January 2005

# PRRSV Negative Herds: A Survival Analysis

Locke Karriker
*Iowa State University*

Ruby Destajo
*Iowa State University*

# PRRSV Negative Herds: A Survival Analysis

**Locke A. Karriker**
**Ruby Destajo**[1]

**Summary and Implications**

*Despite a significant body of research, interventions for PRRSV infection remain elusive. Traditional approaches to managing the risk of diseases have not been successful in many cases of PRRSV infection. While elimination of the virus from farms is possible, it is not without cost and re-infection is common. This survey sought to quantify the expected duration of PRRSV negative status on farms that were repopulated with PRRSV negative animals or had undergone a PRRSV elimination program. Results of 96 cases reveals a range of <1 to 312+ weeks duration of negative status. A survival analysis of 84 farms revealed a probability of surviving with negative status for two full years of 58.3% with a standard error of 11.5%. The probability of survival through 4 years was 42% with a standard error of 16%. A greater percentage of farms that were re-infected shared resources such as equipment, personnel, and/or vehicles with known positive farms. Positive farms also had a relatively shorter average distance to known positive farms than those remaining negative. The results of this study indicate that PRRSV-negative farms are not very likely to remain negative for a long duration given current technologies. Longer survival of negative status appears to be associated with greater distance from known positive farms and stricter biosecurity. Sharing of equipment and other resources as well as a closer distance to other farms should be considered risk factors that can lessen the probability of farms maintaining negative status.*

**Introduction**

Porcine Reproductive and Respiratory Syndrome Virus (PRRSV) remains a constraint to productivity and profitability in swine herds world-wide, costing about \$228 to \$302 per female in the breeding herd and about \$6.25 to \$15.25 per pig in the growing herd according to Iowa State University research. While an extensive body of research over the past decade has characterized the virus, the pathological lesions associated with infection, interactions with other disease etiologies, and eventually led to the development of diagnostic tests for both the virus and antibodies to it, control in and among swine herds remains elusive.

Elimination of the virus from swine herds has proven to be a challenging task and has increasingly been the focus of discussions surrounding the topic of PRRSV management and interventions in the herd. Some of the reasons for its persistence in the herd pertain to what is known or commonly accepted about the behavior of the virus in individual animals:

1) Boars can shed virus in semen intermittently for extended periods of time with few or no clinical signs.
2) Persistently infected animals exist and can shed to naïve contacts.
3) The immune response in the pig is poorly understood and/or variable given different contexts.

Other reasons pertain to established facts about viral behavior in populations:

1) PRRSV subpopulations exist in endemic breeding herds.
2) Multiple genetically diverse PRRSV strains can coexist on farms simultaneously.
3) Vertical and horizontal transmission of PRRSV occurs by many known routes and potentially by additional unknown routes.
4) Infection can occur in utero and produce piglets that are viremic at birth
5) The introduction of negative gilts to positive farms, or gilts that have been exposed to a genetically diverse strain of PRRSV can lead to sustained PRRSV circulation on farms.
6) Vaccine efficacy is highly variable depending on vaccine type (killed versus modified live virus), genetic relatedness of the vaccine virus and wild type, and timing of vaccination relative to exposure.

Because successful, profitable production requires successful risk management, increasingly formal

*(Continued on next page)*

risk analysis methods are being applied to swine health. One formal definition of risk was presented by Iowa State University in 2003:

Risk = Pr(event)*consequence
Where:
Pr = probability
Event = the defined hazard

Therefore, to reduce risk, it is necessary to reduce the probability of disease and/or reduce its consequences. Speaking of disease in general, probability reducers include: biosecurity, uni-directional pig flow, shower-in / shower-out, traffic and visitor control, eliminating employee contact with other swine herds and rodent control. Historical approaches to reducing the consequence of disease include: adequate nutrition, appropriate ventilation, vaccination, acceptable stocking densities, water quality and availability, and reduction of stressors.

