

SWINE HEALTH

Title: Assessment of the Economic Impact of Porcine Reproductive and Respiratory Syndrome Virus on U.S. Pork Producer - **NPB #10-158**

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INDUSTRY SUMMARY

An economic analysis published in 2005 estimated that productivity losses from clinical porcine reproductive and respiratory syndrome (PRRS) virus infections cost U.S. pork producers \$560 million dollars annually. Since the 2005 study, pig production and health strategies have evolved, PRRS virus control/elimination strategies have improved, and structural adjustments have occurred in the industry. Because of these developments, it was reasonable to question whether the incidence, severity, and/or impact of PRRS outbreaks on pig health and productivity in the U.S. herd may have changed since the 2005 study was conducted.

The primary objective of the 2011 study was to estimate the current economic impact of PRRS virus in the U.S., taking into account the noted changes in the industry. The secondary objective of the study was to conduct an economic analysis of PRRS virus elimination from a herd. The information obtained from this analysis will provide data useful for veterinarians and producers responsible for the control and/or elimination of PRRS virus at the herd, local, regional, and national levels and for use by decision makers responsible for the allocation of resources for swine health research. Furthermore, the information will help producers and veterinarians make better decisions when considering strategies to control or eliminate PRRS virus from individual herds.

To initiate the study, a review of the literature was done to collect all information available in the public domain on the economic impact of PRRS virus. Thereafter, data for the economic analysis was compiled from several sources: (1) swine health surveillance data collected by the USDA National Animal Health Monitoring System (NAHMS) from commercial U.S. pork producers; (2) a survey of swine veterinary experts on the incidence and impact of clinical PRRS on pig production efficiency; and (3) a survey of production records recorded during the period 2005 to 2010 from commercial farms with known PRRS virus status.

The economic impact of productivity losses attributed to PRRS virus was estimated separately for breeding and the growing pig herds. Other PRRS virus-related losses evaluated included veterinary costs and other costs that may be attributed to the disease, such as those associated with enhanced biosecurity and changes to pig flow to reduce the impact of PRRS.

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To manage the confounding effects of time post-outbreak on the analysis of productivity losses, breeding herds were categorized both by their current PRRS status and whether they had experienced a PRRS outbreak in the previous 12 months. That is, productivity and cost estimates were estimated in herds with outbreaks on a 12-month basis in order to capture the immediate effects of acute outbreaks on productivity, as well as the lingering, chronic effects of endemic PRRS. The PRRS herd classification definitions developed by the American Association of Swine Veterinarians (AASV) and the United States Department of Agriculture PRRS Coordinated Agricultural Program (PRRS-CAP) were used in categorizing herds. “PRRS virus-infected” breeding herds included herds that met the AASV/PRRS-CAP criteria for category I (positive unstable) or category II (positive stable) breeding herds. “PRRS virus-free” breeding herds included those that met the AASV/PRRS-CAP criteria for category III (provisional negative) or category IV (negative) herds. Once classified as PRRS virus-infected or PRRS virus-free using the AASV/PRRS-CAP criteria, herds were further categorized by whether they had an outbreak within the last 12 months. A herd was categorized as BH-A if it was PRRS virus-free, BH-B if it had experienced a PRRS outbreak within the last 12 months but was PRRS virus-free when the outbreak occurred, BH-C if it was PRRS virus-infected and had not experienced a PRRS outbreak in the previous 12 months or BH-D if it had experienced a PRRS outbreak within the last 12 months and was PRRS virus-infected when the outbreak occurred. The PRRS category assigned to a breeding herd may change over time.

Since most growing pigs in the U.S. are raised in groups, rather than in a continuous flow setting, a simpler means of categorizing growing pigs by their PRRS status was devised. Groups of growing pigs were stratified into three categories according to their PRRS status at placement and at the time of marketing. GP-A groups were PRRS negative at weaning and remained negative until marketing, GP-B groups were PRRS negative at weaning, but became infected sometime prior to marketing, and GP-C groups were PRRS positive at weaning and remained positive throughout the growing period.

Similar to the 2005 cost of PRRS study, a partial budgeting approach was utilized to determine the cost of productivity losses due to the disease in the U.S. industry. This approach had the advantage of producing a result that was directly comparable to the 2005 cost estimate. To avoid the effect of farm-to-farm variation in prices, capital expenditures, and variable input costs, standard values were used in the budgeting model.

The budgeting model was applied to each of the breeding herd categories (BH-A, B, C, D) using estimates for productivity measures obtained from the survey of production records. An estimate of the percent of breeding herds in each category was obtained from the expert opinion survey. For the breeding herd, a “CURRENT” scenario was defined as the average outcome for all four categories, weighted according to the percentage of swine breeding herds in each PRRS category. The “WO PRRS” scenario assumed 100 percent of breeding herds in the U.S. were in category BH-A (PRRS virus-free herds). A similar approach was applied to each of the growing pig herd categories (GP-A, B, C). Estimates of productivity measures obtained from the survey of production records for each growing pig herd category were used in the budgeting model. An estimate of the percent of groups of growing pigs in each category was obtained from the expert opinion survey. The CURRENT scenario was defined as the average outcome for all three categories weighted according to the percentage of groups of pigs in each category. The WO PRRS scenario assumed 100 percent of groups in the U.S. were in category GP-A (negative at placement and at closeout).

The total annual loss from PRRS in U.S. breeding herds was estimated at \$302.06 million, i.e., \$52.19 per breeding female or \$2.36 per pig weaned. The majority of the loss in the breeding herd was due to reduced revenue (\$300.4 million) resulting from weaning 8.3 million fewer pigs. Combining the losses in the breeding and growing pig herds resulted in 9.9 million fewer pigs, or 2.41 billion fewer pounds of pork (carcass weight), sold per year in the U.S. The estimated annual loss in the growing pig herd was \$361.8 million or \$62.52 per breeding female. As in the breeding herd, lost revenue of \$1.62 billion, rather than increased cost, was the primary source of losses attributed to PRRS. With PRRS, costs were lowered by \$1.25 billion because fewer pigs and pounds of pork were produced, thereby partially offsetting the lost revenue.

In summary, the present study estimated the total cost of PRRS in the U.S. national breeding and growing pig herd at \$664 million annually (\$1.8 million per day); an increase of approximately \$104 million from the \$560 million annual cost estimated in 2005. The 2011 study differed most significantly from the 2005 study in the allocation of losses between the breeding and the growing pig herd. Specifically, losses in the breeding herd accounted for 12% of the total cost of PRRS in the 2005 study compared to 45% in the current analysis. Differences between the 2005 and the 2011 studies may be attributed to changes in the prevalence of PRRS virus and incidence of outbreaks, production and animal health management practices, inflation and other pathogens that have emerged since 2005 such as porcine circovirus type 2 (PCV2).

In addition, information on veterinary costs, biosecurity costs, and other costs from the survey of expert opinion were used to estimate an annual costs attributed to PRRS virus. The additional veterinary costs were estimated to be \$140.11 million annually. The annual biosecurity and other outbreak related costs attributed to PRRS were estimated to be \$191.86 million and \$145.82 million, respectively. The total additional costs attributed to PRRS for veterinary, biosecurity and other outbreak related costs were \$477.79 million annually.

A substantial number of U.S. swine farms are currently PRRS virus-free. Based on October 1, 2010 data, it was estimated that 28 percent of the breeding females in the U.S. were in PRRS virus-free herds (BH-A). Forty-two percent of all breeding females were in herds that had a PRRS outbreak in the 12 months prior to October 1, 2010 (BH-B and BH-D), 6 percent were PRRS virus-free before the outbreak (BH-B) and 36 percent PRRS virus-infected before the outbreak (BH-D).

For the year ending October 1, 2010, 60 percent of weaned pigs in the U.S. were estimated to be negative at placement, 25 percent were negative at weaning and remained negative through marketing (GP-A) and 35 were negative at weaning but became infected before they were marketed (GP-B). Forty percent of weaned pigs were positive at placement (GP-C). Of the pigs that were negative at placement, 58 percent were infected before they were marketed.

In breeding herds that had an outbreak, productivity and economic losses in the 12 months after the outbreak were greater when the herd was PRRS virus-free before the outbreak compared to those that were PRRS virus-infected. The timing of infection in growing pigs affects how the pigs performed. Productivity was better in groups of growing pigs that were infected after weaning (GP-B) than those infected before (GP-C).

A net present value (NPV) analysis was performed to evaluate PRRS virus elimination from individual herds. The NPV analysis conducted for this study is the first analysis of which the authors are aware that accounts for the more severe negative production and economic consequences of a PRRS outbreak when a PRRS virus-free herd becomes reinfected. Two approaches to eliminating PRRS virus from a herd were evaluated: (1) complete depopulation and repopulation (CDR) of the herd with PRRS virus-free breeding animals and (2) herd closure and rollover (HCR). When HCR was the method of elimination, the time herds needed to remain PRRS virus-free to break even on the cost of elimination ranged from 4 months to 26 months. When CDR was the method of elimination, the time herds needed to remain PRRS virus-free to break even ranged from 18 to 83 months.

KEYWORDS

Swine, PRRS, economic analysis, partial budget

SCIENTIFIC ABSTRACT

An economic analysis published in 2005 estimated that productivity losses from clinical porcine reproductive and respiratory syndrome (PRRS) virus infections cost U.S. pork producers \$560 million dollars annually. Since the 2005 study, pig production and health strategies have evolved, PRRS virus control/elimination strategies have improved, and structural adjustments have occurred in the industry. Because of these developments, it was reasonable to question whether the incidence, severity, and/or impact of PRRS outbreaks on pig health and productivity in the U.S. herd may have changed since the 2005 study was conducted.

The primary objective of the 2011 study was to estimate the current economic impact of PRRS virus in the U.S., taking into account the noted changes in the industry. The secondary objective of the study was to conduct an economic analysis of PRRS virus elimination from a herd. Similar to the 2005 cost of PRRS study, a budgeting approach was utilized to determine the cost of productivity losses attributed to the disease. This approach had the advantage of producing results that were directly comparable to the 2005 cost estimate.

The economic impact of productivity losses attributed to PRRS was estimated separately for the U.S. breeding herd and the growing pig herd. The primary source for estimates of productivity losses due to PRRS was a survey of production performance records from a sample of U.S. commercial farms with known PRRS status. Breeding herds were categorized according to their PRRS status and whether they experienced a PRRS outbreak in the previous 12 months. Herds categorized as BH-A were PRRS virus-free. BH-B herds had experienced a PRRS outbreak within the last 12 months, but were PRRS virus-free before the outbreak. BH-C herds PRRS virus-infected, but had not experienced a PRRS outbreak for at least 12 months. BH-D herds had experienced a PRRS outbreak within the last 12 months and were PRRS virus-infected before the outbreak. The PRRS category assigned to a breeding herd may change over time. Groups of growing pig were placed into three categories defined by their PRRS status at placement and marketing. GP-A groups were PRRS negative at weaning and remained negative until marketing, GP-B: groups were PRRS negative at weaning, but became infected sometime prior to marketing. GP-C groups were PRRS positive at weaning and remained positive throughout the growing period.

Monthly production measures from the survey of production performance records in the breeding herd were analyzed using linear mixed models. PRRS category, month, and year were used as fixed effects. Farm and production system were included as random effects in models to account for the correlated structure of monthly data within each farm and production system. Each of the productivity measures in the growing pig data were also analyzed using linear mixed models and farm and production system were included as random effects to account for the correlated structure of group closeout data within each farm and production system. The least squares mean estimates of the productivity measures from the statistical analysis of the production records survey were used in the budgeting model. The estimates were made for each PRRS category in the breeding herd (BH-A, B, C, and D) and growing pig herd (GP-A, B, and C).

Other costs evaluated included veterinary expenditures, costs related to enhanced biosecurity, and costs related to management changes implemented to reduce the impact of PRRS. The data for the analysis was obtained from three sources: (1) swine health surveillance data collected by the USDA National Animal Health Monitoring System (NAHMS) from commercial U.S. pork producers; (2) a survey of swine veterinary experts on the incidence and impact of clinical PRRS on pig production efficiency; and (3) a survey of production records recorded during the period 2005 to 2010 from commercial farms with known PRRS virus status.

The total cost of PRRS in the U.S. pork industry due to the combined losses in productivity in the breeding and growing pig herds was estimated to be \$664 million annually. Compared to the \$560 million annual cost estimated in 2005, this represents an increase of approximately \$104 million dollars annually. The 2011 study differed most significantly from the 2005 study in the allocation of losses between the breeding and the growing pig herd. Specifically, losses in the breeding herd accounted for 12% of the total cost of PRRS in the 2005 study compared to 45% in the current analysis. Differences between the 2005 and the 2011 studies may be attributed

to changes in the prevalence of PRRS virus and incidence of outbreaks, production and animal health management practices, influenza and other pathogens that have emerged since 2005 such as porcine circovirus type 2 (PCV2). The total additional costs attributed to PRRS for veterinary, biosecurity and other outbreak related costs were \$477.79 million annually.

A net present value (NPV) analysis was performed to evaluate PRRS virus elimination from individual herds. The NPV analysis conducted for this study is the first analysis of which the authors are aware that accounts for the more severe negative production and economic consequences of a PRRS outbreak when a PRRS virus-free herd is reinfected relative to the consequences had the herd remained PRRS virus-infected. Two approaches to eliminating PRRS virus from a herd were evaluated; (1) complete depopulation and repopulation (CDR) of the herd with PRRS virus-free breeding animals and (2) herd closure and rollover (HCR). When HCR was the method of elimination the time breeding herds need to remain negative to break even on the cost of elimination ranged from 4 to 26 months. When CDR was the method of elimination, the minimum time to break even ranged from 18 to 83 months.

INTRODUCTION

PRRS virus was first recognized in the late 1980's in the United States.^{1,2} Disease impacts included dramatic reproductive losses, increased pneumonia and reduced pig growth.³ At about the same time, a similar disease was spreading across the European swine industry.⁴⁻⁸ By the late 1980's to early 1990's, outbreaks had been documented in Asia and Taiwan and later the disease was confirmed in Poland and the Czech Republic.⁹⁻¹¹ Retrospective studies using archived serum samples confirmed these findings. Serum samples collected in 1980 in Canada were PRRS antibody positive.¹² Serum samples collected from Iowa pigs in 1980 were free of PRRS antibodies though samples collected in 1985 were positive.¹³ The disease appeared to have spread throughout the global swine production industry within a relatively short period of time.

Clinical outbreaks and long-term effects of PRRS are highly variable, but the clinical picture described in 1991 is still accurate: In the breeding herd, initial signs are variable, but may include anorexia, fever, and cyanosis.¹⁴ This may be followed by acute mortality in sows (1 to 2%), late term abortions (1 to 2%), premature farrowings (1 to 20%), farrowing of litters with a combination of live, dead, and mummified piglets, and increased variation in service and farrowing intervals. During the height of an acute outbreak, more than half of the farrowings may be affected. Infected boars may be lethargic, but often show few overt clinical signs. Semen quality may decline temporarily. In piglets, increased pre-weaning mortality (10 to 40%) and secondary infections are common. Mortality often increases in grower/finishers, nearly always in conjunction with other respiratory infections. Slower growth rates, non-uniform performance, and persistent respiratory disease with secondary infections are common sequelae in populations of growing pigs. Cumulatively, PRRS may reduce the annual production of the herd by 15%.¹⁴

Quantifying the cost of swine diseases is an integral component in the development of strategies for their control or elimination at the individual pig, farm, or industry level. However, techniques for assigning cost to a disease and that effectively control for the variable contribution of co-factors such as management skill of the caretaker, the presence of other concurrent diseases, seasonal changes in disease incidence and severity, pathogen virulence, host genetics, and others are not well established. Further difficulties in establishing the cost of a particular disease at an industry or national level are introduced by the macroeconomic effects that occur due to changes in pork supply as a result disease-related pig mortality, changes to slaughter weight, or decreased demand for pork by consumers perceiving pork meat to be less desirable during major disease events.¹⁵ A recent example of this situation is the 2009 global pandemic of influenza in which U.S. pork producers were estimated to have lost \$5-20 per head marketed as a result of the consumer's unwarranted lack of confidence in the safety of the pork supply.^a The scientific literature does include reports of modeling efforts that compare the effectiveness of proposed disease control strategies but these reports generally focus on limiting further spread of the disease without reference to the actual cost of the disease before control strategies are initiated.^{16,17}

In perhaps the earliest economic analysis of PRRS, Dykhuizen et al. (1991) reported losses in herds infected for 3 months constituted 6 to 8% of gross returns (minus feed costs) per month of outbreak. However, Dykhuizen et al. (1991) conceded that not all losses were included in the estimate. Shortly thereafter, Hoefling (1992) reported an acute PRRS breeding herd outbreak in four Illinois herds to cost \$100, \$170, \$428, and \$510 per breeding female, respectively. These estimates were based upon the decreased production of weaned pigs and increased treatment costs. Polson et al. (1992) described a 4-month outbreak in a 250-sow herd in Minnesota and estimated the cost at \$236 per breeding female for the year of outbreak. The losses consisted primarily of lost opportunity for revenues on 966 pigs that would have been produced had the herd performed at the baseline productivity levels of the previous 3 years. This loss represented a reduction of 3.8 pigs weaned per female per year and translated into a decrease in profits of \$59,781 for the operation for the year of the outbreak or a decrease in profit per hundredweight of \$9.42. Dee et al. (1997) documented losses averaging \$228 per sow

^a EVERSON, CARLY. (2009, May 6). Hog farmers brace for financial pain of swine flu The Free Library. (2009). Retrieved March 01, 2011 from [http://www.thefreelibrary.com/Hog farmers brace for financial pain of swine flu-a01611861720](http://www.thefreelibrary.com/Hog+farmers+brace+for+financial+pain+of+swine+flu-a01611861720).

over a 12-month period due to elevated mortality rates, reduced growth rates, and increased medication and vaccination costs.

Schafer and Morrison (2007) evaluated productivity in 15 multiplication sow herds (500 to 1200 sows per site) undergoing "herd closure" for elimination of PRRS virus. These herds reported an average of 686 more pigs weaned per herd for the 52 weeks post closure compared to the 52 weeks prior to closure. However, the authors did not describe the number or type (clinical vs. subclinical) of PRRS outbreaks in these herds prior to closure. Thus, the study did not produce an estimate of the cost of PRRS, rather it suggested that productivity can be improved in the absence of PRRS and maintained during the course of PRRS virus elimination.

