of any state and decisions on advancing from one stage to another would be made by individual states as their situations warrant.

It is expected that individual state programs will vary, and that there may be variations between areas in a state and between herds, depending on:

1. Prevalence of the disease;
2. The type of hog industry or operation: farrow-to-finish, feeder pig production, feeder pig feeding, seedstock producer;
3. Production systems: outdoor or enclosed confinement;
4. Hog concentration;
5. The needs and desires of the industry, including state regulatory officials.

A major recommendation involves the formation of state PRV committees by pork producers in cooperation with state animal health regulatory agencies. These committees should include producers, technical advisors and state animal health regulatory agencies (state departments of agriculture or state boards of animal health). In some states, such committees may already exist. It is important that such committees are broadly representative of all segments of the swine industry, including all organizations which have an interest in or could contribute to the success of the program.

The stages of the proposed plan are:

Stage 1-Preparation, during which industry-wide state PRV committees will be organized by pork producers in cooperation with state animal health regulatory agencies. In states in which producer leadership is lacking, state animal health regulatory agencies will organize the committees. Prevalence of the disease will be measured, as a guide to decisions on future actions and regulations, and legislative authority needed for the program will be reviewed.

Stage 2-Control, during which states will implement surveillance programs to find infected herds, quarantine such herds and, if they choose, begin a voluntary program of eliminating the virus from infected herds.

Stage 3-Continuation of voluntary stage and beginning of mandatory herd cleanup, during which owners of infected herds will be required to develop and implement individual plans to eliminate the virus from their herds. During the second part of this stage, if only a few infected herds remain in a state, depopulation of those herds could be required, with payment of indemnity as funds are available.

Stage 4-Class A, the classification of states that have completed the herd cleanup phase and have no known infected herds.

Free-States which have demonstrated freedom from the disease.

**Stage 1-Preparation**

In this stage states are encouraged to (A) form state advisory committees (B) determine prevalence of the disease as a guide to later actions, (C) assess authorities and regulations in place and needed for later stages of the program, and (D) conduct information and education programs. During this stage, states should:

A. Producers should form an industry-wide state pseudorabies advisory committee in cooperation with the. State animal health regulatory agency to develop a working relationship with state and local veterinary groups, swine producers, and other segments affected by the program.
B. Implement a reliable system for determining prevalence of the disease in the state swine population, which might include reporting of infected herds, testing of breeding animals for change of owner-ship, herd testing and a survey conducted on a statistically valid sample of the swine population. Purpose of this prevalence data is to I evaluate the extent of the problem and measures needed to control it in the state. The state PRV committee should determine courses of action to deal with the prevalence as determined by the system.
C. Assess state legal authorities and regulations in light of needs to accomplish state goals, including consideration in the following areas:
    1. Epidemiologic evaluation
    2. Quarantine authority and conditions under which that authority should be used
    3. Herd inspections and tests
    4. Regulation of intrastate movements of breeding stock and feeder pigs
    5. Control of use of vaccines
    6. Identification to farm of origin of cull sows, boars and stags
    7. Proper disposal of carcasses of dead animals.
    8. Guidelines for herd cleanup
    9. Cleaning and disinfection of premises, vehicles and equipment which have been exposed to infected hogs
    10. Providing for sharing of program costs.
D. Develop a system of organized distribution of information and educational material to livestock producers and other interested groups concerning the disease and details of the PRV program.

**Stage 2-Control**

In this stage, states commit to a control-eradication program. The goal of this stage is to determine which herds are infected with PRV and to begin to reduce the level of infection. States may enter into a cooperative agreement with APHIS specifying details of the program in that state. States in this stage should:

A. Implement a surveillance program to find infected herds, based on either slaughter testing of cull sows and boars, on-the-premises testing of every herd, or first-point testing of cull breeding animals. Such a program requires an effective identification system to permit traceback of positive animals to farm of origin.
B. Develop and plan efforts to seek necessary legislation and regulations for a program to monitor all feeder pig finishing herds. Such a program could involve a statistically valid sample of pigs in each feeding unit or a slaughter hog surveillance program which includes feeder pig finishing herds.
C. Quarantine infected herds. Positives found in a slaughter or firstpoint testing program would be traced to the herd of origin and additional testing and epidemiology conducted to establish infection before such herds are quarantined. While awaiting confirmation of test results, producers would commit to an agreement to not move hogs, except to slaughter, until the herd status is determined. Placing and release of

quarantines would be based on testing and epidemiologic findings.