In the context of "financial loss (or cost) due to PRRSV" as the hazard, reviewing what is already known and generally accepted about PRRSV yields few opportunities to reduce the probability or consequences of clinical PRRSV infection on farms. Most of the typical reducers of consequence have been shown to have little or no impact on the cost of PRRSV. Additionally, farms that have virus circulating would be considered at high probability for clinical signs in animals and therefore have a high risk of cost due to PRRSV. This has led to consideration of PRRSV negative status as an opportunity to greatly reduce the probability of cost due to PRRSV on farms.

Several PRRSV strategies have been outlined to eliminate virus from positive farms. The most common methods are 1) total depopulation/repopulation, 2) "rollover" scenarios where positive farms take advantage of a decline or stop in circulation and switch to introduction of negative replacements, 3) herd closure, and 4) test with removal. These strategies have several common elements including the necessity to stabilize immunity (through depopulation, natural circulation over time, or forced exposure/acclimation) and reduce the risk of new virus exposure. Farms that are populated with naïve animals initially also share the latter risk. It is unrealistic to expect negative farms to remain negative indefinitely because:

1) There are costs associated with the various elimination strategies,
2) Many anecdotal experiences have been described for farms that have been infected or re-infected despite significant biosecurity interventions,
3) Biosecurity interventions incur costs,
4) Existing facility location and design have been identified as risk factors and are not easily changed, especially in light of the political regulatory climate.

As discussed here and elsewhere, the costs of PRRSV (and therefore, the expected improvement in animal performance upon elimination) have been estimated. With the addition of information on the likely duration of negative status, the financial return can be estimated. Thus, a preliminary survey was conducted to quantify the expected duration of PRRSV-negative status on farms that were repopulated with PRRSV negative animals or had undergone a PRRSV elimination program.

### Methods

The survey was conducted in October and November, 2003 among 45 selected swine veterinary practitioners who are American Association of Swine Veterinarians members. Selection criteria included their experience in handling PRRSV-negative farms and /or whether they have initiated elimination of the virus from positive herds.

### Results

Responses were received from 39 veterinarians, an 86% response rate. Forty-six percent of the veterinarians who responded had PRRSV elimination projects occurring on 96 farms.

A majority of the farms serviced by participating veterinarians were farrow-to-wean (63%). About half of those (31%) were farrow-to-finish. Twenty-three percent of the farms (n = 22) inventoried 1,000 or fewer females, about 37% of the farms (n = 36) inventoried 1,000 to 2,000 females, 21% of the farms (n = 20) had 2,000 to 3,000 females, and 19% of farms (n = 18) had more than 3,000 females.

Although the reasons that motivate swine practitioners to strive to eliminate PRRSV are interrelated, most of the respondents indicated a need to eliminate the virus to be able to provide negative replacements (81%) for their current stock. Others were primarily motivated to improve the farm's commercial (17%) and genetic performance (10%). Some did it for other purposes like research and *Actinobacillus pleuropneumonia* depopulation (8%). About 17% of the respondents cited multiple reasons for beginning an elimination effort.

Of the methods of elimination discussed above, 44% of the respondents incorporated herd closure as a technique, wherein introduction of replacement stock was suspended for a defined period of time and subsequently a new naïve batch was introduced. Nearly 40% opted for complete depopulation of the farm and subsequent repopulation with naïve