In growing pigs, PRRS virus affects both growth performance and the rate of clinical disease. However, it is difficult to separate the impact of PRRS virus from other infectious agents and/or the synergism between them in the field. Kerkaert et al. (1994) reported a 70% loss in profits in a feeder pig operation due to endemic PRRS virus infection in the nursery. A reduction in over \$5.00 per pig was attributed in the nursery stage alone due to decreased growth rates, increased feed conversion, and increased mortality. Using a financial model, Polson et al. (1994) estimated that the difference between affected and non-affected nursery pigs ranged from \$0.73 to \$18.21 per head. Dee and Joo (1994) estimated the cost of an endemic PRRS nursery problem in a 600 sow herd at \$225 per sow per year (\$10.50–\$12.50 per pig marketed). This cost estimate was based on 10% nursery mortality, a 50% reduction in average daily gain, and a 33% rate of non-marketable pigs. Based upon productivity levels in herds that had successfully eliminated PRRS virus by nursery depopulation, Dee and Joo (1993) estimated an increase of 14 to 30 days in the finishing stage attributable to PRRS virus in combination with secondary bacterial agents and an additional cost of \$7.50 to \$15.00 per pig marketed due to reduction in growth rates, increased mortality, and increased numbers of non-marketable pigs associated with PRRS virus infection.

In addition to lost production, the impact of PRRS on animal health costs can be dramatic. Expenses associated with prevention and treatment of secondary infections increased 60% during the 12 months following an outbreak of PRRS in a 2700 sow operation in Poland.¹⁸ During the peak of the outbreak, the animal health costs were four times higher than prior to the PRRS infection and a year after the outbreak this parameter had not returned to pre-PRRS levels.

The largest cost component in pork production is feed and the cost of feed is a major player in any economic analysis of the cost of PRRS. It is traditionally stated that 70% of the cost of raising pigs in the U.S. is feed, with corn as the primary ingredient. Other grain prices rise in association with corn as acreage shifts create shortfalls of grains for other competing uses. Previously, the impact of PRRS virus on production efficiencies and cost of production were evaluated in the context of historic average market prices of both feed and hogs.¹⁹ Using the corn price of \$2.25/bu (\$0.088/kg), Neumann et al. (2005) estimated the economic effect of PRRS aggregated across the national herd, the impact of PRRS was estimated at \$561.89 million, with \$45.39 million in the sow herd, \$229.64 million in the nursery herd and \$286.86 million in grow-finisher populations. Johnson et al. (2007) evaluated the impact of feed costs on PRRS losses and determined that every \$0.50/bu (\$0.020/kg) increase in corn price resulted in an increase of \$18.52 million per year in the cost of PRRS to the US pork industry. At the highest corn price utilized in the analysis (\$5.00/bu), the cost of PRRS to U.S. producers rose to \$686.77 million per year.

Porcine reproductive and respiratory syndrome (PRRS) virus has remained a globally important pathogen of pigs since it was first identified in 1991 and productivity losses associated with the disease have had a significant negative impact on the competitive position of the U.S. pork industry. An economic analysis of the impact of PRRS on the U.S. pork production industry published in 2005 estimated the disease cost producers \$560 million dollars annually¹⁹. However, since that time a number of changes have occurred in the industry. Pork production strategies have evolved and PRRS virus control/elimination strategies have changed. In the 2006 National Animal Health Monitoring System (NAHMS) survey of pork production operations, PRRS was the disease most frequently diagnosed in breeding herds, nursery pigs, and grow-finish production sites (Figure

1) and revealed striking increases in the occurrence of PRRS in all phases of production when compared to a similar NAHMS study conducted in 2000 (Figure 2).

In order to account for these industry changes and to provide updated information on the economic impact of PRRS, National Pork Board funded a study in 2011 with the primary objective of estimating the current annual economic effect of PRRS on the United States swine industry. A secondary objective of the study was to conduct an economic analysis of PRRS virus elimination from a herd. Information obtained from this study will provide data useful for veterinarians and producers responsible in development of strategies to control and/or eliminate PRRS virus at the herd, local, regional, and national levels. Furthermore, information from the study will be useful in ensuring appropriate allocation of resources to be invested in swine health research in the future.

METHODS

The economic impact of PRRS virus was estimated separately for the U.S. national breeding and growing pig herds. Costs evaluated included those arising from productivity losses, veterinary expenses, implementation of enhanced biosecurity measures, and changes to pig management implemented to reduce the impact of PRRS on other diseases. Data for the analysis was obtained from three sources: (1) swine health surveillance data collected from commercial U.S. pork producers by the USDA National Animal Health Monitoring System (NAHMS) during 2005 to 2006; (2) a survey of experts (full time clinical swine veterinarians) conducted in 2011 to ascertain their opinions on the incidence of PRRS infection and its impact pig production efficiency; and (3) 2005 to 2010 production records from a sample of commercial farms with known PRRS virus status.

NAHMS data

The USDA National Animal Health Monitoring System (NAHMS) system is designed to periodically provide high-quality, statistically-valid data on U.S. livestock production. The most recent surveys of pig producers were done in 2000 and 2006. The NAHMS survey results provided information for the breeding, gestation, and farrowing phases along with information on the nursery and the finishing phases. Among the data collected was information on pig herd health (including PRRS). The NAHMS survey provided estimates of the percent of sows, pigs, and farms infected with PRRS virus used to help aggregate farm-level estimates of the cost of PRRS to an industry-level.

Survey of expert opinion

Fifty-nine swine veterinary experts, selected by purposive sampling from the membership of the American Association of Swine Veterinarians, were surveyed to obtain subjective data on the incidence, severity, and cost of PRRS on U.S. swine farms. All experts were either employed by commercial swine production systems or by specialty swine veterinary practices that provided services to large production systems, as well as independent producers. This group of experts was selected to ensure that swine herds in various geographic locations of the U.S. were represented in their survey responses.

Experts supplied information based on experience with their own client herds. Care was taken to avoid duplicate information being reported in those instances where more than one veterinarian provided services to a given farm or production system. Information supplied by the experts included population sizes by region, and PRRS status of breeding and growing pig herds. Experts were asked to provide information on the impact of PRRS on measures of pig productivity, e.g., pigs born alive per litter farrowed, mortality rates, pigs weaned, average daily gain, feed efficiency, percent of pigs sold in primary market, and the impact of PRRS on cost-related variables such as veterinary costs, biosecurity costs, and other costs incurred during and after an outbreak due to changes in pig flow, stocking and movement changes, more intensive care of pigs, and production and contract penalties. Survey responses that required quantitative answers were reported as numeric ranges rather than point estimates. Experts were asked to stratify their responses by geographic region,

particularly with regard to their estimates of the percentage of breeding females and growing pigs in each PRRS category that had been previously defined for this study (Tables 2 and 3). The complete survey instrument used in the study is included in Appendix 1.

Production records from commercial farms

Breeding herd data

Estimates of productivity losses due to PRRS were derived from an analysis of farm production records collected from a convenience sample of U.S. commercial farms with known PRRS status. During 2011, monthly production data from 80 breeding herds was collected retrospectively for the period beginning January 1, 2005 and ending December 31, 2010. Seventy-two months of data were requested for each farm with at least 24 consecutive months of data required in order to be included in the study. The PRRS virus status (PRRS virus-infected or PRRS virus-free) of each herd in the study and dates of key events that changed their PRRS status (e.g. a PRRS outbreak, completion of PRRS virus elimination by herd closure and rollover, complete depopulation and repopulation, etc) was established. The 80 breeding herds sampled for this study purposively represented farms of various sizes and geographic regions. Geographic identity was defined using USDA's official farm production regions: (1) East (Appalachian, Delta, Northeast, Southeast), (2) Midwest (Cornbelt, Lake States) and, (3) West (Northern Plains, Pacific Northwest, Southern Plains, Mountain). Breeding herd productivity measures for which data was collected included pigs born alive per litter farrowed (BA), litters per mated female per year (LFY), pre-weaning mortality (PWM), breeding female death rate (BDR) and, breeding female cull rate (BCR). Information on veterinary costs, including pharmaceutical, immunization and diagnostics costs was recorded for each breeding herd when available.

To capture the temporal influence of "time since PRRS infection" on production losses due to the disease, the infection status of each breeding herd was established for each monthly recording period. A two-stage classification system was developed based on standard categories defined by the American Association of Swine Veterinarians (AASV) and the United States Department of Agriculture PRRS Coordinated Agricultural Program (PRRS-CAP).²⁰ Under this system, PRRS virus-infected breeding herds are classified as Category I (positive unstable) or Category II (positive stable) breeding herds. PRRS virus-free herds are classified as either Category III (provisional negative) or Category IV (negative) breeding herds (Table 1). Breeding herds were then further categorized according to changes (if any) in their PRRS status during the previous 12 months: Category III or IV herds were categorized as "BH-A" herds, Category I or II herds that had experienced a PRRS outbreak within the last 12 months but were PRRS virus-free prior to that time were categorized as "BH-B" herds, Category I or II herds that had not experienced a PRRS (re)outbreak for at least 12 months were categorized as "BH-C" herds, and Category I or II herds that had experienced a PRRS (re)outbreak within the last 12 months and were PRRS virus-infected before the (re)outbreak were categorized as "BH-D" herds (Table 2). For herds that experienced outbreaks (BH-B and BH-D), productivity was analyzed and PRRS costs were estimated for a 12-month period following the outbreak to capture both the immediate effects of acute outbreaks on productivity and lingering (chronic) effects.

In breeding herds, profitability is highly correlated with the number of pigs weaned per mated female per year (PFY).²¹ Pigs weaned per mated female per year, when multiplied by the number of breeding females in a herd, yields the total number of pigs weaned annually. From this information, the amount of revenue generated by the herd can be estimated. By comparison, are nearly entirely fixed or determined by the number of breeding females. That is, costs of carrying a breeding female in the farm inventory do not vary with her individual level of productivity. Pigs weaned per mated female per year is calculated as follows:

$$PFY = LFY * BA * (1 - PWM) \quad (\text{Equation 1})$$

Rather than directly obtaining PFY from the production records, data on LFY, BA and PWM were extracted then used to calculate PFY as this allowed the relative effect of PRRS on each of its constituent factors to be

determined. Data on BDR and BCR were also collected to determine the effect of PRRS on a farm's culling practices, a management decision which has a direct effect on the cost of female replacements for breeding. When culling and mortality information were provided as monthly count data, annualized cull and death rates were calculated by dividing the count data by the female inventory then multiplying by 12 months. In those instances whereby cull rates exceeded 200% (a situation suggesting rapid, planned depopulation events), data was excluded from BDR and BCR analyses. Data for 3,963 monthly observations were included in the analysis.

Growing pig herd data

Data on growing pigs were obtained through a convenience sampling of groups of growing pigs where the PRRS status was known at both placement and marketing. Only those groups managed as all-in-all-out cohorts were included in the study. Study groups included both wean-to-finish production systems and only those multi-site production systems (having separate nursery and finisher sites) whereby group integrity was maintained between the sites. Performance data were obtained from 639 groups with a marketing close-out date between January 1, 2005 and December 31, 2010. The minimum data required in order for a group to be included in the study were wean-to-finish average daily gain (ADG), feed conversion rate (FCR), percent of pigs sold in the primary market (PMP), and mortality (MOR). Information on veterinary costs (pharmaceutical, immunization, and diagnostics testing costs) was also collected from groups when available.

Groups of growing pig were classified into one of three PRRS categories according to their PRRS status at time of placement (weaning) and at time of marketing close-out: "GP-A" groups were those known to be PRRS negative at weaning and remained negative until marketing, "GP-B" groups were those known to be PRRS negative at weaning but became infected sometime prior to marketing close-out, and "GP-C" groups were those known to be PRRS positive at weaning and remained positive throughout the growing period (Table 3).

Statistical analysis of production data

Using the monthly breeding herd data extracted from the farm production records, each of the breeding herd productivity measures (BA, LFY, PWM, BCR and BDR) were analyzed as response variables in separate linear mixed models^b. The predictor variables of PRRS category, month, and year were modeled as fixed effects; "farm" and "production system" were included as random effects to account for the correlation between these two nested variables. Similarly, each of the productivity measures in the growing pig data (ADG, FCR, PMP and MOR) were analyzed as the response variable in separate linear mixed models. PRRS category, month and year were modeled as fixed effects and farm and production system were again included as random effects in the models. For both the breeding herd and growing pig data, differences in mean response values for each PRRS category were compared using a t-test with Tukey-Kramer's adjustment to *p*-values for multiple testing. *P*-values ≤ 0.05 were considered significant.

Economic analysis of productivity losses due to PRRS virus in U.S.

Similar to the cost of PRRS study completed in 2005, a partial budgeting approach was utilized to determine the total cost of productivity losses due to the disease in the U.S. industry. This approach had the advantage of producing a result that was directly comparable to the 2005 cost estimate. To avoid the effect of farm-to-farm variation in prices, capital expenditures, and variable input costs, standard values were used in the budgeting model. Fixed costs of production were defined as costs that were incurred regardless of the scale of production. Fixed costs included expenditures for capital inputs (e.g. breeding stock, equipment, and buildings). In general, fixed costs are not significantly impacted by the occurrence of a disease. An exception to this occurs when the fixed costs associated with purchase of replacement breeding females increases as a result of increases in breeding female cull or death rates. Variable costs of production include those that change as the scale of

^b PROC MIXED, SAS 9.2, SAS Institute Inc, Cary, NC.

production changes. Some variable costs, such as those for veterinary costs (vaccines, antimicrobials, and diagnostic testing costs), are likely to increase as a result of disease. However, some variable costs may decline in the face of a disease outbreak (e.g. an increase in mortality rate is likely to result in lower total feed costs) and others may remain unchanged (e.g. breeding herd feed costs may remain unchanged in the face of a disease outbreak as long as the breeding herd inventory remains unchanged). The effect of disease on revenue is however, much more predictable as it is determined largely by the number of pigs weaned (or pounds of pork produced) and their market value. Disease will nearly always reduce farm revenue because of its impact on reproductive performance, mortality, and growth performance of growing pigs.

The budgeting model was applied to each of the breeding herd categories (BH-A, B, C, and D) using estimates for productivity measures obtained from the survey of production records. Productivity measures that were used in the budgeting model were derived from the analysis of herd production records. For breeding herds in each PRRS category, BA, LFY, PWM, BCR, and BDR were used. An estimate of the percentage of the swine breeding herds in each category was obtained from the expert opinion survey. For the breeding herd, a “CURRENT” scenario was defined as the average outcome for all four categories, weighted according to the percentage of swine breeding herds in each category. The “WO PRRS” scenario assumed 100 percent of breeding herds were in category BH-A (PRRS virus-free).

The same approach was applied to each of the growing pig herd categories (GP-A, B, and C). For growing pigs in each PRRS category, estimates of ADG, FCR, PMP and MOR were obtained from the survey of production records. An estimate of the percentage of the groups of growing pigs in each category was obtained from the expert opinion survey. The CURRENT scenario was defined as the average outcome for all 3 categories weighted according to the percentage of groups of pigs in each category. The WO PRRS scenario assumed 100 percent of groups were in category GP-A (negative at placement and at closeout).

Input Parameters

To accurately estimate the herd-level cost of PRRS virus in the budgeting model, additional inputs beyond the biological measures of farm productivity described above were required; a summary of these inputs follows. The U.S. breeding female inventory was estimated to include 5,788,000 sows based on an average of the quarterly breeding herd inventories reported by the United State Department of Agriculture (USDA) for each year from 2005 to 2010.²² For the same time period the average number of pigs marketed annually in the U.S. was estimated to be 109,636,000 based on the average total annual slaughter across all plants (which included domestic production and pigs imported for feeding/slaughter).²³ An annual average of 3,345,902 pigs weighing less than 15 pounds were imported into the U.S. for feeding/slaughter during the period from 2005 to 2010.²⁴ Through use of a computerized optimization tool,^c it was determined that BA, LFY, and PWM should be adjusted downward by a factor of 0.9649 so that the number of pigs predicted to be weaned (in the budgeting model) plus the number imported from other countries, resulted in the correct number of pigs marketed as reported by USDA.

The weaned pig price used in the budgeting model was \$36.19 based on an average of weekly prices reported during the period from 2005 to 2010.²⁵ The market hog price used in the model was \$67.26 per pound of carcass weight based on the average of the monthly negotiated Iowa/Minnesota daily direct prior-day hog report (plant delivered) for 2005 to 2010.²⁶ Breeding herd feed costs in the budgeting model were based on use of a single breeding herd diet calculated as the weighted average cost of typical lactation and gestation diets. Similarly, feed costs for growing pigs was based on use of a single wean-to-finish diet calculated as the weighted average cost of a typical sequence of diets fed from weaning to market.^{27;28} Diet composition was typical for the Midwestern U.S. and in each case was broken into corn, soybean meal, distillers dried grains (DDG), and “other

^c Microsoft Excel “Goal Seek” (Microsoft Corp, Redmond WA, USA)

ingredients". The corn price used in the model diets was \$3.32 per bushel based on the average of monthly prices in Iowa from 2005 to 2010.²⁹ The soybean meal price used was \$265.84 per ton based on the average monthly price in central Illinois from 2005 to 2010.³⁰ The price for DDGs used in the budgeting model was \$114.06 per ton based on the average monthly price in central Illinois from 2005 to 2010.³⁰ The cost of "other ingredients" and diet processing were based on estimates published by Kansas State University.^{27:28}

Economic analysis of PRRS virus elimination from a herd

A net present value (NPV) analysis was performed to evaluate the cost of PRRS virus elimination from an individual farm. Two methods of PRRS virus elimination were evaluated: complete depopulation and repopulation (CDR) of the herd with PRRS virus-free breeding animals, and herd closure and rollover (HCR). Herd closure and rollover involves stopping the introduction of breeding replacements for a period of time followed by the entry of only PRRS virus-free animals and removal of breeding animals previously exposed to the virus. Both methods have proven highly successful for eliminating the PRRS virus from breeding herds.³¹ In addition to the direct cost associated with elimination of the virus, the analysis considered all the monthly costs and revenues associated with being PRRS virus-infected. To provide context in the analysis, an example breeding herd that consisted of 1000 breeding females and a growing pig population consistent with typical output from a breeding herd of that size was modeled. The analysis was conducted over a 120 month period. The key outcome of this analysis was determining the "breakeven point" or the time a breeding herd must remain PRRS virus-free after undertaking an elimination program in order to recover the financial investment in that elimination program. The breakeven point was defined as the point in time at which NPV reached or exceeded zero.

