Economic Analysis of PRRS Virus Elimination from a Herd

A.S. Leaflet R2678

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Summary and Implications

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.

Introduction

A recent study by the authors showed that the annual cost of PRRS to the pork industry was significant. 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 estimated total cost of PRRS in the U.S. national breeding and growing pig head was at $664 million annually ($1.8 million per day).

In addition, information on veterinary costs, biosecurity costs, and other costs from the survey of expert opinion were used to estimate. These 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.

Along with the cost of PRRS through lost productivity, etc. information on the cost of eliminating the virus from a herd is also useful. This was done through the use of a net present value analysis.

Materials and Methods

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. In addition to the direct cost associated with elimination of the virus, the analysis considered all the monthly costs and revenues associated with being PRS 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.

Information in Table 1 shows the classification of breeding herds and growing pig herds. For the breeding herd the classifications are based on the classification system developed by the American Association of Swine Veterinarians (AASV) and the United States Department of Agricultural PRRS Coordinated Agricultural Program (PRRS-CAP). Breeding herd categories are BH-A, BH-B, BH-C, and BH-D. Growing herd categories are GP-A, GP-B, and GP-C. Descriptions of each category are provided in Table 1.

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 2. 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 break even 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 PH-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 product 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 3). 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.

Results and Discussion

The costs and revenues used to conduct the economic analysis of productivity losses due to PRRS are presented in Table 4. 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 5. 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.

Acknowledgements

Funding for this project was provided by the National Pork Board, Des Moines, IA.

Table 1. Classification of breeding herds and growing pig herds for estimating the impact of PRRS virus.

Breeding Herd 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
Growing Pig 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 2. 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.

	Elimination		Status Quo	
Phase	**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	Min. value that yields a positive NPV		
Post-outbreak	BH-B	12		
Remainer 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	Min. 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	Min. 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	Min. 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	Min. 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	Min. value that yields a positive NPV		
Post-outbreak	PH-B	12		
Remainder of 10 year period	BH-C	Balance of months	BH-C	Balance of months

Table 3. 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 4. 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	19289	19,289	19,289
Difference (from BH-A)		-3,977	-3,977	-3,977	-1,423	-1,423	-1,423	-2087	-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
Different (from BH-A)		-$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
Difference (from BH-A)		$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
Difference (from BH-A)		-$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	$1,6077	$18,093	$18,437	$18,609	$17,490	$17,740	$17,823
Difference (from BH-A)		-$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
Difference (from BH-A)		-$587,443	-$540,652	-$524,930	-$284,404	-$212,715	-$176,474	-$363,263	-$311,391	-$294,967
Total costs ($/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	$2,199,200
Difference (from BH-A)		-$489,890	-$472,986	-$467,325	-$202,005	-$176,128	-$163,112	-$276,920	-$258,181	-$251,903
Net profit ($/year)	$200,792	$103,239	$133,126	$143,188	$118,394	$164,206	$187,430	$114,450	$147,582	$158,737
Difference (from BH-A)		-$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
Difference (from BH-A)		-$731,371	-$684,580	-$668,857	-$335,890	-$264,200	-$227,960	-$438,804	-$386,932	-$369,500
Total costs ($/year)	$3,167,447	$269,899	$2,707,803	$2,713,464	$2,978,791	$3,004,668	$3,017,685	$2,907,926	$2,926,665	$293,294
Difference (from BH-A)		-$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
Difference (from BH-A)		-$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
Difference (from BH-A)		-$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 5. 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 (BHB 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