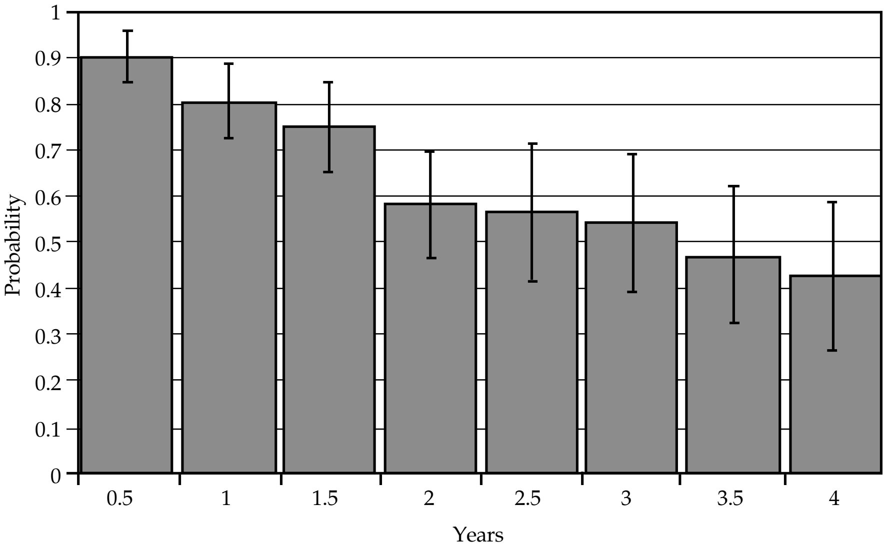


**Figure 1. Probability of survival through time period — all farms (N = 84).**

animals after thorough cleaning. Only 1% followed the test-and-removal method in eliminating the identified positives from the herd. Some (27%) used a combination of the known methods while 26% were not satisfied with these methods and tested other means not mentioned in the list.

The respondents were asked about the week and year of recent clinical PRRSV occurrence prior to elimination to establish the timing of original break and the week and year of completion of the elimination action to establish the timing of the elimination action. Completion of an elimination activity was arbitrarily defined as the date when the first PRRSV naïve animal farrowed. If the farm was subsequently infected, they were asked about the week and year of the first clinical PRRSV infection after the completion of the previous elimination action to establish the timing of subsequent reinfection. Initial PRRSV infection, elimination and reinfection had to be confirmed with diagnostic testing.

Eighty-four of the farms serviced by the respondents were included in the survival analysis. There were 48 farms that had remained negative for PRRSV at the time of the survey. The remaining 36 farms experienced subsequent reinfection (rebreaks). The period of survivorship was defined as that period from the time of completed elimination action to the date of survey (for negative farms) or to the time of rebreak (for positive farms). Survivorship curves and standard errors were estimated for 1) all farms, 2) farms that used depopulation-repopulation method, and 3) farms that used herd-closure technique. No significant differences were found between the curves. Survival analysis of all farms resulted in a decreasing probability of remaining PRRSV-negative with time (Figure 1).

When asked about the causes for PRRSV rebreaks, 36% of the veterinarians who responded indicated they had no explanation. About 31% believed area spread, including lateral spread by insects was believed to be the culprit. Infected replacement stocks including transmission through semen and infected gilts were reasons cited by 22% of the respondents. Eleven percent blamed the cause for reinfection on the equipment being used in the farm (11%). A greater percentage of positive (40%) than negative farms (12.5%) shared resources with a known positive farm. As expected, the average distance of a positive farm to a known PRRSV-positive farm was shorter than that of a negative farm (5.38 miles for positives; 15.15 miles for negatives).

Swine practitioners were also encouraged to give their comments about PRRSV. One of the problems encountered with remaining PRRSV negative is farm location, according to some respondents. The area around the farm became highly populated with swine sometime after the farm was built. Another problem mentioned was that the farm's isolation facility was located too close to the sow farm to prevent infection of incoming gilts. Some complained of positive pigs located within half a mile of the farm. There were those who suspected transport transmission but could not verify it because no similar PRRSV isolates were identified in the nearby area. Others obtained PRRSV viral isolates that were more closely related to the neighbor's farm than historical isolates from the home farm.

While a good starting point, the results of this preliminary survey are limited because of bias in recall or in targeting farms, small sample size, in the classification of strategies, in definitions, and in the setting of an arbitrary starting point. To further understand the issue, it is recommended a prospective study and a thorough epidemiologic investigation of breaks be performed.

---

[1]Locke Karriker and Ruby Destajo are veterinarians in the Veterinary Diagnostic and Production Animal Medicine Department at Iowa State University. References are available from the authors at karriker@iastate.edu. This paper was made possible by the contribution of numerous practitioners who donated the time necessary to compile and summarize their experiences. We sincerely appreciate their willingness to share that information and time.