Breeding herd effects

To evaluate the benefit of elimination, an option where the virus was eliminated (ELIMINATION) was compared to a scenario where virus elimination was not completed and the herd remained endemically infected with PRRS virus (INFECTED). For both scenarios, it is important to consider that the PRRS category of the breeding herd would change over time. The PRRS category would be expected to change over several phases: (1) active PRRS virus elimination, (2) achievement of PRRS virus-free status, (3) post-outbreak, and (4) balance of the 10 year period based on ELIMINATION or INFECTED. For CDR and HCR, the active elimination phase was set at one and seven months respectively, as these are typical time periods required for each method of elimination.

As not all PRRS virus infected farms are in the same category when the decision is made to eliminate the virus, a breakeven analysis was conducted for example herds that started elimination as a BH-B, BH-D, or BH-C category. A summary of each of these examples, for both a CDR and HCR elimination strategy, is presented in **Table 4**. For the BH-B and BH-D examples, it was assumed that the active elimination phase began immediately after the outbreak occurred. The achievement of PRRS virus-free status phase begins at the point at which active elimination is completed and ends at the point when another (re)outbreak occurs. In the model, the duration of the achievement of PRRS virus-free status phase was varied to identify the time required to remain PRRS virus-free in order to breakeven on the investment made in PRRS virus elimination. During the return to PRRS virus-free status phase, the PRRS category of the breeding herd was defined as productivity level BH-A. The post-outbreak phase was set at 12 months for all examples during which time productivity level was defined as BH-B. The productivity level defined for the balance of the 10 year period phase varied based on the particular scenario that was being modeled. If the example herd started elimination as a BH-B or BH-D, it was assumed that the productivity level during the balance of the 10 year period phase was that of a BH-D herd. If the example herd started elimination as a BH-C, it was assumed that the productivity level during the balance of the 10 year period phase was that of a BH-C. The herd remained PRRS virus-infected for the balance of the 10 year period since only a single virus elimination project was evaluated for the 120 months.

Growing pig herd effects

By definition, PRRS virus-free breeding herds will only produce PRRS virus negative weaned pigs. However, PRRS virus-infected breeding herds, depending on various farm, management, and temporal factors, will produce both virus positive and virus negative groups of weaned pigs. Data was not available from the study to determine the frequency at which virus PRRS virus-infected breeding herds will produce virus negative groups of weaned pigs. As substantial differences in productivity are expected from virus positive and negative growing pigs, it was important to incorporate this into the PRRS virus elimination model. Several alternative scenarios were developed to investigate the effect of changes in the frequency of virus positive and virus negative weaned pig groups being produced under the different elimination conditions described above (Table 5). In the models, it was assumed that one-half of the groups of pigs that were negative at placement were still negative at marketing in order to reflect the occurrence of growing pig outbreaks due to horizontal introduction of the virus (i.e. weaned pig production was split evenly between GP-A and GP-B groups). To incorporate this in the model, whenever an example breeding herd is defined as PRRS virus-infected, three outcomes were created: (1) frequently weaned negative pigs, (2) occasionally weaned negative pigs, and (3) never weaned negative pigs. Breeding herds that had an outbreak within the previous 12 months (BH-B or BH-D herds) were believed to be less likely to wean groups of negative pigs. Therefore, BH-C breeding herds produced a higher proportion of weaned pig groups categorized as “frequently negative” and “occasionally negative” as compared to breeding herds of status BH-B or BH-D.

Costs and revenues for each combination of breeding herd PRRS category (and their respective allocation of PRRS negative and positive groups of growing pigs) were estimated. The partial budgeting model and estimated productivity losses used to conduct the economic analysis of productivity losses due to PRRS were used to estimate the annual costs and revenues for each example 1000 sow herd. Monthly costs and revenues were obtained by dividing the annual costs and revenues from the partial budgeting model by 12. Estimates of veterinary costs provided from the swine veterinary experts were also included in the total costs for the NPV analysis. The costs of elimination by the stated methods can be highly variable between farms and is highly dependent on how one chooses to manage and house replacement breeding females during the virus elimination program. To assess this, low and high cost options for each elimination strategy (CDR and HCR) were evaluated. Specific costs attributed to implementation of an elimination strategy included the value of residual depreciation that is forgone on early-culled replacement breeding females, additional costs of production (and interest) related to early purchase of replacement breeding females, facility and labor costs for off-site breeding projects or replacement breeding female development, additional veterinary costs, and forgone revenue in the event weaned pig production is temporarily reduced. The low and high cost estimates for a CDR and HCR were based on the experience of the authors and an informal survey of three swine veterinarians experienced in multiple elimination projects (Table 6).

RESULTS

A retrospective cross-sectional survey of United States swine farms was undertaken to estimate the economic burden of PRRS virus infection at the farm level. Production records from breeding herds and growing pig herds were convenience sampled from swine producers willing to participate in the study through provision of performance records and respond to a questionnaire. Using an economic model that standardized the cost of PRRS virus infection based on negative impacts on key farm performance indicators, the cost of the disease was determined for each farm in the study. National data was used to estimate the prevalence and incidence of PRRS virus infection in the country and this information, in combination with individual farm performance data and feed cost data, were analyzed to determine the annual cost of PRRS virus infection on the United States pig industry during the period from 2006 through 2010. This data was collected and reported in a manner consistent with a similar study conducted on data from 2003 to 2005 in order to facilitate comparative cost estimates between the two time periods.¹⁹

Survey of expert opinion

Twenty-six of 59 veterinarians (44%) responded to the request to provide expert opinions. The respondents provided veterinary services to a substantial part of the U.S. swine breeding herd. Sixty-nine percent of the veterinarians surveyed serviced client herds in the Midwest, while 31% serviced herds in the East, and 46% serviced herds in the West. The total figure equals more than 100% because some veterinarians serviced herds in more than one region. As shown in Table 7, the 26 respondents were responsible for the health of 2,339,800 breeding sows or approximately 46 percent of the breeding sows in the U.S. herd. The respondents accounted for 754,700 sows in the East, 1,075,800 sows in the Midwest, and 509,300 sows in the West.

The respondents were asked to estimate the proportion of breeding females, for which they provided veterinary services, in each of the four PRRS breeding herd categories (as of October 1, 2010). Of these, 28% were in the BH-A category, 6% were in the BH-B category, 30% were in the BH-C category, and 36% were in the BH-D category; Table 8 presents the data stratified by region. The Midwest region had the highest proportion of BH-A herds (32%) while the East had the lowest (19%). The Midwest region also had the highest proportion of BH-B herds (10%) while the East (2%) and West (3%) regions had only negligible numbers. BH-C herds were most prevalent in the East (36%) compared to the Midwest (29%) and West (21%) regions. The experts reported the West region as having the highest proportion of BH-D herds (48%) with the East (42%) and Midwest (25%) regions having somewhat fewer herds in the category.

Table 9 describes the level of productivity for breeding herds, by PRRS category, as estimated by the survey of swine veterinary experts. Productivity on BH-A farms represents the base level of output against which the productivity on BH-B, BH-C, and BH-D farms can be compared. The number of pigs born alive per litter on BH-A farms was 12.14. Of these, 11 percent died before reaching weaning age, or about 1.28 pigs per litter. The experts reported there were 2.36 litters farrowed per mated female per year and 22.18 pigs weaned per mated female per year. Veterinary costs were comprised of immunizations (\$1.35 per weaned pig), pharmaceuticals (\$0.59 per weaned pig), and diagnostic testing (\$0.14 per weaned pig).

Based on opinions expressed by the experts that were surveyed, PRRS has its greatest impact when introduced into a PRRS virus-free breeding herds (BH-B) (Table 9). A PRRS outbreak in a BH-B breeding herd can be expected to have the following effects on productivity: the number of pigs born alive per litter will be reduced by 1.55 pigs (13-14% decline), pre-weaning mortality will increase by 6%, litters farrowed per mated female per year will decrease by 0.27 (11-12% decrease), and veterinary costs (immunization costs, pharmaceutical costs, and diagnostic testing costs) will increase by \$0.56, \$0.56, and \$0.12 respectively, per pig weaned. Breeding herds that were PRRS virus-infected and experienced a (re)outbreak of PRRS (BH-D herds) generated losses that were less severe than those occurring in a BH-B herd. BH-C herds experienced an average decrease in the number of pigs born alive per litter of 0.91 pigs, pre-weaning mortality was 3% higher, litters farrowed per mated female per year decreased by 0.15 litters. Veterinary costs per pig were also higher.

Table 10 provides information on the number of growing pigs marketed, that are serviced by the 26 swine veterinary experts that responded to the survey. Twenty-five percent (10,601,820 pigs) of the growing pigs were PRRS negative throughout the grow/finishing phase(s), 35% (14,359,796 pigs) entered the growing phase negative and became infected with PRRS while 40 percent (16,535,009 pigs) of the pigs entered the growing phase PRRS positive. In total, 41,496,625 growing pigs, representing approximately 40% of growing pigs marketed annually in the U.S., were being serviced by the experts that responded to the survey.

Table 11 shows the proportion of grow-finish herds in each PRRS category by region, as estimated by the surveyed experts. The experts that responded provided veterinary services to 10,583,625 pigs in the East, 23,267,450 pigs in the Midwest and 7,645,550 in the West. The East had 12% GP-A pigs, the Midwest had 32% GP-A pigs, and the West had 25% GP-A pigs. Experts indicated that the Midwest had 46% GP-B pigs, while the West and East had 36% and 9% GP-B pigs, respectively. The East had the highest proportion of GP-C pigs (79%), while the West had 39% and the Midwest had 22%.

Table 12 provides information on the expected level of wean-to-finish production for a PRRS negative pig in the growing phase: mortality rate was 4 percent of the pigs placed, average daily gain per pig was 1.71 pound, pounds of feed per pound of gain was 2.54 pounds, 94 percent of the pigs were sold to the primary market, and veterinary costs per pig sold was \$2.67. Table 12 contrasts these numbers by providing information on the impact of PRRS on growing pig performance. For GP-C groups, mortality rate increased by 5 percentage points while GP-B groups had only a 3 percentage point increase in mortality. Average daily gain was negatively affected in PRRS positive pigs. GP-B groups gained 0.14 pounds per day less and GP-C groups gained 0.17 pounds per day less as compared to GP-A pigs. Feed conversion was also worse for the PRRS positive pigs. Pigs in GP-B groups required 0.11 more pounds of feed per pound of gain and pigs in GP-C groups required 0.12 more pounds of feed per pound of gain as compared GP-A groups. Veterinary costs were approximately 100 percent higher for both GP-B and GP-C groups than for GP-Z groups.

Survey respondents indicated that on average, the annual biosecurity costs attributable to PRRS were \$1.86 per pig sold. Other PRRS outbreak related costs were on average \$1.44 per pig sold. Other related costs include costs during and after the outbreak due to pig flow, stocking and pig movement changes, more intensive care of pigs, production contract penalties, etc. Information on the distribution of impacts of PRRS on biosecurity and other related costs are shown in Figures 3 and 4 respectively. Eleven of the 26 respondents indicated biosecurity costs increased from \$0.01-\$1.00 per pig sold. Six respondents indicated biosecurity costs increased by \$2.00-\$3.00 per pig sold. One respondent indicated that biosecurity increased by \$6.00-\$7.00 per pig sold. A wide distribution of responses is also shown for the other PRRS related outbreak costs. Again, one respondent indicated no impact, six respondents indicated an impact of \$0.01-\$0.50 per pig, seven indicated an impact of \$1.00-\$1.50 per pig, and one respondent indicated that other outbreak related costs increased by \$3.00-\$3.50 per pig marketed. The high response of a \$6.00-\$7.00 increase in biosecurity and a \$3.00-\$3.50 increase in other related outbreak costs was from the same respondent. For that respondent, the increase in costs was in the \$9.00-\$10.50 per pig sold range.

Analysis of production records

Data for 3,963 monthly observations from 80 enrolled breeding herds were included in the analysis. Based on the information provided, the PRRS category was determined for each month for which data was provided (based on the criteria described in Table 2). Forty-two of the 80 breeding herds were in the BH-A category for at least part of the time for which data was provided. Nineteen, 38 and 30 breeding herds were in BH-B, BH-C and BH-D category respectively for at least part of the time.

Breeding herds from 18 states were enrolled. Of the 80 herds enrolled, 6 (8%) were in the East, 61 (76%) were in the Midwest and 13 (16%) were in the West. The herd size ranged from 400 to 15,800 breeding females. Eight (10%) of the herds were smaller than 1000 sows, 33 (41%) were between 1000 and 3999 sows and 39 (49%) of the herds were 4000 sows or larger. The breeding herds represented 14 production systems (defined as operating under management of a common business entity) though not every breeding herd in the study was part of a coordinated production system.

The least squares means of the breeding herd productivity measures for each PRRS category are reported in Table 9. Values with different superscripts were significantly different at $p = 0.05$. In the absence of PRRS outbreaks, PRRS virus-free herds outperformed PRRS virus-infected herds. Productivity in herds as measured by BA and LFY was significantly better in BH-A herds as compared to BH-C herds. Productivity of herds as measured by BA, LFY, and PWM, was significantly better in BH-A herds as compared to herds classified as either BH-B or BH-D. The occurrence of outbreaks in both PRRS virus-free and PRRS virus-infected farms was detrimental. Herds categorized as BH-C herds performed significantly better for BA and PWM compared to herds classified as BH-B and BH-D. PRRS virus-free herds that had an outbreak performed worse in the 12 months subsequent to the outbreak than PRRS virus-infected herds that had a (re)outbreak. Productivity in herds as measured by BA and PWM was significantly worse in BH-B herds as compared to herds classified as BH-D.

Of the 639 groups of growing pigs enrolled in the study, 149 (23%) were categorized as GP-A, 243 (38%) as GP-B and 247 (39%) as GP-C. Groups of growing pigs from 3 states were enrolled. Most of the groups of pigs (594 groups; 93%) were from Iowa and Minnesota (Midwest study region). Forty-five groups (7%) were from Oklahoma in the West study region and no groups of growing pigs were enrolled from the East study region. Groups included in the study were marketed throughout the year with the fewest groups (45 groups) being marketed in each of April and in May and the most (68 groups) being marketed in November.

The least squares means of the growing pig productivity measures for each PRRS category are reported in Table 12. Groups of pigs classified as GP-A had significantly better ADG and MOR than groups classified as GP-B or GP-C. Pigs that were negative at placement and became positive later in the growing period had lower mortality than those that were positive at placement. Groups classified as GP-B had significantly better wean-to-finish mortality than groups classified as GP-C. FCR was numerically better for the groups classified as GP-B or GP-C compared to those classified as GP-A, but the difference was small and not statistically significant. PMP was numerically better for the groups classified as GP-A relative to GP-B or GP-C, but the difference was also small and not statistically significant.

Comparison of production records and survey of expert opinion

Productivity information obtained from the analysis of production records and provided by the expert opinions was similar. However, the estimated productivity losses due to PRRS were greater than those estimated from the production records. For example in BH-B herds, the number of pigs born alive per litter was 10.60 based on analysis of the production records and was 10.59 based on information provided by the experts (Table 9). For BH-C herds, the number of pigs born alive per litter was 11.20 based on analysis of the production records and was 11.23 based on information provided by the experts. The two estimates were also similar for the number of litters farrowed per mated female per year with the analysis of production records providing an estimate of 2.33 while the mean opinion of the experts was 2.09. Other measures of productivity showed more disparity when the two data sources were compared. The number of litters farrowed per female per year on BH-D herds was estimated by the experts to be 0.27 fewer than the BH-A herds while the records analysis suggested the difference was only 0.12 fewer.

Productivity levels of growing pig herds, as assessed by analysis of production records and as provided through expert opinion, were generally similar. However, as with the breeding herd productivity estimates, the extent of productivity losses due to PRRS based on expert opinion were greater than those losses estimated based on analysis of production records. For example, the mortality rate in GP-B growing herds was estimated to be 7.4 percent based on analysis of production records and 7.0 percent when based on expert opinion (Table 12). Similarly, the mortality rate for GP-C groups was estimated to be 9.3 percent when based on analysis of production records and 9.0 percent when based on expert opinion survey.

NAHMS

During 2000 and 2006, NAHMS conducted national surveys of the commercial swine production industry. In 2000, two surveys were completed. One survey covered the December 1999 to May 2000 time period while the second survey covered the June 2000 to November 2000 time period. In 2006, the first survey covered the period between December 2005 and May 2006 while the second survey covered the period from June 2006 to November 2006. Information was collected on a variety of items including if PRRS was present in the swine herd. Information was also collected on pig productivity such as pigs weaned per litter, farrowing rate, pig mortality, etc. Tables 13, 14, and 15 provide information from the NAHMS 2006 surveys, similar information from the 2000 survey is published elsewhere.^d

^d http://www.aphis.usda.gov/animal_health/nahms/swine/index.shtml#swine2000.

The NAHMS survey reported that PRRS was present in more than 60 percent of breeding herds in the South and Midwest regions of the U.S. in 2000 and was present in about 40 percent of breeding herds in the Mideast and West region (Table 16). In 2006, the prevalence of PRRS in breeding herds was lower in the Midwest and West regions compared to what it was in 2000. The prevalence of PRRS in pre-weaned pigs was the highest in the South region in both the 2000 and 2006 surveys. The prevalence in the Midwest and West regions dropped between 2000 and 2006.

PRRS was also more prevalent in the nursery and grow-finish operations in the South region in both 2000 and 2006. In 2000, 84.5 percent of the nurseries in the South were infected with PRRS as compared to the 95.5 percent that were reported as infected in the 2006 study. The prevalence of PRRS was lower for the Midwest, Mideast, and West regions in both nursery and grow-finish operations for both years. The prevalence of PRRS was higher in the Midwest region as compared with the Mideast and West regions in 2000 and 2006.

PRRS appeared to be more prevalent in larger swine production operations as compared to smaller operations in both the 2000 and 2006 studies (Table 17). The NAHMS 2006 survey reported that of those operations having 5,000 or more hogs and pigs per site, about 60 percent had PRRS in the breeding herd and the grow-finish herd. About 70 percent reported being infected with PRRS in their nursery and grow-finish pigs. For those operations with less than 2,000 hogs and pigs per site, only about 20 percent reported having PRRS in the breeding herd. Only about 30 percent of these herds reported PRRS in the nursery and grow-finish herd.

Cost of productivity losses due to PRRS virus in U.S.

The least squares means estimates for BA, LFY, PWM, BCR and BDR in the breeding herd (Table 9) and ADG, FCR, PMP and MOR in the growing pigs (Table 12) from the statistical analysis of the production records survey were used to populate the budgeting model regardless of statistical significance. The estimated economic losses due to PRRS obtained when productivity losses from the analysis of production records were used in the budgeting model are summarized in Tables 18, 19 and 20. In the breeding herd analysis, it was estimated that PRRS reduced the annual number of pigs weaned in the U.S. by 8.29 million pigs. The total annual loss from PRRS in U.S. breeding herds was estimated to be \$302.06 million, equivalent to \$52.19 per breeding female or \$2.36 per pig weaned. The majority of the loss in the breeding herd (\$300.38 million) was due to a reduction in revenue caused by fewer pigs being weaned.