D. Control use of vaccines, restricting or encouraging their use depending on conditions in that state.
E. States would be encouraged to conduct voluntary herd cleanup programs designed to reduce the level of infection in the state. Such programs should include funding to provide technical assistance in evaluating individual herd status, preparing herd plans and testing. Accredited veterinarians should play major roles in developing and implementing herd cleanup plans which may involve the use of new, rapid diagnostic tests.
F. Consider the desirability of:
    1. A requirement for change of ownership testing for intrastate movements;
    2. Required testing of feeder pigs, feeder pig finishing or feeder pig production herds;
    3. Quarantined feedlots as an aid to herd cleanup.
G. Continue to:
    1. Conduct an information and education campaign;
    2. Assess and develop, where needed, regulations needed for later stages;
    3. Build swine producer commitment for advancing to the later stages;
    4. Improve epidemiologic evaluation of the PRV situation in the state.

**Stage 3A-Mandatory Herd Cleanup**

Through continuation of actions begun in Stage 2 (i.e., surveillance, quarantines, and control of use of vaccines), states would eliminate infection from herds. In addition, states would begin to implement the following:

A. Required cleanup of infected herds, based on development of an effective herd plan. One of the cleanup alternatives as outlined in the LCI publication "Swine Pseudorabies Eradication Guidelines (Second Edition)" may be used. Advisory committees shall provide for time limits on developing and completing herd plans. Accredited veterinarians should play major roles in developing and implementing herd cleanup plans which may involve use of new, rapid diagnostic tests.
B. Control of all movements of swine into and within the states.
C. Implement surveillance program for feeder pig finishing herds developed as outlined in Stage 2 (B).
D. Continue to:
    1. Conduct an information and education campaign;
    2. Assess and develop, where needed, regulations needed for later stages;
    3. Build swine producer commitment for advancing to the later stages;
    4. Improve epidemiologic evaluation of the PRV situation in the state.

**Stage 3B-Mandatory Herd Cleanup, Phase 2**

In this stage states would continue the activities begun in Stage 3A, involving mandatory herd cleanup of herds detected through any of the surveillance methods in effect: change of ownership testing; monitoring of feeder pigs, feeder pig production and feeder pig finishing herds; slaughter testing; first-point testing; on-the-premises testing of every herd.

A. In addition to the activities carried out in 3A, this final stage, when few infected herds remain in the state, could involve mandatory depopulation of newly infected herds or remaining infected herds in which the owners have been unable or unwilling to eliminate infection from their herd, with payment of indemnity as funding is available.
B. This stage, together with the activities carried out in Stage 3-4, should qualify a state to meet the criteria for Class B status as outlined by the National Pseudorabies Control Board.
C. Continue to:
    1. Conduct an information and education campaign;
    2. Assess and develop, where needed, regulations needed for later stages;

3. Build swine producer commitment for advancing to the later stages;
4. Improve epidemiologic evaluation of the PRV situation in the state.

D. It is expected that states with lower classification (those in Stage 1 and 2) and states in Stage 3A will accept feeder pigs from states in Stage 3B without further testing of either sow herds producing feeder pigs or feeder pigs.

**Stage 4-Class A**

This is the surveillance stage after a state has eliminated all known infection. It involves surveillance to find any infection not previously discovered or newly introduced, and cleanup of any such infected herds by procedures as outlined in Stage 3.

A. To qualify for this stage, a state would meet the requirements for Class A status as defined by the National Pseudorabies Control Board (NPCB) and be so certified by that group:
   1. Operation in Stage 3A and 3B under one of the surveillance options and with ability to trace positives to herd of origin (traceback capability) as outlined by the NPCB:
      a. Slaughter surveillance of cull sows and boars for a period of two years with a traceback capability of at least 25% (percentage of population sampled multiplied by percentage of positive reactors traced), with no new confirmed cases during the second year of the testing period and no infected-quarantined herds remaining in the state at the end of the period, or
      b. On-the-premises testing of every herd in the state during a period of no more than one year with no infected-quarantined herds remaining in the state at the end of the testing period.
   2. Controls on vaccination and importations as outlined in NPCB standards.

B. Surveillance required during this stage would involve testing of cull breeding stock at slaughter or first point of sale as follows:
   1. For the first year with a traceback capability of 25%
   2. For succeeding years with a traceback capability of 5%

C. In the case of a confirmed outbreak, status will be suspended until 60 days after the last confirmed case has been cleaned up.

D. It is expected that all states except Free states will accept breeding stock and feeder pigs from Class A states without further testing.

**Free Status**

States will be declared Free on the basis of standards yet to be determined. It is expected that states will accept breeding stock and feeder pigs from Free states without a test on either the animals or the sow herd from which they originated.