Losses in the breeding and growing pig herds resulted in 9.93 million fewer pigs per year, or approximately 2.41 billion fewer pounds of pork (as measured by carcass weight) marketed per year in the U.S. The estimated annual loss in the growing pig herd was \$361.8 million. As in the breeding herd, lost revenue (\$1.61 billion) rather than increased cost, was the primary source of losses attributed to PRRS. With PRRS fewer pigs and pounds of pork are produced and consequently costs were lower by \$1.25 billion, offsetting some of the lost revenue. The total annual cost of PRRS in the U.S. due to the combined productivity losses in the breeding and growing pig herd was estimated to be \$663.916 million.

The sensitivity of these results to changes in the price of weaned pigs, market hogs, corn, soybean meal, and DDG was evaluated. In addition to a baseline model, eight scenarios were created by simultaneously increasing or decreasing the feed ingredient prices by 20 percent and simultaneously increasing or decreasing the weaned pig and market hog prices by 20 percent. The total annual cost of PRRS due to productivity losses in the breeding and growing pig herd combined for each of these scenarios are presented in Table 21. Over the range of prices evaluated, the total annual cost of PRRS ranged from \$223 million dollars to \$1.104 billion dollars. The annual cost of PRRS increased as weaned pig and market hog prices increased, and as feed ingredient prices declined. The financial impact of PRRS was therefore highest under the scenario where pork production was expected to be most profitable.

Other costs attributed to PRRS virus in U.S.

Data on veterinary costs provided from the survey of production records was very sparse. However, information on veterinary costs provided through the survey of swine veterinary experts opinion was more complete and was therefore used to estimate the annual increase in veterinary costs attributed to PRRS (Table 22). The veterinary costs in the breeding herd were reported on a per pig weaned basis. In the growing pig herd they were reported on a per pig sold basis. To arrive at a national cost figure, the cost values provided by the survey respondents were multiplied by the total annual number of pigs weaned and the annual number of pigs sold in the U.S. for both the CURRENT and WO PRRS scenarios. The difference in the total veterinary costs between the two scenarios represented additional veterinary costs that could be attributed to PRRS. The additional veterinary costs were estimated to be \$62.63 million and \$77.49 million annually in the breeding and growing pig herds respectively, for a total of \$140.11 million per year.

Data on biosecurity related and management costs during and after an outbreak (due to changes in pig flow, stocking rates and pig movements, more intensive care of pigs, production and contract penalties) was also collected in the survey of expert opinion. They were reported on a per pig sold basis for the entire production system (or farm) and were not split between the growing pig and breeding herds. Like veterinary costs, the cost values provided by the survey respondents were multiplied by the total annual number of pigs sold in the U.S. for both the CURRENT and WO PRRS scenarios to estimate a total cost per year. The annual biosecurity related (\$191.86 million) and other outbreak related (\$145.82 million) costs attributed to PRRS were estimated at \$337.67 million per year (Table 23).

The total additional costs attributed to PRRS for veterinary costs, biosecurity related costs, and other outbreak related costs were \$477.79 million annually.

Economic analysis of PRRS virus elimination from a herd

The costs and revenues used to conduct the economic analysis of productivity losses due to PRRS are presented in Table 24. They are presented for a 1000 sow breeding herd for each of the breeding herd PRRS categories and growing pig scenarios. Monthly costs and revenues were obtained by dividing the annual costs and revenues from the partial budgeting model by 12. Veterinary costs from the expert opinion survey were also included in the total costs for the NPV analysis. The return on the investment in elimination was evaluated by calculating the NPV of the increased/decreased costs and revenues, including the cost of elimination, between the INFECTED and ELIMINATION scenarios for each of the 120 months. A positive NPV was indicative of a positive return on the investment in elimination. The minimum time a breeding herd must stay PRRS virus-free to get a positive return on the investment in PRRS virus elimination is reported in Table 25. When HCR was the method of elimination, the minimum time to get a positive NPV ranged from four months to 26 months. Assuming a low cost of elimination, only four months of PRRS virus-free production was required for a herd that had a recent PRRS outbreak when elimination was initiated, was PRRS virus-free before the outbreak occurred and produced no groups of negative weaned pigs when the breeding herd was PRRS virus-infected. This is the scenario where elimination is most beneficial since for the INFECTED scenario, the breeding herd was classified as BH-B for the first 12 months and no groups of negative weaned pigs were produced for the entire 120 months. Twenty-six months was required for a herd that did not have a recent outbreak when elimination was initiated and frequently produced groups of negative weaned pigs and a high cost of elimination was assumed. This is the scenario where elimination was least beneficial since for the INFECTED scenario, the breeding herd was classified as BH-C for the first 12 months and groups of negative weaned pigs were produced, therefore reducing the benefit of eliminating the virus. However, this scenario may be more typical of breeding herds that have a low risk of a (re)outbreak of PRRS and therefore, the minimum time the herd must stay PRRS virus-free to get a positive return on the investment in elimination may be easier to achieve. When CDR was the method of elimination, the minimum time to achieve positive NPV ranged from 18 to 83 months.

DISCUSSION

The total U.S. annual cost of PRRS due to productivity losses in the breeding and growing pig herds during the period 2006 to 2010 was approximately \$104 million dollars higher than the \$560 million annual cost estimated in 2005.¹⁹ Furthermore, the relative proportion of the total loss attributed to either the breeding herd or the growing pig herd was considerably different than was reported in 2005. In the 2005 study, the breeding herd accounted for only 12 percent of the total cost of PRRS compared to 45 percent in the current analysis.

Since 2005, the incidence of PRRS outbreaks may have changed, pork production strategies have evolved, and PRRS virus control/elimination strategies have changed. Methods used to increase the likelihood of weaning PRRS virus negative pigs from PRRS virus-infected breeding herds have evolved significantly. Use of vaccination, live virus inoculation, temporary closure of herds to introduction of new breeding replacements, and limited use of cross fostering to stop circulation of the PRRS virus in the breeding herd following a PRRS outbreak have likely increased the number of PRRS negative groups of pigs being weaned in the U.S. However, these strategies may also have impacted productivity in the breeding herd or changed the incidence of PRRS outbreaks in breeding and growing pig herds nationwide. Unfortunately, reliable data to support or refute this hypothesis is not available. Other strategies that may reduce the detrimental effects of PRRS on growing pigs include improved management of co-infections with other agents and use of vaccines in weaned pigs, especially in those weaned pigs that are PRRS virus negative at the time of weaning but relocated to growing facility where the risk of lateral infection is high. A shift toward wean-to-finish facilities, where pigs are not moved and instead are raised in the same facility from weaning until they are marketed, and improvements in the management of pig flow including the reduction in the frequency of comingling pigs from multiple breeding herds into a single group of pigs may also have affected the impact of PRRS on productivity in the growing pig herd.

Porcine circovirus type 2 (PCV2) associated disease (PCVAD) has continued to evolve since the previous cost of PRRS study was published. Specifically, use of efficacious vaccines for control of PCVAD has become widespread. Co-infection of pigs with PRRS virus and PCV2 has been associated with expression of severe clinical disease; the effect of widespread use of PCV2 vaccine since 2005 on the cost of PRRS to the U.S. industry is unknown.³²

Inflation alone explains 40 percent of the increase in the cost of PRRS. Average annual rate of inflation between 2005 and 2010, as measured by the consumer price index (CPI), was 2.4 percent.³³ The future value of the cost of PRRS estimate published in 2005 is equal to \$602 million measured in 2010 dollars.

In addition to the cost of productivity losses due to PRRS, \$140.11 million in veterinary costs, \$191.86 million in biosecurity related costs, and \$145.82 million in other outbreak related costs per year were estimated in this study. The total attributed to PRRS for these additional costs was \$477.79 million annually and these costs were not included as part of the 2005 study. These costs were based on subjective estimates reported by the survey of swine veterinary experts.

Losses not considered as part of this study included those uniquely associated with outbreaks in genetic supplier herds (suppliers of female breeding replacements or boar studs). Nearly all genetic herds and boar studs in the U.S. are maintained as PRRS virus-free because genetic customers demand PRRS virus-free replacement breeding females and semen. When PRRS outbreaks do occur in genetic supplier herds, costs often exceed those associated with an outbreak in a commercial herd due to the follow-on effects of disrupted genetic supply, loss of customers, direct loss of genetic sales, additional diagnostic testing costs, creation of secondary outbreaks, and high cost of elimination due to the need to return to PRRS virus-free status as rapidly as possible.

A substantial number of U.S. swine farms are currently PRRS virus-free. Based on October 1, 2010 data, it was estimated that 28 percent of the breeding females in the U.S. were in PRRS virus-free herds (BH-A). Forty-two percent of all breeding females were in herds that had a PRRS outbreak in the 12 months prior to October 1,

2010 (BH-B and BH-D), 6 percent were PRRS virus-free before the outbreak (BH-B) and 36 percent PRRS virus-infected before the outbreak (BH-D).

For the year ending October 1, 2010, 60 percent of weaned pigs in the U.S. were estimated to be negative at placement, 25 percent were negative at weaning and remained negative through marketing (GP-A) and 35 were negative at weaning but became infected before they were marketed (GP-B). Forty percent of weaned pigs were positive at placement (GP-C). Of the pigs that were negative at placement, 58 percent were infected before they were marketed. Recent efforts to improve biosecurity and eliminate the PRRS virus from individual breeding herds or regions may increase the number of breeding females in herds categorized as BH-A and growing pigs in groups categorized as GP-A over time.

Estimates of productivity losses attributed to PRRS made by the respondents to the survey of expert opinion generally closely followed the same pattern for each of the PRRS categories but were generally higher than those from the survey of production records. The respondents were asked to only estimate the impacts for the herds to which they provided veterinary services. Therefore, their estimates were based on clinical experience and their knowledge of the production records. However, their responses were more subjective than the estimates made from actual production records.

In breeding herds that had an outbreak, productivity and economic losses in the 12 months after the outbreak were greater when the herd was PRRS virus-free before the outbreak compared to those that were PRRS virus-infected. This difference may be attributed to the relative lack of immunity in PRRS virus-free herds. The timing of infection in growing pigs affects how the pigs performed. Productivity was better in groups of growing pigs that were infected after weaning (GP-B) than those infected before (GP-C).

An evaluation of how long breeding herds must stay PRRS virus-free to get a positive return on the investment in elimination was conducted. Utilization of herd closure and rollover is a relatively inexpensive method of eliminating the PRRS virus from breeding herds but its adoption has been limited by frequent reintroductions of the virus before a positive return on the investment in elimination can be obtained. Producers and veterinarians frequently cite the prospect of a more severe outbreak in PRRS virus-free herds when the herd is reinfected as a reason to remain PRRS virus-infected and not attempt to eliminate the PRRS virus. The data from the survey of production records and expert opinion support this belief that outbreaks are more severe in PRRS virus-free herds when the herd is reinfected. The NPV analysis conducted for this study is the first analysis, of which the authors are aware, that considered the negative production and economic consequences when a herd that is PRRS virus-free following successful elimination is reinfected and has an outbreak. When elimination by herd closure and rollover was evaluated for a range of elimination costs from \$10 to \$40 per breeding female, the time required to be PRRS virus-free to get a positive return on the investment in elimination was 4 to 26 months even when the consequence of the more severe break following the reintroduction of the virus was considered. The time to get a positive return is shortest when the cost of elimination is lowest and the consequences of staying PRRS virus-infected are highest, that is when the elimination is initiated immediately following an outbreak when the herd was PRRS virus-free before that outbreak occurred and when it is assumed that the herd would not produce any groups of negative pigs if elimination were not pursued. When CDR was the method of elimination, the time herds needed to remain PRRS virus-free to get a return on the investment in elimination ranged from 18 to 83 mo

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I. TABLES

Table 1. Criteria and summary of supporting evidence required for breeding herd classification.

| Herd category | Criteria | Supporting Evidence Required |
|--|---|--|
| Positive Unstable (I) | Any virus detected on the site along with clinical signs consistent with PRRS. Herds that do not meet the criteria for any of the other categories (II through IV) are category I by default. | None required. Non-tested herds are category I by default. Detection of virus in any tissue and presence of clinical signs would confirm status. |
| Positive Stable (II-A) | Category II starts after a 90 day period of sustained lack of viremia in weaning age pigs and no clinical signs of PRRS in the breeding herd. Herd has not initiated an elimination program. | Test serum from weaning age pigs by PCR ¹ . No positive results over a 90 day period (4 consecutive negative herd tests sampling every 30 days or more frequently) and no clinical signs consistent with PRRS observed in breeding herd. |
| Positive Stable, undergoing elimination (II-B) | Category II starts after a 90 day period of sustained lack of viremia in weaning age pigs and no clinical signs of PRRS in the breeding herd. Herd has initiated an elimination program and intends to become negative. | Test serum from weaning age pigs by PCR ¹ . No positive results over a 90 day period (4 consecutive negative herd tests sampling every 30 days or more frequently) and no clinical signs consistent with PRRS observed in breeding herd. |
| Provisional Negative (III) | Category III starts 60 days after negative breeding replacements are first introduced during a herd rollover with diagnostic evidence that they remain uninfected. If growing pigs are present at the same premises, a confirmation of negative exposure status in that sub-population is also required. | Test serum from negative breeding replacements by ELISA ² . No positive results, after ruling out false positives, at least 60 days after the initial introduction of negative breeding replacements. Test serum from growing pigs by ELISA ² . No positive results, after ruling out false positives |
| Negative (IV) | For herd rollovers category IV starts when all previously infected animals have been removed from the herd. | Test serum from adult breeding animals by ELISA ² . No positive results, after ruling out false positives, subsequent to completion of rollover. Confirmed by breeding animal |

| | | |
|--|---|--|
| | <p>Alternatively, category IV starts one year after the herd was classified as category III if all animals in the herd are seronegative by ELISA.</p> <p>For herds established Negative as a new startup or by complete depopulation and repopulation</p> <p>If growing pigs are present at the same premises, confirmation of a negative exposure status in that sub-population is also required</p> | <p>inventory lists from production records.</p> <p>Test serum from adult breeding animals by ELISA². No positive results, after ruling out false positives, one year after the herd was classified as category III. Individual animal records are not required for the alternative criteria.</p> <p>Test serum from adult breeding animals by ELISA². No positive results, after ruling out false positives, at least 30 days after population of premises with negative breeding replacements.</p> <p>Test serum from growing pigs by ELISA². No positive results, after ruling out false positives.</p> |
|--|---|--|

¹ Other virus or antigen detection tests may be used

² Other antibody detection tests may be use

Table 2. Classification of breeding herds for estimating the impact of PRRS virus.

| PRRS Category | Description |
|----------------------|--|
| BH-A | PRRS virus-free herd (AASV/PRRS-CAP category III or IV) |
| BH-B | Herd that had a PRRS outbreak within the last 12 months and was PRRS virus-free (AASV/PRRS-CAP category III or IV) before the outbreak |
| BH-C | PRRS virus-infected herd (AASV/PRRS-CAP category I or II) that has not had a PRRS outbreak for at least 12 months |
| BH-D | Herd that had a PRRS outbreak within the last 12 months and was PRRS virus-infected (AASV/PRRS-CAP category I or II) before the outbreak |

Table 3. Classification of growing pig herds for estimating the impact of PRRS virus.

| PRRS Category | Description |
|----------------------|--|
| GP-A | PRRS negative at weaning and remained negative until marketing |
| GP-B | PRRS negative at weaning but became infected sometime prior to marketing |
| GP-C | PRRS positive at weaning and remained positive throughout the growing period |

Table 4. PRRS category in the breeding herd and duration of time in each phase used for the NPV analysis of virus elimination from a breeding herd.

| Phase | Elimination | | Status Quo | |
|---|---------------|--|---------------|-------------------|
| | PRRS Category | Months in Phase | PRRS Category | Months in Phase |
| Complete depop/repop (CDR) | | | | |
| Recent outbreak, herd was PRRS virus-free before outbreak occurred | | | | |
| Elimination | BH-B | 1 | BH-B | 12 |
| PRRS virus-free | BH-A | Minimum value that yields a positive NPV | | |
| Post-outbreak | BH-B | 12 | | |
| Remainder of 10 year period | BH-D | Balance of months | BH-D | Balance of months |
| Complete depop/repop (CDR) | | | | |
| Recent outbreak, herd was PRRS virus-infected before outbreak occurred | | | | |
| Elimination | BH-D | 1 | BH-D | 12 |
| PRRS virus-free | BH-A | Minimum value that yields a positive NPV | | |
| Post-outbreak | BH-B | 12 | | |
| Remainder of 10 year period | BH-D | Balance of months | BH-D | Balance of months |
| Herd rollover (HCR) | | | | |
| Recent outbreak, herd was PRRS virus-free before outbreak occurred | | | | |
| Elimination | BH-B | 7 | BH-B | 12 |
| PRRS virus-free | BH-A | Minimum value that yields a positive NPV | | |
| Post-outbreak | BH-B | 12 | | |
| Remainder of 10 year period | BH-D | Balance of months | BH-D | Balance of months |
| Herd rollover (HCR) | | | | |

Recent outbreak, herd was PRRS virus-infected before outbreak occurred

| | | | | |
|-----------------------------|------|--|------|-------------------|
| Elimination | BH-D | 7 | BH-D | 12 |
| PRRS virus-free | BH-A | Minimum value that yields a positive NPV | | |
| Post-outbreak | BH-B | 12 | | |
| Remainder of 10 year period | BH-D | Balance of months | BH-D | Balance of months |

Complete depop/repop (CDR)

No recent outbreak

| | | | | |
|-----------------------------|------|--|------|-------------------|
| Elimination | BH-C | 1 | BH-C | 12 |
| PRRS virus-free | BH-A | Minimum value that yields a positive NPV | | |
| Post-outbreak | BH-B | 12 | | |
| Remainder of 10 year period | BH-C | Balance of months | BH-C | Balance of months |

Herd rollover (HCR)

No recent outbreak

| | | | | |
|-----------------------------|------|--|------|-------------------|
| Elimination | BH-C | 7 | BH-C | 12 |
| PRRS virus-free | BH-A | Minimum value that yields a positive NPV | | |
| Post-outbreak | BH-B | 12 | | |
| Remainder of 10 year period | BH-C | Balance of months | BH-C | Balance of months |

Table 5. Allocation of growing pigs weaned from each PRRS category of breeding herd to the PRRS categories of growing pigs (% of all groups of growing pigs from the breeding herd).