# Appendix VI:

OMB NO 0579-00/0

| QUARTERLY REPORT OF PSEUDORABIES CONTROL/ERADICATION ACTIVITIES | State name | Stage | Month | Year |
|---|---|---|---|---|
| | | | | |

## SECTION A – HERD STATUS DATA

| THIS QUARTER | INFECTED | | QUALIFIED NEGATIVE | FEEDER PIG MONITORED | QN-VACCINATED | UNDER HERD CLEANUP PLAN |
|---|---|---|---|---|---|---|
| | Herds A | Swine B | Herds C | Herds D | Herds E | Herds F |
| 1 Beginning of quarter | | | | | | |
| 2a New herds added during quarter | | | | | | |
| b Previously infected herds added | | | | | | |
| 3a Removed during quarter | | | | | | |
| b By statistical sampling | | | | | | |
| 4 At ending of quarter | | | | | | |

## SECTION B – MARKET/SLAUGHTER SURVEILLANCE DATA

| | BLOOD SAMPLES COLLECTED IN THIS STATE | | | | | | | | BLOOD SAMPLES FROM THIS STATE COLLECTED IN OTHER STATES | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FROM THIS STATE | | | | FROM OTHER STATES | | | | | | | |
| | Barrows and Gilts | | Sows and Boars | | Barrows and Gilts | | Sows and Boars | | Barrows and Gilts | | Sows and Boars | |
| Samples from | Tested A | Positive B | Tested C | Positive D | Tested E | Positive F | Tested G | Positive H | Tested I | Positive J | Tested K | Positive L |
| 5 Slaughter establishments | | | | | | | | | | | | |
| 6 First point testing | | | | | | | | | | | | |

## SECTION C – TRACEBACK OF MARKET/SLAUGHTER SURVEILLANCE POSITIVES

| Samples from | Total Positive Samples for This State A | Trace Not Required B | Trace to Known Infected Herd C | Traced and Herd Test Required D | Traced and Herd Test not Required E | Traced to Sold Out Herd F | Traced to Another State G | Unable to Trace H | Pending I |
|---|---|---|---|---|---|---|---|---|---|
| 7 Slaughter establishments | | | | | | | | | |
| 8 First point testing | | | | | | | | | |

## SECTION D – SUMMARY OF PSEUDORABIES VACCINATION

9. Vaccination θ Permitted in State θ Not Permitted in State

*Complete the following if Vaccination Permitted in State*

| NAME OF VACCINE USED *(Brand Name or Trade Name)* | BREEDING HERD VACCINATED | | GROWER/FINISHER HERDS VACCINATED | |
|---|---|---|---|---|
| | Herds A | Swine B | Herds C | Swine D |
| **10** | | | | |
| **11** | | | | |
| **12** | | | | |
| **13** | | | | |
| **14** | | | | |

**VS FORM 7-1**
**(APR 90)**

## SECTION E – SOURCE OF NEW HERD INFECTIONS

| | Purchased Feeder Pigs A | Purchased Breeding Swine B | Feral Swine C | Feed Bedding D | Area Spread E | Infected Swine Carcasses F | Created by Herd Division G | Unknown H |
|---|---|---|---|---|---|---|---|---|
| 15 Number of herds | | | | | | | | |
| 16 | | | | | | | | |

## SECTION F – SUMMARY OF ON FARM TESTING RESULTS

| | NO INFECTION FOUND | | INFECTION FOUND | | | TOTAL HERDS TESTED | |
|---|---|---|---|---|---|---|---|
| Reason for test | Herds Tested A | Swine Tested B | Herds Tested C | Swine Tested D | Herds Tested E | Herds Tested F | Swine Tested G |
| **EPIDEMIOLOGIC TESTING** 17 Slaughter traceback | | | | | | | |
| 18 First point test traceback | | | | | | | |
| 19 Tracing movements from infected herds | | | | | | | |
| 20 Tracing additions to infected herds | | | | | | | |
| 21 Circle testing around infected herds | | | | | | | |
| 22 Other epidemiologic testing *(Explain)* | | | | | | | |
| | | | | | | | |
| **AREA TESTING FOR SURVEILLANCE** 23 Breeding herds | | | | | | | |
| 24 Grower/Finisher Herds | | | | | | | |
| **HERD STATUS TESTING** 25 Feeder pig monitoring | | | | | | | |
| 26 Qualified negative herd tests | | | | | | | |
| 27 QN-Vaccinated Herd Tests | | | | | | | |
| 28 Retest of infected herds | | | | | | | |
| 29 Test for Sale/Exhibition | | | | | | | |
| 30 Retest of imported swine | | | | | | | |
| 31 **DIAGNOSTIC TESTING** | | | | | | | |