| | PRRS category of growing pigs | | |
|--|-------------------------------|------|------|
| | GP-A | GP-B | GP-C |
| For breeding herds categorized as BH-A | | | |
| | 50% | 50% | |
| For breeding herds categorized as BH-B and BH-D | | | |
| Frequent negative pig production when breeding herd is PRRS virus-infected | 33% | 33% | 33% |
| Occasional negative pig production when breeding herd is PRRS virus-infected | 25% | 25% | 50% |
| No negative pig production when breeding herd is PRRS virus-infected | 0% | 0% | 100% |
| For breeding herds categorized as BH-C | | | |
| Frequent negative pig production when breeding herd is PRRS virus-infected | 50% | 50% | 0% |
| Occasional negative pig production when breeding herd is PRRS virus-infected | 33% | 33% | 33% |
| No negative pig production when breeding herd is PRRS virus-infected | 0% | 0% | 100% |

Table 6. Cost of eliminating the PRRS virus from a breeding herd (\$/breeding female).

| Method of Elimination | Low Cost | High Cost |
|------------------------------|-----------------|------------------|
| HCR | \$10 | \$40 |
| CDR | \$250 | \$350 |

Table 7. Percentage of swine breeding herds in each PRRS category from the survey of expert opinion.

| Number of Respondents (surveys) | | 26 |
|--|--|-------------------------------|
| PRRS Category | Number of Females Represented | Percent of Females |
| BH-A | 664,953 | 28% |
| BH-B | 144,970 | 6% |
| BH-C | 693,949 | 30% |
| BH-D | 835,928 | 36% |
| TOTAL number females | 2,339,800 | 100 |

Table 8. Percentage of swine breeding herds in each PRRS category by region from the survey of expert opinion.

| PRRS Category | Region | | |
|----------------------|---------------|----------------|-------------|
| | East | Midwest | West |
| BH-A | 19% | 35% | 28% |
| BH-B | 2% | 10% | 3% |
| BH-C | 36% | 29% | 21% |
| BH-D | 42% | 25% | 48% |
| Total number females | 754,700 | 1,075,800 | 509,300 |

Table 9. Productivity estimates from survey of expert opinion and production records for breeding herds by PRRS category.

| Item | Source | Baseline Values | | | | Differences from BH-A | | |
|--|--------------------------|--------------------|--------------------|--------------------|--------------------|-----------------------|---------|---------|
| | | BH-A | BH-B | BH-C | BH-D | BH-B | BH-C | BH-D |
| Number pigs born alive/ litter | Survey of Expert Opinion | 12.14 | 10.59 | 11.23 | 10.74 | -1.55 | -0.91 | -1.40 |
| | Production Records | 11.6 ^a | 10.6 ^b | 11.2 ^c | 11.0 ^d | -1.0 | -0.4 | -0.6 |
| Pre-wean mortality percent farrowed | Survey of Expert Opinion | 11.0% | 17.0% | 14.0% | 16.0% | +6.0% | +3% | +5% |
| | Production Records | 12.2% ^a | 18.0% ^b | 12.6% ^a | 13.7% ^c | +5.8% | +0.4% | +1.5% |
| Number litters farrowed/mated female/ year | Survey of Expert Opinion | 2.36 | 2.09 | 2.21 | 2.13 | -0.27 | -0.15 | -0.23 |
| | Production Records | 2.45 ^a | 2.33 ^b | 2.39 ^b | 2.38 ^b | -0.12 | -0.06 | -0.07 |
| Immunization cost/pig weaned | Survey of Expert Opinion | \$1.35 | \$1.91 | \$1.74 | \$1.79 | +\$0.56 | +\$0.39 | +\$0.44 |
| Pharmaceutical cost/pig weaned | Survey of Expert Opinion | \$0.59 | \$1.15 | \$0.91 | \$1.13 | +\$0.56 | +\$0.32 | +\$0.54 |
| Diagnostic cost/ pig weaned | Survey of Expert Opinion | \$0.14 | \$0.26 | \$0.22 | \$0.23 | +\$0.12 | +\$0.08 | +\$0.09 |
| Breeding female cull rate | Production Records | 50.7% ^a | 47.7% ^a | 50.5% ^a | 49.8% ^a | -3% | -0.2% | -0.9% |
| Breeding female death rate | Production Records | 8.4% ^a | 9.5% ^{ab} | 9.1% ^{ab} | 9.6% ^b | +1.1% | +0.7% | +1.2% |

Values with different superscripts are significantly different at p = 0.05

Table 10. Percentage of growing pigs in each PRRS category from the survey of expert opinion.

| Number of Participants (surveys) | | 26 |
|---|-----------------------|------------------------|
| Herd Category | Number of Pigs | Percent of Pigs |
| GP-A | 10,601,820 | 25% |
| GP-B | 14,359,796 | 35% |
| GP-C | 16,535,009 | 40% |
| TOTAL number pigs | 41,496,625 | 100% |

Table 11. Percentage of growing pigs in each PRRS category by region from the survey of expert opinion.

| PRRS Category | Region | | |
|----------------------|---------------|----------------|-------------|
| | East | Midwest | West |
| GP-A | 12% | 32% | 25% |
| GP-B | 9% | 46% | 36% |
| GP-C | 79% | 22% | 39% |
| TOTAL number pigs | 10,583,625 | 23,267,450 | 7,645,550 |

Table 12. Wean-to-finish productivity estimates from survey of expert opinion and production records for growing pigs by PRRS category.

| Item | Source | Baseline Values | | | Differences from GP-A | |
|-----------------------------------|--------------------------|--------------------|--------------------|--------------------|-----------------------|---------|
| | | GP-A | GP-B | GP-C | GP-B | GP-C |
| Mortality rate (% of pigs placed) | Survey of Expert Opinion | 4% | 7% | 9% | +3% | +5% |
| | Production Records | 6% ^a | 7.4% ^b | 9.3% ^c | +1.4% | +3.3% |
| Average daily gain (lb/pig/day) | Survey of Expert Opinion | 1.71 | 1.57 | 1.54 | -0.14 | -0.17 |
| | Production Records | 1.56 ^a | 1.53 ^b | 1.53 ^b | -0.03 | -0.03 |
| Feed conversion (lb/feed/lb gain) | Survey of Expert Opinion | 2.54 | 2.65 | 2.66 | +0.11 | +0.12 |
| | Production Records | 2.61 ^a | 2.57 ^a | 2.57 ^a | -0.04 | -0.04 |
| Percent sold to primary market | Survey of Expert Opinion | 94% | 91% | 90% | -3% | -4% |
| | Production Records | 96.4% ^a | 95.7% ^a | 95.8% ^a | -0.7% | -0.6% |
| Immunization cost (\$/pig sold) | Survey of Expert Opinion | \$1.50 | \$1.81 | \$1.78 | +\$0.31 | +\$0.28 |
| Pharmaceutical cost (\$/pig sold) | Survey of Expert Opinion | \$1.01 | \$1.89 | \$2.03 | +\$0.88 | +\$1.02 |
| Diagnostic cost (\$/pig sold) | Survey of Expert Opinion | \$0.16 | \$0.26 | \$0.25 | +\$0.10 | +\$0.09 |

Values with different superscripts are significantly different at p = 0.05

Table 13. PRRS productivity impact in gestation-farrowing – 2006 NAHMS study.

| (PRRS NEGATIVE INCLUDES ONLY THOSE INDICATED AS NEGATIVE) | | | | | | | | | | |
|--|------------------------------|---------------|------------|--------------------|-------------------------------|---------------|------------|--------------------|--------------------|----------------------------|
| (PRRS POSITIVE OPERATIONS ARE DOCUMENTED POSITIVE IN SOW HERD) | | | | | | | | | | |
| Item | Period 1 (Dec 2005-May 2006) | | | | Period 2 (June 2006-Nov 2006) | | | | Average Difference | Average Percent Difference |
| | PRRS Positive | PRRS Negative | Difference | Percent Difference | PRRS Positive | PRRS Negative | Difference | Percent Difference | | |
| Number Operations | 33 | 139 | | | 33 | 139 | | | | |
| FARROWING | | | | | | | | | | |
| Total Born Per Litter | 11.22 | 10.89 | 0.33 | 3.04% | 11.4 | 10.86 | 0.54 | 4.98% | 0.44 | 4.01% |
| Born Alive Per Litter | 10.15 | 10.02 | 0.13 | 1.285% | 10.37 | 10.03 | 0.34 | 3.44% | 0.24 | 2.35% |
| Percent Born Alive Per Litter | 90.57 | 92.17 | -1.6 | -1.74% | 91.07 | 92.43 | -1.36 | -1.47% | -1.48 | -1.60% |
| Born Dead Per Litter | 1.07 | 0.87 | 0.21 | 23.61% | 1.03 | 0.84 | 0.20 | 23.36% | 0.2 | 23.49% |
| Percent Born Dead Per Litter | 9.43 | 7.83 | 1.6 | 20.43% | 8.93 | 7.57 | 1.36 | 17.90% | 1.48 | 19.16% |
| Number Weaned Per Litter | 8.85 | 8.99 | -0.13 | -1.05% | 9.31 | 8.95 | 0.36 | 4.03% | 0.11 | 1.26% |
| Percent Weaned Per Litter | 87.58 | 89.67 | -2.1 | -2.34% | 89.94 | 89.29 | 0.65 | .73% | -0.72 | -0.80% |
| Farrowing Rate | 90.95 | 88.1 | 2.85 | 3.24% | | | | | | |
| PREWEANING | | | | | | | | | | |
| Percent Prewean Mortality | 12.42 | 10.33 | 2.1 | 20.29% | 10.06 | 10.71 | -0.65 | 6.08% | 0.72 | 7.10% |
| Prewean Death – Respiratory | 472.77 | 10.05 | 462.72 | 4604.18% | 52.08 | 12.45 | 39.63 | 318.26% | 251.17 | 2461.22% |
| Percent Prewean Death - Respiratory | 7.76 | 2.76 | 5.01 | 181.57% | 5.05 | 2.73 | 2.31 | 84.65% | 3.66 | 133.11% |
| NURSERY | | | | | | | | | | |
| Percent Mortality | 7.65 | 3.58 | 4.07 | 113.53% | 2.8 | 3.37 | -0.56 | -16.70% | 1.75 | 48.41% |

| | | | | | | | | | | |
|---------------------------------|-------|-------|-------|---------|-------|-------|-------|--------|-------|---------|
| Percent Mortality – Respiratory | 4.82 | 1.04 | 3.78 | 362.47% | 1.37 | 0.82 | 0.45 | 49.20% | 2.12 | 205.83% |
| Percent Death – Respiratory | 38.46 | 21.08 | 17.38 | 82.41% | 38.75 | 23.21 | 15.55 | 67.00% | 16.46 | 74.71% |
| SOW HERD | | | | | | | | | | |
| Percent Mortality | 5.69 | 3.73 | 1.96 | 52.58% | 5.26 | 3.41 | 1.86 | 54.54% | 1.91 | 53.56% |
| Cull Rate | 20.2 | 17.42 | 2.78 | 15.95% | 32.84 | 19.89 | 12.95 | 65.08% | 7.86 | 40.52% |
| Cull Rate – Old Age | 39.59 | 41.22 | -1.63 | -3.96% | 24.5 | 31.33 | -6.83 | -21.79 | -4.23 | -12.87 |
| Cull Rate – Lameness | 8.25 | 11.57 | -3.32 | -28.71% | 11.06 | 11.85 | -0.79 | -6.67 | -2.06 | -17.69 |
| Cull Rate – Performance | 10.7 | 13.12 | -2.42 | -18.45% | 19.01 | 17.18 | 1.83 | 10.63 | -0.3 | -3.941 |
| Cull Rate – Reproductive | 30.39 | 26.44 | 3.95 | 14.92% | 31.49 | 31.44 | 0.05 | 0.16 | 2 | 7.54 |
| Cull Rate - Other | 8.12 | 4.45 | 3.67 | 82.44% | 9.02 | 5.21 | 3.82 | 73.3 | 3.74 | 77.87 |

Table 14. PRRS productivity impact in nursery and grow-finish – 2006 NAHMS study.

| (PRRS NEGATIVE INCLUDES ONLY THOSE INDICATED AS NEGATIVE) | | | | | | | | | | |
|--|-------------------------------------|----------------------|-------------------|---------------------------|--------------------------------------|----------------------|-------------------|---------------------------|---------------------------|-----------------------------------|
| (PRRS POSITIVE OPERATIONS ARE DOCUMENTED POSITIVE IN NURSERY) | | | | | | | | | | |
| Item | Period 1 (Dec 2005-May 2006) | | | | Period 2 (June 2006-Nov 2006) | | | | Average Difference | Average Percent Difference |
| | PRRS Positive | PRRS Negative | Difference | Percent Difference | PRRS Positive | PRRS Negative | Difference | Percent Difference | | |
| Number Operations | 49 | 153 | | | 49 | 153 | | | | |
| NURSERY | | | | | | | | | | |
| Mortality Percent | 5.01 | 3.22 | 1.78 | 55.31% | 3.81 | 3.01 | 0.80 | 26.62% | 1.29 | 40.96% |
| Mortality Percent – Respiratory | 3.60 | 0.91 | 2.70 | 298.00% | 2.11 | 0.98 | 1.13 | 115.59% | 1.92 | 206.79% |
| Percent Mortality - Respiratory | 59.41 | 22.12 | 37.28 | 168.51% | 51.08 | 24.65 | 26.43 | 107.23% | 31.86 | 137.87% |
| GROW-FINISH | | | | | | | | | | |
| Mortality Percent | 4.44 | 2.63 | 1.80 | 68.46% | 7.38 | 32.23 | 4.15 | 128.61% | 2.98 | 98.53% |
| Mortality Percent – Respiratory | 3.26 | 1.05 | 2.21 | 210.39% | 4.82 | 1.50 | 3.32 | 221.26% | 2.76 | 215.82% |
| Percent Mortality - Respiratory | 67.26 | 33.42 | 33.85 | 101.27% | 57.81 | 37.52 | 20.30 | 54.09% | 27.07 | 77.68% |

Table 15. PRRS productivity impact in grow-finishing – 2006 NAHMS study.

| (PRRS NEGATIVE INCLUDES ONLY THOSE INDICATED AS NEGATIVE) | | | | | | | | | | |
|--|-------------------------------------|--------------------------|-------------------|-------------------------------|--------------------------------------|--------------------------|-------------------|-------------------------------|---|---------|
| (PRRS POSITIVE OPERATIONS ARE DOCUMENTED POSITIVE IN GROW/FINISH) | | | | | | | | | | |
| Item | Period 1 (Dec 2005-May 2006) | | | | Period 2 (June 2006-Nov 2006) | | | | Average Percent Difference | |
| | PRRS Positive | PRRS Negative | Difference | Percent Difference | PRRS Positive | PRRS Negative | Difference | Percent Difference | | |
| Number Operations | 80 | 202 | | | 80 | 202 | | | | |
| Mortality Percent | 24 | 2.63 | 3.61 | 137.62% | 7.36 | 3.34 | 4.02 | 120.48% | 3.82 | 129.05% |
| Mortality Percent – Respiratory | 4.90 | 1.06 | 3.85 | 364.43% | 5.23 | 1.54 | 3.69 | 240.01% | 3.77 | 302.22% |
| Percent Mortality - Respiratory | 70.31 | 34.55 | 35.77 | 103.52% | 64.50 | 38.85 | 25.65 | 66.02% | 30.71 | 84.77% |

Table 16. Percent of swine herd on PRRS positive farms 2000 and 2006 – by region.

| Item | NAHMS Survey Results 2000 | | | | NAHMS Survey Results 2006 | | | |
|------------------------------------|-----------------------------|---------|---------|------|-----------------------------|---------|---------|------|
| | Region of the United States | | | | Region of the United States | | | |
| | South | Midwest | Midwest | West | South | Midwest | Midwest | West |
| PRRS in breeding herd | | | | | | | | |
| Yes | 62.8 | 63.3 | 36.4 | 38.0 | 61.7 | 16.8 | 48.3 | 10.8 |
| No | 34.8 | 36.0 | 55.2 | 58.4 | 38.1 | 80.9 | 51.7 | 86.1 |
| Don't know | 2.4 | 0.7 | 8.4 | 3.7 | 0.2 | 2.3 | 0.0 | 3.1 |
| PRRS in pre-weaned pigs | | | | | | | | |
| Yes | 50.6 | 34.7 | 17.6 | 17.6 | 63.5 | 9.7 | 34.5 | 5.5 |
| No | 45.8 | 60.2 | 71.2 | 66.0 | 36.2 | 90.1 | 65.3 | 91.4 |
| Don't know | 3.6 | 5.2 | 11.2 | 16.3 | 0.3 | 0.3 | 0.2 | 3.1 |
| PRRS present in nursery | | | | | | | | |
| Yes | 84.5 | 30.1 | 32.2 | 40.2 | 95.5 | 43.7 | 44.7 | 34.3 |
| No | 11.2 | 67.7 | 60.2 | 53.8 | 4.6 | 56.3 | 54.0 | 63.6 |
| Don't know | 4.4 | 2.2 | 7.5 | 6.0 | 0.0 | 0.0 | 1.3 | 2.1 |
| PRRS present in grow-finish | | | | | | | | |
| Yes | 69.6 | 43.9 | 22.3 | 39.2 | 90.4 | 62.5 | 37.8 | 48.0 |

| | | | | | | | | |
|------------|------|------|------|------|-----|------|------|------|
| No | 23.4 | 51.5 | 63.1 | 51.7 | 9.6 | 36.2 | 61.2 | 51.3 |
| Don't know | 6.7 | 4.6 | 14.7 | 9.1 | 0.0 | 1.3 | 1.0 | 0.7 |

Table 17. Percent of swine herd on PRRS positive farms 2000 and 2006 – by operation size.

| Item | NAHMS Survey Results 2000 | | | NAHMS Survey Results 2006 | | |
|--------------------------------|---------------------------------|-------------|---------|---------------------------------|-------------|--------|
| | Site Size – Total Hogs and Pigs | | | Site Size – Total Hogs and Pigs | | |
| | 0-1,999 | 2,000-9,999 | 10,000+ | 0;-1,999 | 2,000-4,999 | 5,000+ |
| PRRS in breeding herd | | | | | | |
| Yes | 28.60 | 48.70 | 83.3 | 23.6 | 21.4 | 56.9 |
| No | 61.50 | 49.10 | 16.7 | 75.9 | 76.8 | 42.5 |
| Don't know | 9.90 | 2.20 | 0.0 | 0.5 | 1.8 | 0.6 |
| PRRS in pre-weaned pigs | | | | | | |
| Yes | 13.40 | 24.90 | 63.4 | 16.7 | 8.1 | 49.3 |
| No | 74.10 | 64.60 | 35.7 | 82.8 | 89.8 | 50.7 |
| Don't know | 12.50 | 10.40 | 0.9 | 0.4 | 2.1 | 0.0 |
| PRRS present in nursery | | | | | | |
| Yes | 19.62 | 44.56 | 60.8 | 30.7 | 51.7 | 68.2 |
| No | 70.93 | 50.20 | 39.2 | 69.3 | 45.1 | 31.8 |
| Don't know | 9.45 | 5.24 | 0.0 | 0.0 | 3.3 | 0.0 |
| PRRS present in | | | | | | |

| grow-finish | | | | | | |
|-------------|-------|-------|------|------|------|------|
| Yes | 17.80 | 40.20 | 79.7 | 26.8 | 51.8 | 76.0 |
| No | 67.40 | 50.80 | 15.0 | 72.6 | 46.0 | 23.9 |
| Don't know | 14.80 | 9.00 | 5.3 | 0.6 | 2.2 | 0.1 |

Table 18. Productivity and economic impact of PRRS virus in the breeding herd.

| Breeding Herd | WO PRRS | CURRENT |
|--|-----------------|-----------------------|
| <i>Productivity Impact</i> | | |
| Breeding female inventory | 5,788,000 | 5,788,000 |
| <i>Difference</i> | | 0 |
| Litters farrowed (litters/year) | 12,658,607 | 12,393,428 |
| <i>Difference</i> | | -265,178 |
| Pigs born alive (pigs/year) | 141,538,890 | 133,676,522 |
| <i>Difference</i> | | -7,862,368 |
| Pigs weaned (pigs/year) | 123,727,558 | 115,428,101 |
| <i>Difference</i> | | -8,299,457 |
| Pigs weaned / female / year | 21.38 | 19.94 |
| <i>Difference</i> | | -1.43 |
| <i>Economic Impact (Annual)</i> | | |
| Total revenue (\$/year) | \$4,478,107,438 | \$4,177,722,775 |
| <i>Difference</i> | | -\$300,384,664 |
| Total fixed costs (\$/year) | \$1,503,328,961 | \$1,510,525,063 |
| <i>Difference</i> | | \$7,196,102 |
| Total variable costs (\$/year) | \$2,533,049,882 | \$2,527,529,759 |
| <i>Difference</i> | | -\$5,520,124 |
| Total costs (\$/year) | \$4,036,378,843 | \$4,038,054,822 |
| <i>Difference</i> | | \$1,675,979 |
| Net (\$/year) | \$441,728,595 | \$139,667,953 |
| <i>Total annual cost of PRRS in U.S. breeding herds</i> | | -\$302,060,642 |
| <i>Economic Impact (Per breeding female)</i> | | |
| Total revenue (\$/breeding female) | \$773.69 | \$721.79 |
| <i>Difference</i> | | -\$51.90 |
| Total fixed costs (\$/breeding female) | \$259.73 | \$260.98 |
| <i>Difference</i> | | \$1.24 |
| Total variable costs (\$/breeding female) | \$437.64 | \$436.68 |
| <i>Difference</i> | | -\$0.95 |
| Total costs (\$/breeding female) | \$697.37 | \$697.66 |
| <i>Difference</i> | | \$0.29 |
| Net (\$/breeding female) | \$76.32 | \$24.13 |
| <i>Annual cost of PRRS in U.S. breeding herds</i> | | -\$52.19 |

| <i>(\$/breeding female)</i> | | |
|--|---------------|-----------------------|
| <i>Economic Impact (Per pig weaned)</i> | | |
| Total revenue (\$/pig weaned) | \$36.19 | \$36.19 |
| <i>Difference</i> | | <i>\$0.00</i> |
| Total fixed costs (\$/pig weaned) | \$12.15 | \$13.09 |
| <i>Difference</i> | | <i>\$0.94</i> |
| Total variable costs (\$/pig weaned) | \$20.47 | \$21.90 |
| <i>Difference</i> | | <i>\$1.42</i> |
| Total costs (\$/pig weaned) | \$32.62 | \$34.98 |
| <i>Difference</i> | | <i>\$2.36</i> |
| Net (\$/pig weaned) | \$3.57 | \$1.21 |
| <i>Annual cost of PRRS in U.S. breeding herds (\$/pig weaned)</i> | | <i>-\$2.36</i> |

Table 19. Productivity and economic impact of PRRS virus in the growing pig herd.

| Growing Pig Herd | WO PRRS | CURRENT |
|---|------------------------|------------------------|
| <i>Productivity Impact</i> | | |
| Pigs marketed (pigs/year) | 119,401,146 | 109,469,896 |
| <i>Difference</i> | | -9,931,250 |
| Live weight marketed in category (lbs/year) | 31,461,977,512 | 28,246,221,079 |
| <i>Difference</i> | | -3,215,756,432 |
| Carcass weight marketed in category (lbs/year) | 23,596,483,134 | 21,184,665,809 |
| <i>Difference</i> | | -2,411,817,324 |
| <i>Economic Impact (Total)</i> | | |
| Total revenue (\$/year) | \$16,067,034,807 | \$14,451,784,609 |
| <i>Difference</i> | | -\$1,615,250,199 |
| Total weaned pig costs (\$/year) | \$4,599,206,623 | \$4,298,821,959 |
| <i>Difference</i> | | -\$300,384,664 |
| Total fixed costs (\$/year) | \$1,468,541,544 | \$1,372,627,750 |
| <i>Difference</i> | | -\$95,913,794 |
| Total variable costs (\$/year) | \$8,599,832,491 | \$7,742,736,709 |
| <i>Difference</i> | | -\$857,095,783 |
| Total costs (\$/year) | \$14,667,580,658 | \$13,414,186,417 |
| <i>Difference</i> | | -\$1,253,394,241 |
| Net (\$/year) | \$1,399,454,149 | \$1,037,598,191 |
| <i>Total annual cost of PRRS in U.S. growing pig herds</i> | | -\$361,855,958 |
| <i>Economic Impact (Per breeding female)</i> | | |
| Total revenue (\$/breeding female) | \$2,775.92 | \$2,496.85 |
| <i>Difference</i> | | -\$279.07 |
| Total weaned pig costs (\$/breeding female) | \$794.61 | \$742.71 |
| <i>Difference</i> | | -\$51.90 |
| Total fixed costs (\$/breeding female) | \$253.72 | \$237.15 |
| <i>Difference</i> | | -\$16.57 |
| Total variable costs (\$/breeding female) | \$1,485.80 | \$1,337.72 |
| <i>Difference</i> | | -\$148.08 |
| Total costs (\$/breeding female) | \$2,534.14 | \$2,317.59 |
| <i>Difference</i> | | -\$216.55 |

| | | |
|--|----------|------------------------|
| Net (\$/breeding female) | \$241.79 | \$179.27 |
| <i>Annual cost of PRRS in U.S. growing pig herds (\$/breeding female)</i> | | <i>-\$62.52</i> |
| <i>Economic Impact (Per cwt live weight)</i> | | |
| Total revenue (\$/cwt live wt) | \$51.07 | \$51.16 |
| <i>Difference</i> | | <i>\$0.10</i> |
| Total weaned pig costs (\$/cwt live wt) | \$14.62 | \$15.22 |
| <i>Difference</i> | | <i>\$0.60</i> |
| Total fixed costs (\$/cwt live wt) | \$4.67 | \$4.86 |
| <i>Difference</i> | | <i>\$0.19</i> |
| Total variable costs (\$/cwt live wt) | \$27.33 | \$27.41 |
| <i>Difference</i> | | <i>\$0.08</i> |
| Total costs (\$/cwt live wt) | \$46.62 | \$47.49 |
| <i>Difference</i> | | <i>\$0.87</i> |
| Net (\$/cwt live wt) | \$4.45 | \$3.67 |
| <i>Annual cost of PRRS in U.S. growing pig herds (\$/cwt live wt)</i> | | <i>-\$0.77</i> |

Table 20. Economic impact of PRRS virus in the breeding and growing pig herds combined.

| Breeding and Growing Pig Herds Combined | WO PRRS | CURRENT |
|---|------------------|-----------------------|
| <i>Economic Impact (Total)</i> | | |
| Total revenue (\$/year) | \$20,545,142,246 | \$18,629,507,383 |
| <i>Difference</i> | | -\$1,915,634,862 |
| Total weaned pig costs (\$/year) | \$4,599,206,623 | \$4,298,821,959 |
| <i>Difference</i> | | -\$300,384,664 |
| Total fixed costs (\$/year) | \$2,971,870,505 | \$2,883,152,813 |
| <i>Difference</i> | | -\$88,717,692 |
| Total variable costs (\$/year) | \$11,132,882,374 | \$10,270,266,467 |
| <i>Difference</i> | | -\$862,615,906 |
| Total costs (\$/year) | \$18,703,959,501 | \$17,452,241,239 |
| <i>Difference</i> | | -\$1,251,718,262 |
| Net (\$/year) | \$1,841,182,745 | \$1,177,266,144 |
| Total annual cost of PRRS in U.S. | | -\$663,916,600 |
| <i>Total cost of PRRS in U.S. (\$/day)</i> | | <i>-\$1,818,950</i> |
| <i>Economic Impact (Per breeding female)</i> | | |
| Total revenue (\$/breeding female) | \$3,549.61 | \$3,218.64 |
| <i>Difference</i> | | -\$330.97 |
| Total weaned pig costs (\$/breeding female) | \$794.61 | \$742.71 |
| <i>Difference</i> | | -\$51.90 |
| Total fixed costs (\$/breeding female) | \$513.45 | \$498.13 |
| <i>Difference</i> | | -\$15.33 |
| Total variable costs (\$/breeding female) | \$1,923.44 | \$1,774.41 |
| <i>Difference</i> | | -\$149.04 |
| Total costs (\$/breeding female) | \$3,231.51 | \$3,015.25 |
| <i>Difference</i> | | -\$216.26 |
| Net (\$/breeding female) | \$318.10 | \$203.40 |
| Total annual cost of PRRS in U.S. | | -\$114.71 |

Table 21. Sensitivity of the economic impact of PRRS virus in the breeding and growing pig herds combined to changes in feed ingredient, weaned pig and market hog prices.

| | | Feed Ingredient Prices ¹ | | | |
|---|------|-------------------------------------|----------------|------------------|----------|
| | | 20% | 0% | -20% | |
| Weaned Pig and Market Hog Prices ¹ | -20% | -\$223,540,772 | -\$340,866,561 | -\$458,192,349 | |
| | 0% | -\$546,590,812 | -\$663,916,600 | -\$781,242,388 | |
| | 20% | -\$869,640,852 | -\$986,966,640 | -\$1,104,292,428 | |
| Change in feed ingredient prices | | | -20% | 0% | 20% |
| Corn | | | \$2.66 | \$3.32 | \$3.98 |
| Soybean meal | | | \$212.67 | \$265.84 | \$319.01 |
| DDGS | | | \$91.25 | \$114.06 | \$136.87 |
| Change in weaned pig and market hog prices | | | -20% | 0% | 20% |
| Wean pig price | | | \$28.95 | \$36.19 | \$43.43 |
| Market hog price (\$/lb carcass wt) | | | \$53.81 | \$67.26 | \$80.72 |

¹Percentage are changes in prices from the baseline values

Table 22. Immunization, pharmaceutical and diagnostic costs attributed to PRRS virus from the survey of expert opinion.

| Breeding Herd | BH-A | BH-B | BH-C | BH-D | WO/ PRRS | CURRENT | Difference |
|---|-------------|-------------|-------------|-------------|-----------------|---------------------|---------------------|
| Percentage of breeding herds in category, U.S. | 28% | 6% | 30% | 36% | | | |
| U.S. breeding female inventory | | | | | 5,788,000 | 5,788,000 | |
| Number of pigs weaned/year | | | | | 123,727,558 | 115,428,101 | |
| Veterinary Costs in Breeding Herd | | | | | | | |
| Immunization costs (\$/pig weaned) | \$1.35 | \$1.91 | \$1.74 | \$1.78 | \$1.35 | \$1.66 ¹ | \$0.31 |
| Pharmaceutical costs (\$/pig weaned) | \$0.59 | \$1.15 | \$0.91 | \$1.13 | \$0.59 | \$0.91 ¹ | \$0.32 |
| Diagnostic costs (\$/pig weaned) | \$0.14 | \$0.25 | \$0.22 | \$0.22 | \$0.14 | \$0.20 ¹ | \$0.06 |
| Annual immunization costs (\$/year) | | | | | \$166,651,504 | \$191,098,653 | \$24,447,149 |
| Annual pharmaceutical costs (\$/year) | | | | | \$72,904,084 | \$105,103,146 | \$32,199,062 |
| Annual diagnostic costs (\$/year) | | | | | \$16,909,433 | \$22,889,989 | \$5,980,556 |
| <i>Additional veterinary costs in the breeding herd due to PRRS virus (\$/year)</i> | | | | | | | \$62,626,767 |
| Growing Pig Herd | | | | | | | |
| | GP-A | GP-B | GP-C | | | | |
| Percentage of pigs in each category, U.S. | 29% | 36% | 35% | | | | |
| Pigs marketed (pigs/year) | | | | | 119,401,146 | 109,636,000 | |
| Veterinary Costs in Growing Pig Herd | | | | | | | |
| Immunization costs (\$/pig marketed) | \$1.50 | \$1.80 | \$1.78 | | \$1.50 | \$1.71 ² | \$0.21 |
| Pharmaceutical costs (\$/pig marketed) | \$1.01 | \$1.89 | \$2.03 | | \$1.01 | \$1.68 ² | \$0.67 |
| Diagnostic costs (\$/pig marketed) | \$0.16 | \$0.25 | \$0.24 | | \$0.16 | \$0.22 ² | \$0.06 |
| Annual immunization costs (\$/year) | | | | | \$178,944,109 | \$187,225,313 | \$8,281,204 |
| Annual pharmaceutical costs (\$/year) | | | | | \$120,993,161 | \$184,672,003 | \$63,678,842 |

| | | | |
|---|--------------|--------------|----------------------|
| Annual diagnostic costs (\$/year) | \$18,805,680 | \$24,330,969 | \$5,525,289 |
| <i>Additional veterinary costs in the growing pig herd due to PRRS virus (\$/year)</i> | | | \$77,485,335 |
| Combined | | | |
| <i>Additional veterinary costs in the breeding and growing pig herd combined due to PRRS virus</i> | | | \$140,112,102 |

¹ Calculated as the average of all PRRS categories weighted by the percentage of pigs in each category.

² Calculated as the average of all PRRS categories weighted by the percentage of breeding herds in each category.

Table 23. Other costs attributed to PRRS virus from the survey of expert opinion.

| | WO/ PRRS | CURRENT | Difference |
|---|---------------------|----------------|----------------------|
| Biosecurity costs attributable to PRRS virus in the production system (\$/pig marketed) | \$0.00 | \$1.75 | \$1.75 |
| Other outbreak related costs (\$/pig marketed) ¹ | \$0.00 | \$1.33 | \$1.33 |
| Biosecurity costs attributable to PRRS virus in the production system (\$/year) | \$0 | \$191,863,000 | \$191,863,000 |
| Other outbreak related costs (\$/year) ¹ | \$0 | \$145,815,880 | \$145,815,880 |
| <i>Additional other costs attributed to PRRS virus (\$/year)</i> | | | \$337,678,880 |

¹*Include costs during and after an outbreak due to pig flow, stocking and movement changes, more intensive care of pigs, production contract penalties, etc.*

Table 24. Estimates of net profit for a 1000 sow breeding herd in each PRRS category and growing pig scenario.

| | BH-A | BH-B; GP Scenario 1 | BH-B; GP Scenario 2 | BH-B; GP Scenario 3 | BH-C; GP Scenario 1 | BH-C; GP Scenario 2 | BH-C; GP Scenario 3 | BH-D; GP Scenario 1 | BH-D; GP Scenario 2 | BH-D; GP Scenario 3 |
|-------------------------------|-------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| Breeding Herd | | | | | | | | | | |
| Pigs weaned (pigs/year) | 21,377 | 17,400 | 17,400 | 17,400 | 19,954 | 19,954 | 19,954 | 19,289 | 19,289 | 19,289 |
| <i>Difference (from BH-A)</i> | | -3,977 | -3,977 | -3,977 | -1,423 | -1,423 | -1,423 | -2,087 | -2,087 | -2,087 |
| Total revenue (\$/year) | \$773,688 | \$629,761 | \$629,761 | \$629,761 | \$722,202 | \$722,202 | \$722,202 | \$698,147 | \$698,147 | \$698,147 |
| <i>Difference (from BH-A)</i> | | -\$143,928 | -\$143,928 | -\$143,928 | -\$51,486 | -\$51,486 | -\$51,486 | -\$75,542 | -\$75,542 | -\$75,542 |
| Total costs (\$/year) | \$716,336 | \$729,677 | \$729,677 | \$729,677 | \$729,685 | \$729,685 | \$729,685 | \$733,734 | \$733,734 | \$733,734 |
| <i>Difference (from BH-A)</i> | | \$13,342 | \$13,342 | \$13,342 | \$13,349 | \$13,349 | \$13,349 | \$17,398 | \$17,398 | \$17,398 |
| Net profit (\$/year) | \$57,352 | -\$99,917 | -\$99,917 | -\$99,917 | -\$7,483 | -\$7,483 | -\$7,483 | -\$35,588 | -\$35,588 | -\$35,588 |
| <i>Difference (from BH-A)</i> | | -\$157,269 | -\$157,269 | -\$157,269 | -\$64,835 | -\$64,835 | -\$64,835 | -\$92,940 | -\$92,940 | -\$92,940 |
| Growing Pig Herd | | | | | | | | | | |
| Pigs marketed (pigs/year) | 19,936 | 15,777 | 16,002 | 16,077 | 18,093 | 18,437 | 18,609 | 17,490 | 17,740 | 17,823 |
| <i>Difference (from BH-A)</i> | | -4,159 | -3,934 | -3,859 | -1,843 | -1,499 | -1,327 | -2,446 | -2,196 | -2,113 |
| Total revenue (\$/year) | \$2,651,904 | \$2,064,461 | \$2,111,252 | \$2,126,974 | \$2,367,500 | \$2,439,190 | \$2,475,430 | \$2,288,641 | \$2,340,513 | \$2,357,943 |
| <i>Difference (from BH-A)</i> | | -\$587,443 | -\$540,652 | -\$524,930 | -\$284,404 | -\$212,715 | -\$176,474 | -\$363,263 | -\$311,391 | -\$293,961 |
| Total costs (\$/year) | \$2,451,112 | \$1,961,221 | \$1,978,125 | \$1,983,786 | \$2,249,106 | \$2,274,983 | \$2,288,000 | \$2,174,191 | \$2,192,931 | \$2,199,206 |
| <i>Difference (from BH-A)</i> | | -\$489,890 | -\$472,986 | -\$467,325 | -\$202,005 | -\$176,128 | -\$163,112 | -\$276,920 | -\$258,181 | -\$251,905 |
| Net profit (\$/year) | \$200,792 | \$103,239 | \$133,126 | \$143,188 | \$118,394 | \$164,206 | \$187,430 | \$114,450 | \$147,582 | \$158,737 |
| <i>Difference (from BH-A)</i> | | -\$97,553 | -\$67,666 | -\$57,604 | -\$82,399 | -\$36,586 | -\$13,362 | -\$86,342 | -\$53,210 | -\$42,056 |
| Combined | | | | | | | | | | |
| Total revenue (\$/year) | \$3,425,592 | \$2,694,221 | \$2,741,012 | \$2,756,735 | \$3,089,702 | \$3,161,392 | \$3,197,632 | \$2,986,788 | \$3,038,660 | \$3,056,090 |
| <i>Difference (from BH-A)</i> | | -\$731,371 | -\$684,580 | -\$668,857 | -\$335,890 | -\$264,200 | -\$227,960 | -\$438,804 | -\$386,932 | -\$369,502 |
| Total costs (\$/year) | \$3,167,447 | \$2,690,899 | \$2,707,803 | \$2,713,464 | \$2,978,791 | \$3,004,668 | \$3,017,685 | \$2,907,926 | \$2,926,665 | \$2,932,941 |