REMARKS AND EXPLANATIONS

| SIGNATURE | TITLE | DATE |
|---|---|---|
| | | |

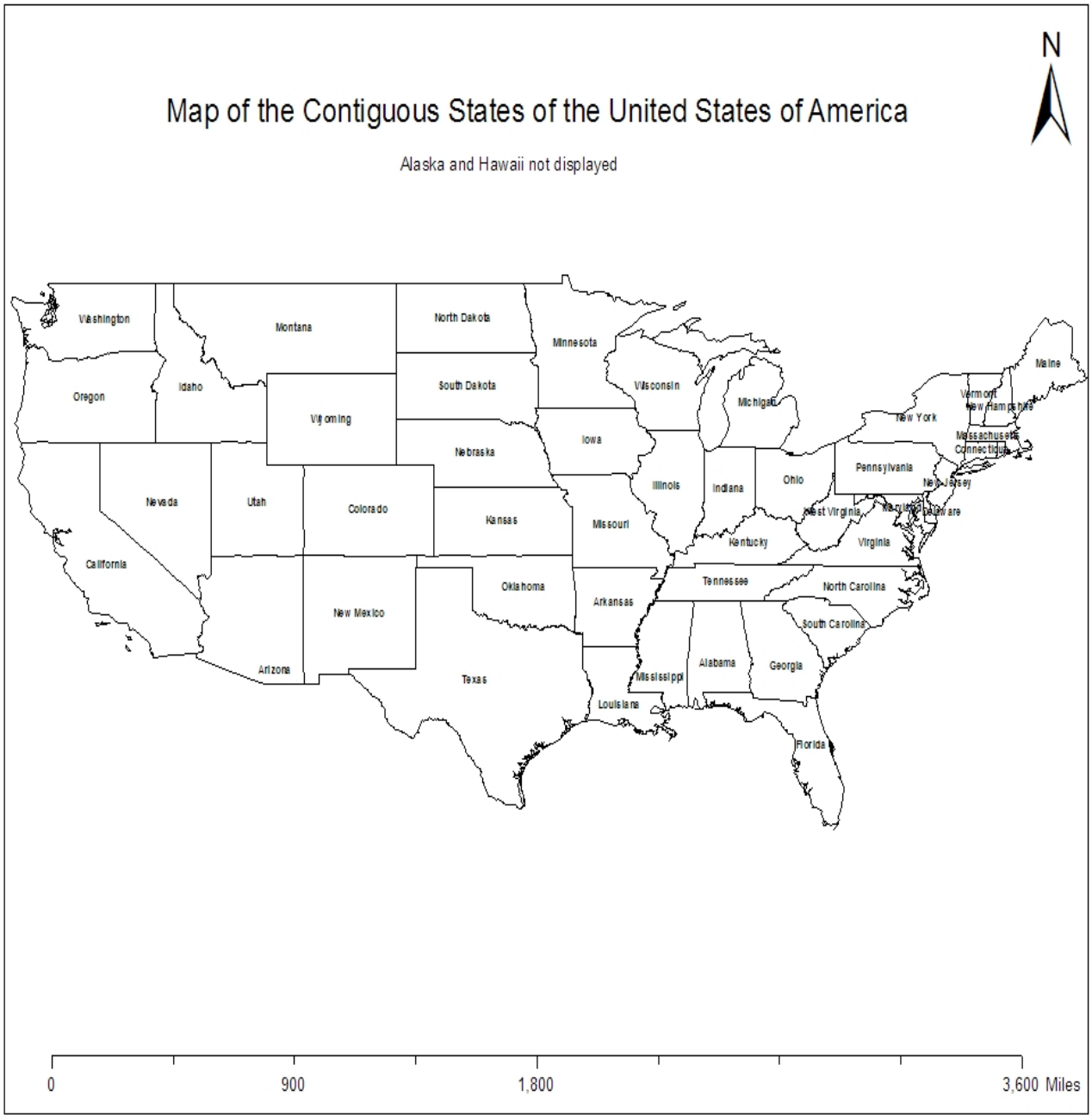
**VS FORM 7-1 (Reverse)**

# Appendix VII:

**Pseudorabies Stage V Status States & Territories**

| Stage V | Year Achieved | Stage V | Year Achieved |
|---|---|---|---|
| Alabama | 1997 | Nebraska | 2003 |
| Alaska | 1993 | Nevada | 1995 |
| Arizona | 1997 | New Hampshire | 1996 |
| Arkansas | 2000 | New Jersey | 2003 |
| California | 2001 | New Mexico | 1994 |
| Colorado | 1996 | New York | 1996 |
| Connecticut | 1993 | North Carolina | 2000 |
| Delaware | 1995 | North Dakota | 1994 |
| Florida | 2004 | Ohio | 2000 |
| Georgia | 1999 | Oklahoma | 2000 |
| Hawaii | 1998 | Oregon | 1995 |
| Idaho | 1996 | Pennsylvania | 2004 |
| Illinois | 2002 | Puerto Rico | 1997 |
| Indiana | 2002 | Rhode Island | 2000 |
| Iowa | 2004 | South Carolina | 1995 |
| Kansas | 1999 | South Dakota | 2003 |
| Kentucky | 1997 | Tennessee | 2002 |
| Louisiana | 2003 | Texas | 2004 |
| Maine | 1991 | US Virgin IS | 1997 |
| Maryland | 1996 | Utah | 1992 |
| Massachusetts | 1998 | Vermont | 1995 |
| Michigan | 2000 | Virginia | 1996 |
| Minnesota | 2003 | Washington | 1994 |
| Mississippi | 1996 | West Virginia | 1996 |
| Missouri | 2000 | Wisconsin | 2000 |
| Montana | 1994 | Wyoming | 1993 |