| | | | | | | | | | | |
|-------------------------------|-----------|------------|------------|------------|------------|------------|------------|------------|------------|------------|
| <i>Difference (from BH-A)</i> | | -\$476,549 | -\$459,645 | -\$453,984 | -\$188,656 | -\$162,779 | -\$149,763 | -\$259,522 | -\$240,782 | -\$234,507 |
| Net profit (\$/year) | \$258,145 | \$3,323 | \$33,209 | \$43,271 | \$110,911 | \$156,724 | \$179,948 | \$78,862 | \$111,995 | \$123,149 |
| <i>Difference (from BH-A)</i> | | -\$254,822 | -\$224,935 | -\$214,874 | -\$147,234 | -\$101,421 | -\$78,197 | -\$179,282 | -\$146,150 | -\$134,996 |
| Combined (monthly) | | | | | | | | | | |
| Net profit (\$/month) | \$21,512 | \$277 | \$2,767 | \$3,606 | \$9,243 | \$13,060 | \$14,996 | \$6,572 | \$9,333 | \$10,262 |
| <i>Difference (from BH-A)</i> | | -\$21,235 | -\$18,745 | -\$17,906 | -\$12,269 | -\$8,452 | -\$6,516 | -\$14,940 | -\$12,179 | -\$11,250 |

GP Scenario 1: No negative pig production when breeding herd is PRRS virus-infected

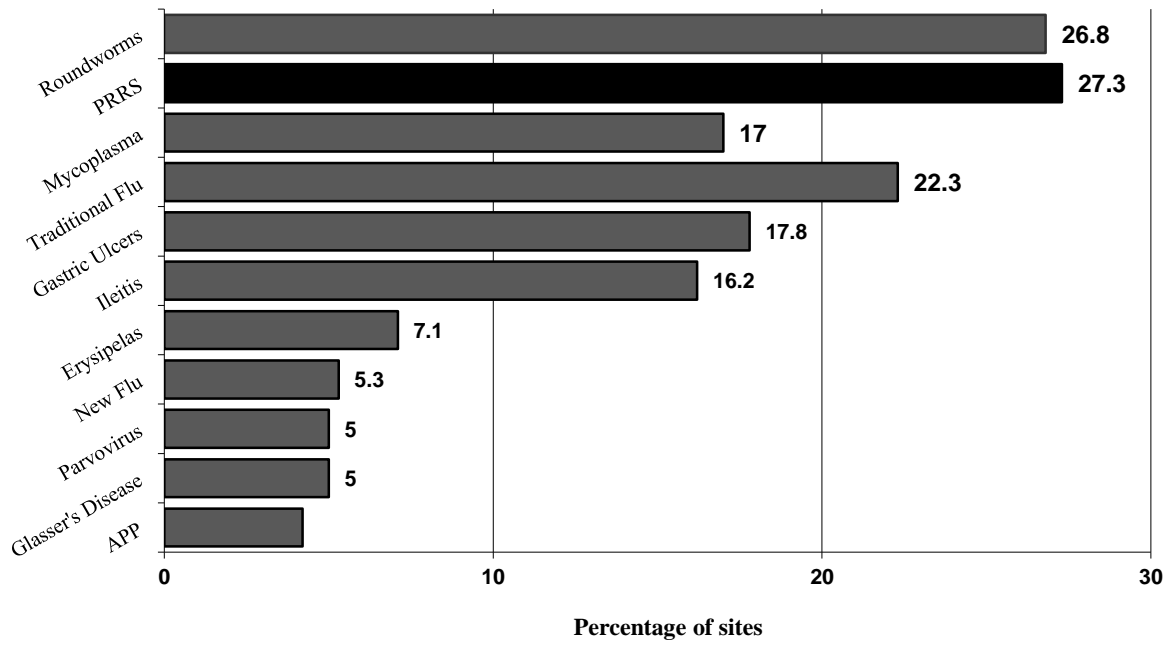
GP Scenario 2: Occasional negative pig production when breeding herd is PRRS virus-infected

GP Scenario 3: Frequent negative pig production when breeding herd is PRRS virus-infected

Table 25. Shortest time, in months, a breeding herd must stay PRRS virus-free to yield a positive net present value on the investment to eliminate PRRS virus from the breeding herd.

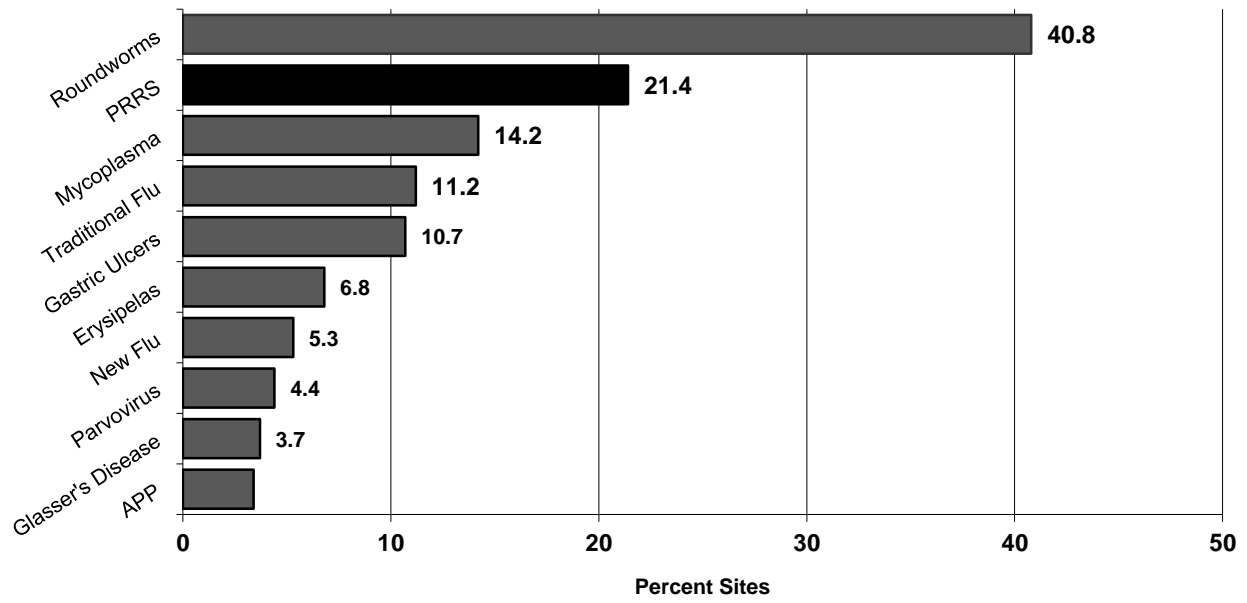
| | Herd rollover | | Complete depop/repop | |
|--|---------------|-----------|----------------------|-----------|
| | Low Cost | High Cost | Low Cost | High Cost |
| Recent outbreak, herd was PRRS virus-free before outbreak occurred (BH-B when elimination is initiated) | | | | |
| No negative pig production when breeding herd is PRRS virus-infected | 4 | 6 | 18 | 25 |
| Occasional negative pig production when breeding herd is PRRS virus-infected | 5 | 7 | 22 | 31 |
| Frequent negative pig production when breeding herd is PRRS virus-infected | 5 | 8 | 24 | 34 |
| Recent outbreak, herd was PRRS virus-infected before outbreak occurred (BH-D when elimination is initiated) | | | | |
| No negative pig production when breeding herd is PRRS virus-infected | 6 | 8 | 23 | 30 |
| Occasional negative pig production when breeding herd is PRRS virus-infected | 8 | 10 | 28 | 38 |
| Frequent negative pig production when breeding herd is PRRS virus-infected | 8 | 11 | 31 | 41 |
| No recent outbreak (BH-C when elimination is initiated) | | | | |
| No negative pig production when breeding herd is PRRS virus-infected | 10 | 12 | 30 | 40 |
| Occasional negative pig production when breeding herd is PRRS virus-infected | 15 | 19 | 46 | 61 |
| Frequent negative pig production when breeding herd is PRRS virus-infected | 21 | 26 | 63 | 83 |

II. FIGURES



Source: NAHMS-USDA-APHIS-VS, Swine 2006 Part II 2007.

Figure 1. Disease problems present in breeding females during the previous 12 months-2006.



Source: NAHMS-USDA-APHIS-VS, Swine 2000 Part II, 2001.

Figure 2. Disease problems present in breeding females during the previous 12 months-2000.

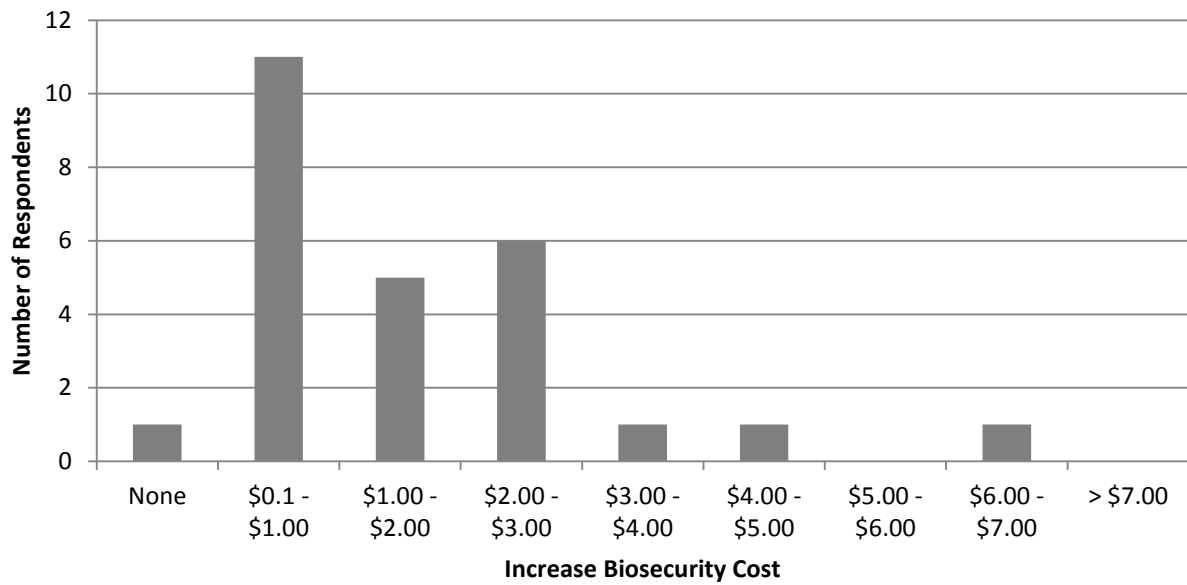


Figure 3. Frequency of biosecurity costs attributed to PRRS virus from the survey of expert opinion (\$ per pig sold).

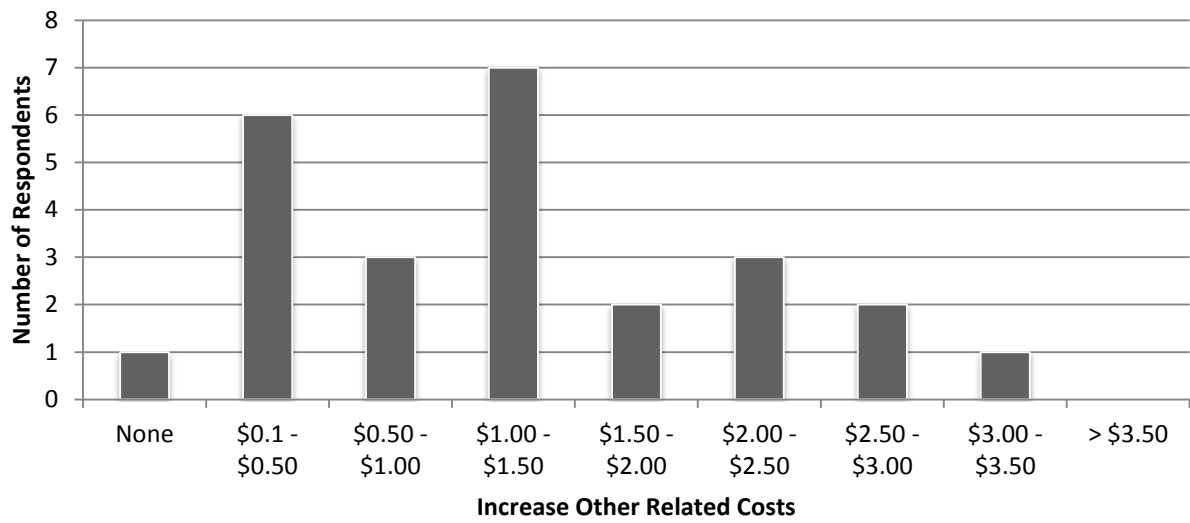


Figure 4. Frequency of other outbreak related costs attributed to PRRS virus from the survey of expert opinion (\$ per pig sold).

III. Appendix

Start Here - Enter all values into yellow boxes.

Section 1: Demographics and Background Information

Survey #: _____ (Leave Blank)

Company / Organization: _____
Date: _____

Veterinarian: _____
Mailing Address: _____
E-Mail: _____
Phone Number: _____

1.1 Size and Characteristics of Operation / Represented in Survey: *This will be limited to the herds that you provide direct services over the last 2 yrs.

Avg. Sow Inventory, Practice / System: _____

Avg. Pigs Marketed / Year, Practice / System: _____

1.2 Location of production flows?

USDA Climate Regions

- | | | | | | |
|-------------|---|----------------|--------------------------------|-------------|---|
| East | 1) Appalachian KY, NC, VA, WV, TN | Midwest | 2) Cornbelt IL, IN, IA, MO, OH | West | 6) Northern Plains KS, NE, ND, SD |
| | 3) Delta AR, LA, MS | | 4) Lake States MI, MN, WI | | 7) Pacific Northwest OR, WA, CA |
| | 5) Northeast CN, DE, ME, MD, MA, NH, NJ, NY, PA, RI, VT | | | | 9) Southern Plains OK, TX |
| | 8) Southeast AL, FL, GA, SC | | | | 10) Mountain AZ, CO, ID, MT, NM, NV, UT |

Breeding Herd Sows By Region (Avg. Annual Inventory October 1, 2009 to October 1, 2010).

East # Sows: _____ Midwest # Sows: _____ West # Sows: _____

Wean to Finish Herds By Region (Avg. Annual Inventory October 1, 2009 to October 1, 2010).