# Appendix VIII:


Map of the Contiguous States of the United States of America
Alaska and Hawaii not displayed
N
Washington
Oregon
California
Idaho
Nevada
Montana
Wyoming
Utah
Arizona
Colorado
New Mexico
North Dakota
South Dakota
Nebraska
Kansas
Oklahoma
Texas
Minnesota
Iowa
Missouri
Arkansas
Louisiana
Wisconsin
Illinois
Michigan
Indiana
Ohio
Kentucky
Tennessee
Mississippi
Alabama
Georgia
Florida
South Carolina
North Carolina
Virginia
West Virginia
Pennsylvania
New York
Maryland
Delaware
New Jersey
Connecticut
Massachusetts
Vermont
New Hampshire
Maine
0
900
1,800
3,600 Miles

# Appendix IX:

National Pseudorabies Control Board
Checklist for Applying for Stage III, IV or V (Free)

1. State _____
2. Number of sows in State _____
   (National Agricultural Statistics Service – if different explain)

3. Number of infected herds in State _____
4. Twelve month period for which data is submitted_____
5. Test titer or reading considered positive _____
6. Surveillance (check system used)
   _____ (1) Herd testing
   a. Number of herds tested _____
   b. Number of sows/boars tested _____
   c. Percentage of sows/boars tested _____ (b/#2)
   d. Surveillance index _____ (b/#2)

   _____ (2) Slaughter or first-point (from this State only)
   a. Number of sows/boars tested as reported on VS Form 7-1
      In this State (section B, Column C_____
      In other States (section B, Column K)_____

      Total
      _____
   b. Percentage of sows/boars tested _____ (a/#2)
   c. Traceback percentage (data from VS form 7-1, Section C)

      Columns: D+E+F = W
      Unable to trace: Column H

      $$\frac{W}{H + W} = \text{Traceback \%}$$

   d. Surveillance index (% tested x traceback %) =
      _____

7. Explain the measures taken to make sure that the surveillance program is random and representative of all herds in the State.

## National Pseudorabies Control Board
## Checklist for Applying for Stage IV or V (Free) Status

(Revised September 1, 2005)

**State:_____** **Stage applied for:_____**

**Date submitted:_____**

**Twelve month period for which the data is submitted:_____**
(Data ending date should fall within 3 months of date submitted)

Certified lab used and screening test used for surveillance sampling:

Procedure(s) used for further testing of positive surveillance samples including cut-off values:

Number of breeding swine in state: (a)_____
(National Agricultural Statistics Service December Report Data- if different, explain)

Surveillance employed:

Slaughter/first point:

Number tested in-state: _____

Number tested in other states: _____
Total: (b)_____

**Percentage Tested:_____**
(Total tested (b) divided by number of breeding swine (a) times 100)

Positive samples traced: (c)_____
(Test required, no test required, and traced to sold out farms)

Positive samples not traced: (d)_____
(Unable to trace)

Total positive samples detected: (e)_____
((c) + (d))

**Traceback percentage:_____**
((c) divided by (e) times 100)

**Surveillance index:_____**
(Percentage tested times the traceback percentage)

**If alternate surveillance is used please explain in narrative.**

Explain methods used to insure randomization of surveillance sampling of the State's breeding herd:

If large commercial production companies are excluded from the pool for surveillance purposes, explain:

1) How animals from these companies are excluded from market swine surveillance samples

2) What measures are used to assure that the swine within the production companies are tested in a statistically valid way for PRV infection

Describe the PRV vaccination policy or regulations within your state and present any available data on vaccine usage:

Describe any outbreaks of PRV confirmed in commercial or transitional herds, including measures taken for notification, trace-outs, further testing, and subsequent surveillance:

Other Comments/Narrative:

# Feral/Transitional Swine Management Plan

**State: _____ PRV Stage applied for:_____**

**Date submitted:_____**

**Please completely answer the questions below in a narrative or Q/A form to meet the requirements for submitting a Feral/Transitional Swine Management Plan for your state. Use N/A for those parts of the questionnaire that don't apply. States without feral swine need only certify that Wildlife Services and/or State Natural Resources Department personnel find that no feral swine exist within the state's borders, then exit the document.**

## Section 1-Feral Populations:

- Are there feral swine in the state?
  - If no, how did you determine? (Wildlife Services input, other surveillance) **You're finished!**
  - If yes, where are they relative to domestic swine production? *(include maps)*
  - What protection has the domestic industry taken to prevent contamination (fencing, trapping, population control, etc.)
- Describe the feral population:
  - Confined or free-roaming
  - Geographical distribution *(include maps)*
  - Natural barriers
- Surveillance of the feral population:
  - Describe surveillance conducted for *Brucella suis* and PRV infections and its results.
  - If results have been negative, how is the prevalence periodically rechecked?

## Section 2-Marketing/Commerce:

- How and where are commercial pigs marketed in the state?
- How and where are transitional pigs and feral pigs marketed?
- How are breeding animals and feeder swine **moved from** areas with feral swine?
- What are the separations between commercial production and transitional swine in non-slaughter marketing channels?
- Are transitional swine allowed to move from markets to slaughter only? If not, explain.
- Are feral swine captured for hunting preserves required to test negative for PRV and Brucellosis before moving interstate? What enforcement mechanisms are in place?

## Section 3-Verification/ Review/ Program Effectiveness:

- What legal, financial and personnel resources for feral pig control are identified and available?
- What interaction occurs with other agencies and groups (e.g. wildlife organizations, hunting groups)?
- What extra surveillance is conducted on transitional and commercial swine in high-risk areas?
  - What extra surveillance is conducted on at-risk commercial production herds marketing breeding and feeder swine?
  - What measures are taken to assure non-slaughter transitional swine are not in commerce?
- Have all transitional and commercial production swine outbreaks been explained and factors mitigated?
  - How were PRV and brucellosis outbreaks investigated?
  - What were the characteristics of the outbreaks?
  - Where did the infection spread?
  - What were results of genetic PRV virus characterization?
- What other evidence is available to support full application of your program?

## Glossary of Terms and Abbreviations-

**AASP** – American Association Swine Practitioners. See AASV.

**AASV** – American Association of Swine Veterinarians. Formerly known as the American Association of Swine Practitioners (AASP). It is the mission of the American Association of Swine Veterinarians to increase the knowledge of swine veterinarians by promoting the development and availability of the resources that enhance the effectiveness of professional activities; creating opportunities that inspire personal and professional growth; advocating science-based approaches to industry issues; encouraging personal and professional interaction; and, mentoring students, encouraging life-long careers as swine veterinarians. http://www.aasv.org/

**AAVLD** - American Association of Veterinary Laboratory Diagnosticians (AAVLD). AAVLD's mission is to disseminate information relating to the diagnosis of animal diseases; coordinate diagnostic activities of regulatory, research, and service laboratories; establish uniform diagnostic techniques; improve existing diagnostic techniques; develop new diagnostic techniques; establish accepted guidelines for the improvement of diagnostic laboratory organizations relative to personnel qualifications and facilities; and, act as a consultant to the United States Animal Health Association on uniform diagnostic criteria involved in regulatory animal disease programs. http://www.aavld.org/mc/page.do

**AFBF** - American Farm Bureau Federation (AFBF) - is the unified national voice of agriculture, working through grassroots organizations to enhance and strengthen the lives of rural Americans and to build strong, prosperous agricultural communities. http://www.fb.org/

**AHT** – Animal Health Technician

**ALA** – Automated Latex Agglutination

**APEP** – Accelerated Pseudorabies Eradication Program

**ARS** – USDA's Agricultural Research Service (ARS). ARS conducts research to develop and transfer solutions to agricultural problems of high national priority and provide information access and dissemination to ensure high-quality, safe food, and other agricultural products; assess the nutritional needs of Americans; sustain a competitive agricultural economy; enhance the natural resource base and the environment; and, provide economic opportunities for rural citizens, communities, and society as a whole. http://www.ars.usda.gov/main/main.htm

**AVIC** – Area Veterinarian in Charge

**CEAH** – USDA-APHIS Veterinary Services Centers for Epidemiology and Animal Health. The Centers for Epidemiology and Animal Health (CEAH) is a part of USDA-APHIS' Veterinary Services (VS) program. Within VS, CEAH is looked to for its innovation and teamwork in helping the U.S. agricultural community deal with challenging animal health issues. The multidisciplinary staff produces timely, factual information and knowledge about animal heath. CEAH is comprised of three centers. While each center has a specific focus, all three centers share resources with similar areas of expertise that all combine to meet the needs of VS and APHIS. CEAH is also the OIE Collaborating Center for Animal Disease Information Systems and Risk Analysis and is involved in various international activities. http://www.aphis.usda.gov/vs/ceah/

**CFR** – Code of Federal Regulations

**Cleanup** – A term used to describe procedures to eliminate PRV from swine herds. This elimination could be accomplished by depopulating all animals, testing and removing the positive animals, or segregat-

ing noninfected offspring and using these animals to replace infected breeding animals over time.