East # Wean to Finish Pigs: _____ Midwest # Wean to Finish Pigs: _____ West # Wean to Finish Pigs: _____

Notes:

1.3 Health Status of Breeding Herd:

Breeding Herd (BH) PRRSV status classifications:

| | | |
|------|---|--|
| BH-A | **Negative herd on October 1, 2009 with <u>NO</u> PRRSV outbreaks through October 1, 2010 | Outbreak Definition 1. A change in one or more reproductive performance measures where the change exceeds the expected with "normal" variation. a. increase in 45 to 112 day abortions b. increase in born dead (monozones or stillborn) per litter far c. increase in pre-wean mortality d. increase in sow deaths 2. Diagnostic confirmation of PRRSV involvement |
| BH-B | **Negative herd on October 1, 2009 with <u>ONE</u> OR <u>MORE</u> PRRSV outbreaks through October 1, 2010 | |
| BH-C | **Positive herd on October 1, 2009 with <u>NO</u> PRRSV outbreaks through October 1, 2010 | |
| BH-D | **Positive herd on October 1, 2009 with <u>ONE</u> OR <u>MORE</u> PRRSV outbreaks through October 1, 2010 | |
| | **Negative is AASV/PRRS-CAP categories III or IV | |
| | **Positive is AASV/PRRS-CAP categories I or II | |

| East Sows % of population by PRRS Status | Midwest Sows % of population by PRRS Status | West Sows % of population by PRRS Status |
|--|---|--|
| BH-A: _____ | BH-A: _____ | BH-A: _____ |
| BH-B: _____ | BH-B: _____ | BH-B: _____ |
| BH-C: _____ | BH-C: _____ | BH-C: _____ |
| BH-D: _____ | BH-D: _____ | BH-D: _____ |

Notes:

1.4 Health Status of Wean to Finish Herd:

Wean to Finish PRRSV status classification:

| | |
|------|--|
| GP-A | Negative at placement and at closeout, for groups placed between October 1, 2009 to October 1, 2010 |
| GP-B | Negative at placement and positive at closeout, for groups placed between October 1, 2009 to October 1, 2010 |
| GP-C | Positive at placement and at closeout, for groups placed between October 1, 2009 to October 1, 2010 |

| East Wean to Finish % of population by PRRS Status | Midwest Wean to Finish % of population by PRRS Status | West Wean to Finish % of population by PRRS Status |
|--|---|--|
| GP-A: _____ | GP-A: _____ | GP-A: _____ |
| GP-B: _____ | GP-B: _____ | GP-B: _____ |
| GP-C: _____ | GP-C: _____ | GP-C: _____ |

Notes:

Proceed to Section 2 by clicking on tab titled "Section 2"

Section 2: Estimate productivity losses associated with PRRSV

2.1 Breeding Herd

Estimate productivity losses associated with PRRSV in breeding herds

- for the production system you represent or herds you provided services to
- between January 1, 2005 and December 31, 2010
- do not pick one herd for each category, but report averages for all herds that fall into each category that you were provide veterinary support

Breeding Herd PRRSV status classifications:

| | |
|------|---|
| BH-A | Enter estimates for any 12 months in a *Negative herd with ≥ 24 months of no PRRS outbreaks |
| BH-B | Enter estimates for the 12 months following a PRRS outbreak in a *Negative herd |
| BH-C | Enter estimates for any 12 months in a **Positive herd with ≥24 months of no PRRS outbreaks |
| BH-D | Enter estimates for the 12 months following a PRRS outbreak in a **Positive herd |

*Negative is AASV/PRRS-CAP categories III (Provisional Negative) or IV (Negative)
 **Positive is AASV/PRRS-CAP categories I (Positive Unstable) or II (Positive Stable)

Estimate the expected average productivity of a PRRSV free breeding herd (i.e. BH-A) for the following measures:

| | |
|---|--|
| Pigs Born Alive / Litter Farrowed | |
| Prewrite Mortality Rate (% of pigs born alive) | |
| Litters / Farrowed / Mated Female / Year | |
| Pigs Weaned / Mated Female / Year | |
| Animal Health Cost - Immunizations / Pig Weaned | |
| Animal Health Cost - Pharmaceuticals / Pig Weaned | |
| Animal Health Cost - Diagnostics / Pig Weaned | |

Estimate the expected ANNUAL AVERAGE loss associated with PRRSV in the affected breeding herds (i.e. loss compared to PRRSV free breeding herds: BH-A)

| Response # | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Fill answer below Response (#) or Range | Comments |
|--|------|---------------|-----------------|----------------|----------------|----------------|----------------|----------------|----------------------------------|--|----------|
| Decrease in Pigs Born Alive / Litter Farrowed | | | | | | | | | | | |
| BH-B | None | 0 - 0.25 pigs | 0.25 - 0.5 pigs | 0.5 - 1.0 pigs | 1.0 - 1.5 pigs | 1.5 - 2.0 pigs | 2.0 - 2.5 pigs | 2.5 - 3.0 pigs | IF > 3.0 pigs give 1.0 pig range | | |
| BH-C | None | 0 - 0.25 pigs | 0.25 - 0.5 pigs | 0.5 - 1.0 pigs | 1.0 - 1.5 pigs | 1.5 - 2.0 pigs | 2.0 - 2.5 pigs | 2.5 - 3.0 pigs | IF > 3.0 pigs give 1.0 pig range | | |
| BH-D | None | 0 - 0.25 pigs | 0.25 - 0.5 pigs | 0.5 - 1.0 pigs | 1.0 - 1.5 pigs | 1.5 - 2.0 pigs | 2.0 - 2.5 pigs | 2.5 - 3.0 pigs | IF > 3.0 pigs give 1.0 pig range | | |

Increase in Prewrite Mortality Rate (% of pigs born alive)

| | | | | | | | | | | | |
|------|------|----------|------------|------------|------------|------------|------------|-------------|----------------------------|--|--|
| BH-B | None | 0 - 1.5% | 1.5 - 3.0% | 3.0 - 4.5% | 4.5 - 6.0% | 6.0 - 7.5% | 7.5 - 9.0% | 9.0 - 10.5% | IF > 10.5% give 1.5% range | | |
| BH-C | None | 0 - 1.5% | 1.5 - 3.0% | 3.0 - 4.5% | 4.5 - 6.0% | 6.0 - 7.5% | 7.5 - 9.0% | 9.0 - 10.5% | IF > 10.5% give 1.5% range | | |
| BH-D | None | 0 - 1.5% | 1.5 - 3.0% | 3.0 - 4.5% | 4.5 - 6.0% | 6.0 - 7.5% | 7.5 - 9.0% | 9.0 - 10.5% | IF > 10.5% give 1.5% range | | |

Decrease in Litters Farrowed / Mated Female / Year

| | | | | | | | | | | | |
|------|------|-----------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|------------------------------------|--|--|
| BH-B | None | 0 - 0.1 litters | 0.1 - 0.2 litters | 0.2 - 0.3 litters | 0.3 - 0.4 litters | 0.4 - 0.5 litters | 0.5 - 0.6 litters | 0.6 - 0.7 litters | IF > 0.7 pig give 0.1 litter range | | |
| BH-C | None | 0 - 0.1 litters | 0.1 - 0.2 litters | 0.2 - 0.3 litters | 0.3 - 0.4 litters | 0.4 - 0.5 litters | 0.5 - 0.6 litters | 0.6 - 0.7 litters | IF > 0.7 pig give 0.1 litter range | | |
| BH-D | None | 0 - 0.1 litters | 0.1 - 0.2 litters | 0.2 - 0.3 litters | 0.3 - 0.4 litters | 0.4 - 0.5 litters | 0.5 - 0.6 litters | 0.6 - 0.7 litters | IF > 0.7 pig give 0.1 litter range | | |

Decrease in Pigs Weaned / Mated Female / Year

| | | | | | | | | | | | |
|------|------|--------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------------------------|--|--|
| BH-B | None | 0 - 0.5 pigs | 0.5 - 1.0 pig | 1.0 - 1.5 pig | 1.5 - 2.0 pig | 2.0 - 2.5 pig | 2.5 - 3.0 pig | 3.0 - 3.5 pig | IF > 3.5 pig give 1.0 pig range | | |
| BH-C | None | 0 - 0.5 pigs | 0.5 - 1.0 pig | 1.0 - 1.5 pig | 1.5 - 2.0 pig | 2.0 - 2.5 pig | 2.5 - 3.0 pig | 3.0 - 3.5 pig | IF > 3.5 pig give 1.0 pig range | | |
| BH-D | None | 0 - 0.5 pigs | 0.5 - 1.0 pig | 1.0 - 1.5 pig | 1.5 - 2.0 pig | 2.0 - 2.5 pig | 2.5 - 3.0 pig | 3.0 - 3.5 pig | IF > 3.5 pig give 1.0 pig range | | |

Animal Health Costs - Immunizations (including vaccines, LVI, feedback, etc.) (\$ / pig weaned)

| | | | | | | | | | | | |
|------|------|--------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|-----------------------------------|--|--|
| BH-B | None | \$0.0 - \$0.20/pig | \$0.20 - \$0.40/pig | \$0.40 - \$0.60/pig | \$0.60 - \$0.80/pig | \$0.80 - \$1.00/pig | \$1.00 - \$1.20/pig | \$1.20 - \$1.40/pig | IF > \$1.40/pig give \$0.30 range | | |
| BH-C | None | \$0.0 - \$0.20/pig | \$0.20 - \$0.40/pig | \$0.40 - \$0.60/pig | \$0.60 - \$0.80/pig | \$0.80 - \$1.00/pig | \$1.00 - \$1.20/pig | \$1.20 - \$1.40/pig | IF > \$1.40/pig give \$0.30 range | | |
| BH-D | None | \$0.0 - \$0.20/pig | \$0.20 - \$0.40/pig | \$0.40 - \$0.60/pig | \$0.60 - \$0.80/pig | \$0.80 - \$1.00/pig | \$1.00 - \$1.20/pig | \$1.20 - \$1.40/pig | IF > \$1.40/pig give \$0.30 range | | |

Animal Health Costs - Pharmaceuticals (\$ / pig weaned)

| | | | | | | | | | | | |
|------|------|--------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|-----------------------------------|--|--|
| BH-B | None | \$0.0 - \$0.20/pig | \$0.20 - \$0.40/pig | \$0.40 - \$0.60/pig | \$0.60 - \$0.80/pig | \$0.80 - \$1.00/pig | \$1.00 - \$1.20/pig | \$1.20 - \$1.40/pig | IF > \$1.40/pig give \$0.30 range | | |
| BH-C | None | \$0.0 - \$0.20/pig | \$0.20 - \$0.40/pig | \$0.40 - \$0.60/pig | \$0.60 - \$0.80/pig | \$0.80 - \$1.00/pig | \$1.00 - \$1.20/pig | \$1.20 - \$1.40/pig | IF > \$1.40/pig give \$0.30 range | | |
| BH-D | None | \$0.0 - \$0.20/pig | \$0.20 - \$0.40/pig | \$0.40 - \$0.60/pig | \$0.60 - \$0.80/pig | \$0.80 - \$1.00/pig | \$1.00 - \$1.20/pig | \$1.20 - \$1.40/pig | IF > \$1.40/pig give \$0.30 range | | |

Animal Health Costs - Diagnostics (\$ / pig weaned)

| | | | | | | | | | | | |
|------|------|--------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|-----------------------------------|--|--|
| BH-B | None | \$0.0 - \$0.05/pig | \$0.05 - \$0.10/pig | \$0.10 - \$0.15/pig | \$0.15 - \$0.20/pig | \$0.20 - \$0.25/pig | \$0.25 - \$0.30/pig | \$0.30 - \$0.35/pig | IF > \$0.35/pig give \$0.05 range | | |
| BH-C | None | \$0.0 - \$0.05/pig | \$0.05 - \$0.10/pig | \$0.10 - \$0.15/pig | \$0.15 - \$0.20/pig | \$0.20 - \$0.25/pig | \$0.25 - \$0.30/pig | \$0.30 - \$0.35/pig | IF > \$0.35/pig give \$0.05 range | | |
| BH-D | None | \$0.0 - \$0.05/pig | \$0.05 - \$0.10/pig | \$0.10 - \$0.15/pig | \$0.15 - \$0.20/pig | \$0.20 - \$0.25/pig | \$0.25 - \$0.30/pig | \$0.30 - \$0.35/pig | IF > \$0.35/pig give \$0.05 range | | |

2.2 Growing Pig Herd

Estimate productivity losses associated with PRRSV in growing pig herds

- for the production system you represent or herds you provided services to
- between January 1, 2005 and December 31, 2010
- do not pick one herd for each category, but report averages for all herds that fall into each category

Growing Pig Herd PRRSV status classifications:

| | |
|------|--|
| GP-A | Enter estimates for groups of growing pigs that are negative at placement and at closeout |
| GP-B | Enter estimates for groups of growing pigs that are negative at placement and positive at closeout |
| GP-C | Enter estimates for groups of growing pigs that are positive at placement |

Estimate the expected average productivity of a PRRSV free group of pigs (i.e. GP-A) from wean to finish for the following measures:

| | |
|--|--|
| Mortality Rate (% of pigs placed) | |
| Average Daily Gain (lbs/pig/day) | |
| Feed Conversion (lbs of feed/lb of gain) | |
| % Sold to Primary Market | |
| Animal Health Cost - Immunizations (\$/pig sold) | |
| Animal Health Cost - Pharmaceuticals (\$/pig sold) | |
| Animal Health Cost - Diagnostics (\$/pig sold) | |

Estimate the loss associated with PRRSV in affected groups of pigs from wean to finish (i.e. loss compared to groups of pigs negative at placement and closeout: GP-A)

| Response # | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Fill answer below | |
|---|------|----------|-------------|------------|------------|------------|------------|-------------|-----------------------------|-----------------------|----------|
| Increase in Mortality Rate (% of pigs placed) | | | | | | | | | | Response (#) or Range | Comments |
| GP-B | None | 0 - 1.5% | 1.5 - 3.0 % | 3.0 - 4.5% | 4.5 - 6.0% | 6.0 - 7.5% | 7.5 - 9.0% | 9.0 - 10.5% | IF > 10.5 % give 1.5% range | | |
| GP-C | None | 0 - 1.5% | 1.5 - 3.0 % | 3.0 - 4.5% | 4.5 - 6.0% | 6.0 - 7.5% | 7.5 - 9.0% | 9.0 - 10.5% | IF > 10.5 % give 1.5% range | | |

Decrease in Average Daily Gain (lbs / pig / day)

| | | | | | | | | | | | |
|------|------|--------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------------------------|--|--|
| GP-B | None | 0 - 0.05 lbs | 0.05 - 0.10 lbs | 0.10 - 0.15 lbs | 0.15 - 0.20 lbs | 0.20 - 0.25 lbs | 0.25 - 0.30 lbs | 0.30 - 0.35 lbs | IF > 0.35 lbs give 0.05 lbs range | | |
| GP-C | None | 0 - 0.05 lbs | 0.05 - 0.10 lbs | 0.10 - 0.15 lbs | 0.15 - 0.20 lbs | 0.20 - 0.25 lbs | 0.25 - 0.30 lbs | 0.30 - 0.35 lbs | IF > 0.35 lbs give 0.05 lbs range | | |

Increase in Feed Conversion (lbs of feed / lb of gain)

| | | | | | | | | | | | |
|------|------|--------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|------------------------------------|--|--|
| GP-B | None | 0 - 0.03 lbs | 0.03 - 0.06 lbs | 0.06 - 0.10 lbs | 0.13 - 0.16 lbs | 0.16 - 0.20 lbs | 0.20 - 0.23 lbs | 0.23 - 0.26 lbs | IF > 0.26 lbs give 0.035 lbs range | | |
| GP-C | None | 0 - 0.03 lbs | 0.03 - 0.06 lbs | 0.06 - 0.10 lbs | 0.13 - 0.16 lbs | 0.16 - 0.20 lbs | 0.20 - 0.23 lbs | 0.23 - 0.26 lbs | IF > 0.26 lbs give 0.035 lbs range | | |

Decrease in % Sold to Primary Market (% of pigs sold)

| | | | | | | | | | | | |
|------|------|----------|-------------|-------------|-------------|-------------|-------------|-------------|----------------------------|--|--|
| GP-B | None | 0 - 1.0% | 1.0 - 2.0 % | 2.0 - 3.0 % | 3.0 - 4.0 % | 4.0 - 5.0 % | 5.0 - 6.0 % | 6.0 - 7.0 % | IF > 7.0 % give 1.0% range | | |
| GP-C | None | 0 - 1.0% | 1.0 - 2.0 % | 2.0 - 3.0 % | 3.0 - 4.0 % | 4.0 - 5.0 % | 5.0 - 6.0 % | 6.0 - 7.0 % | IF > 7.0 % give 1.0% range | | |

Animal Health Costs - Immunizations (including vaccines, LVI, feedback, etc.) (\$ / pig sold)

| | | | | | | | | | | | |
|------|------|--------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|-----------------------------------|--|--|
| GP-B | None | \$0.0 - \$0.30/pig | \$0.30 - \$0.60/pig | \$0.60 - \$0.90/pig | \$0.90 - \$1.20/pig | \$1.20 - \$1.50/pig | \$1.50 - \$1.80/pig | \$1.80 - \$2.10/pig | IF > \$2.10/pig give \$0.30 range | | |
| GP-C | None | \$0.0 - \$0.30/pig | \$0.30 - \$0.60/pig | \$0.60 - \$0.90/pig | \$0.90 - \$1.20/pig | \$1.20 - \$1.50/pig | \$1.50 - \$1.80/pig | \$1.80 - \$2.10/pig | IF > \$2.10/pig give \$0.30 range | | |

Animal Health Costs - Pharmaceuticals (\$ / pig sold)

| | | | | | | | | | | | |
|------|------|--------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|-----------------------------------|--|--|
| GP-B | None | \$0.0 - \$0.30/pig | \$0.30 - \$0.60/pig | \$0.60 - \$0.90/pig | \$0.90 - \$1.20/pig | \$1.20 - \$1.50/pig | \$1.50 - \$1.80/pig | \$1.80 - \$2.10/pig | IF > \$2.10/pig give \$0.30 range | | |
| GP-C | None | \$0.0 - \$0.30/pig | \$0.30 - \$0.60/pig | \$0.60 - \$0.90/pig | \$0.90 - \$1.20/pig | \$1.20 - \$1.50/pig | \$1.50 - \$1.80/pig | \$1.80 - \$2.10/pig | IF > \$2.10/pig give \$0.30 range | | |

Animal Health Costs - Diagnostics (\$ / pig sold)

| | | | | | | | | | | | |
|------|------|--------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|-----------------------------------|--|--|
| GP-B | None | \$0.0 - \$0.05/pig | \$0.05 - \$0.10/pig | \$0.10 - \$0.15/pig | \$0.15 - \$0.20/pig | \$0.20 - \$0.25/pig | \$0.25 - \$0.30/pig | \$0.30 - \$0.35/pig | IF > \$0.35/pig give \$0.05 range | | |
| GP-C | None | \$0.0 - \$0.05/pig | \$0.05 - \$0.10/pig | \$0.10 - \$0.15/pig | \$0.15 - \$0.20/pig | \$0.20 - \$0.25/pig | \$0.25 - \$0.30/pig | \$0.30 - \$0.35/pig | IF > \$0.35/pig give \$0.05 range | | |

2.3 Biosecurity and other outbreak related losses associated with PRRSV in the production system

Estimate biosecurity and other outbreak losses associated with PRRSV in production systems

- *for the production system you represent or herds you provided services to*
- *between January 1, 2005 and December 31, 2010*
- *report averages of all production systems*
- *Reference PDF Guidance Documents to complete this section*

Estimate AVERAGE ANNUAL biosecurity costs attributable to PRRSV in the production system

| Response # | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Fill answer below | |
|-----------------------------|--|--------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|-----------------------------------|-----------------------|----------|
| Biosecurity (\$ / pig sold) | <i>Note: see the <u>Biosecurity Costs Worksheet</u> for specific biosecurity costs to consider</i> | | | | | | | | | Response (#) or Range | Comments |
| | None | \$0.0 - \$1.00/pig | \$1.00 - \$2.00/pig | \$2.00 - \$3.00/pig | \$3.00 - \$4.00/pig | \$4.00 - \$5.00/pig | \$5.00 - \$6.00/pig | \$6.00 - \$7.00/pig | IF > \$7.00/pig give \$1.00 range | | |

Other Outbreak Related Costs (\$ / pig sold)

Note: see the Other Outbreak Related Costs Worksheet for specific biosecurity costs to consider

Include costs during and after an outbreak due to pig flow, stocking and movement changes, more intensive care of pigs, production contract penalties, etc.

| Response # | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Fill answer below | |
|------------|------|--------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|-----------------------------------|-----------------------|----------|
| | None | \$0.0 - \$0.50/pig | \$0.50 - \$1.00/pig | \$1.00 - \$1.50/pig | \$1.50 - \$2.00/pig | \$2.00 - \$2.50/pig | \$2.50 - \$3.00/pig | \$3.00 - \$3.50/pig | IF > \$3.50/pig give \$0.50 range | Response (#) or Range | Comments |

Survey complete, THANK YOU!