**Commercial Production Swine** – Commercial production swine, also called commercial swine, are swine continually managed and have adequate facilities and management practices to prevent exposure to either transitional or feral swine. Occasionally, the term domestic swine is used to define commercial swine in contrast to free-roaming swine. The term "commercial" has also been used to describe swine or operations that produce pigs for meat production in contrast to operations that produce breeding swine, which are also termed "seedstock."

**County Extension Education Director** – The Cooperative Extension System is a nationwide, non-credit educational network. Each U.S. State and Territory has a State office at its land-grant university and a network of local or regional offices. Cooperative State Research, Education, and Extension Service (CSREES) is the Federal partner in the Cooperative Extension System. The County Extension Education Director facilitates the implementation and distribution of these educational programs at the local level. http://www.csrees.usda.gov/

**CVB** – USDA-APHIS Veterinary Services' Center for Veterinary Biologics (CVB) regulates veterinary biologics (vaccines, bacterins, antisera, diagnostic kits, and other products of biological origin) to ensure that the veterinary biologics available for the diagnosis, prevention, and treatment of animal diseases are pure, safe, potent, and effective. http://www.aphis.usda.gov/animal_health/vet_biologics/

**ELISA** – Enzyme-Linked Immunosorbent Assay

**EMRS** – The Emergency Management Response System (EMRS) is a Web-based database used by Veterinary Services to manage and investigate animal disease outbreaks in the United States. The EMRS is also used for recording and reporting information acquired from conducting routine foreign animal disease and emerging disease incident investigations.

**FA** – Fluorescent Antibody

**FY** – Fiscal Year

**GDB** – Generic Database

gE, gB, gC, gD, gI, gG – All refer to various glycoproteins (g) contained within the virus envelope of the Herpes virion. Modifying the viral genome by deleting specific genes prevents expression of certain glycoproteins. This leads to reduction of virulence for vaccine production and also leads to creating diagnostic tests that differentiate antibody produced by swine exposed to vaccine strains versus field strains. Originally, these glycoproteins were designated by Roman numerals or by their molecular mass. Currently, this nomenclature has been replaced to maintain consistency when referring to glycoproteins of both animal and human Herpes viruses. This table summarizes current accepted versus former nomenclature:

| Current, Accepted | Former abbreviation |
|---|---|
| gE | gI |
| gB | gII |
| gC | gIII |
| gD | gp50 |
| gI | gp63 |
| gG | gX |

**Hog Cholera** – Hog Cholera (also known as Classical Swine Fever, or CSF) is a highly contagious viral septicemia affecting only swine.

**Hog Cholera Eradication** – The Hog Cholera Eradication Program was a national program that officially began in 1961 to eliminate hog cholera virus from U.S.

swine. On January 31, 1978, the Secretary of Agriculture declared the United States free of hog cholera.

**Kbp** – Kilobase Pairs

**LCI** – Livestock Conservation Institute. Currently the National Institute for Animal Agriculture (NIAA). See NIAA (below) for more information. http://www.animalagriculture.org/

**MLV** – Modified Live Virus

**NC** - Nucleocapsid

**NCAHP** - National Center for Animal Health Programs (NCAHP). NCAHP initiates, leads, coordinates, and facilitates national certification and eradication programs, which promote, ensure, and improve U.S. animal health by preventing, minimizing, or eradicating animal diseases of economic concern in light of constituent values. http://www.aphis.usda.gov/vs/nahps/

**NEPA** – The National Environmental Policy Act (NEPA) requires federal agencies to integrate environmental values into their decisionmaking processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions. To meet this requirement, Federal agencies prepare a detailed statement known as an Environmental Impact Statement (EIS). The Environmental Protection Agency reviews and comments on EISs prepared by other Federal agencies, maintains a national filing system for all EISs, and assures that its own actions comply with NEPA.

**NIAA** – National Institute for Animal Agriculture (NIAA), formerly the Livestock Conservation Institute (LCI). The mission of the NIAA is to provide a forum for building consensus and advancing solutions for animal agriculture and to provide continuing education and communication linkages to animal agriculture professionals. http://www.animalagriculture.org/

**NPB** – The National Pork Board (NPB) contributes to the success of all pork producers by managing issues related to research, education, and product promotion and by establishing U.S. pork as the preferred protein worldwide. http://www.pork.org/

**NPPC** – The National Pork Producers Council (NPPC) conducts public policy outreach on behalf of its 44 affiliated State association members, enhancing opportunities for the success of U.S. pork producers and other industry stakeholders by establishing the U.S. pork industry as a consistent and responsible supplier of high-quality pork to the domestic and world market. http://www.nppc.org/

**NVSL** – National Veterinary Services Laboratories (NVSL). A part of USDA-APHIS' Veterinary Services. NVSL serves as the national reference laboratory for a variety of domestic and foreign animal diseases. It provides other diagnostic laboratories with animal disease information and technical guidance and support. NVSL also serves as an international reference laboratory for specific animal diseases, including pseudorabies. http://www.aphis.usda.gov/vs/nvsl/

**OIE** - World Organisation for Animal Health (OIE). The objectives of the OIE are to ensure transparency in the global animal disease situation; collect, analyze and disseminate veterinary scientific information; provide expertise and encourage international solidarity in the control of animal diseases; safeguard world trade by publishing health standards for international trade in animals and animal products; and, provide a better guarantee of food animal origin and promote animal welfare through a science-based approach. http://www.oie.int/eng/en_index.htm

**PCFIA** – Particle Concentration Fluorescence Immunoassay®

**PDA** – Pennsylvania Department of Agriculture

**PRV** – Pseudorabies virus, Pseudorabies, Aujeszky's disease, Mad Itch, Infectious Bulbar Paralysis.

**R Allen Packer Heritage Room** - The R Allen Packer Heritage Room is a museum of historical veterinary medicine located at Iowa State University's College of Veterinary Medicine, in Ames, Iowa. George W. Beran, DVM, PhD, LHD, distinguished professor emeritus, is program director for the Veterinary Heritage Room. http://www.vetmed.iastate.edu/the_college/default.aspx?id=920

**SCWDS** - Southeastern Cooperative Wildlife Disease Study (SCWDS). The State-Federal cooperative structure of the SCWDS is the most cost-efficient means of providing high-quality wildlife disease expertise to State and Federal agencies responsible for the Nation's wildlife and domestic livestock resources. By sharing facilities, vehicles, scientific equipment, salaries, and other costs, each sponsoring agency has access to wildlife capabilities far more sophisticated and responsive than could be afforded individually. The SCWDS program does not duplicate the efforts of any existing State or Federal laboratory or agency; rather, it provides services of broad scope and high quality that otherwise would not be available. SCWDS is supported by 15 southeastern States and Puerto Rico, the Biological Resources Division of the U.S. Department of the Interior, and USDA-APHIS Veterinary Services (for consultation and surveillance on a national and international basis where diseases may interact among wildlife, domestic livestock, and poultry). In addition to the financial benefits of a cooperative approach, there are numerous other points of consideration. Wildlife disease problems are of mutual concern to a variety of people (i.e., wildlife managers, outdoor recreationists, farmers, landowners, veterinarians, and physicians). SCWDS serves as common ground where wildlife experts work hand-in-hand with private, State, and Federal authorities toward a common goal. http://www.uga.edu/scwds/

**SPF** – Specific Pathogen Free

**SVN** – Serum Virus Neutralization

**tk** – Thymidine kinase

**TS** – Technical Services

**UM&R** – Uniform Methods and Rules

**USAHA** – The United States Animal Health Association (USAHA), the Nation's animal health forum for over a century, is a science-based, non-profit, voluntary organization. Its 1,400 members are State and Federal animal health officials, national allied organizations, regional representatives, and individual members. USAHA works with State and Federal governments, universities, veterinarians, livestock producers, national livestock and poultry organizations, research scientists, the cooperative extension service, and seven foreign countries to control livestock diseases in the United States. USAHA represents all 50 states, 7 foreign countries, and 18 allied groups serving health, technical, and consumer markets. http://www.usaha.org/

**USDA, APHIS, VS** – United States Department of Agriculture, Animal Plant Health Inspection Service, Veterinary Services. The mission of USDA is to protect the health and value of American agriculture and natural resources. APHIS works in a variety of ways to protect and improve the health, quality, and marketability of our nation's animals, animal products, and veterinary biologics. http://www.aphis.usda.gov/animal_health/

**VMO** – Veterinary Medical Officer

**VS** – Veterinary Services (VS) – see USDA, APHIS, VS.

**WS** – USDA-APHIS' Wildlife Services (WS) provides Federal leadership and expertise to resolve wildlife conflicts and create a balance that allows people

and wildlife to coexist peacefully. Health and safety hazards can exist due to interactions between wildlife and humans (or other animals). WS works to prevent these types of hazards, such as aviation safety, wildlife diseases affecting animals or humans, and property damage and other similar threats in urban locations. WS frequently cooperates with land owners, resource managers, and the public to protect natural resources. These activities include projects to protect threatened and endangered animal/plant species, natural areas, game species, and other valued wildlife. http://www.aphis.usda.gov/wildlife_damage/