Control and Elimination of PRRS Virus

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Introduction

Porcine Reproductive and Respiratory Syndrome virus (PRRSv) can cause significant production losses due to reproductive failure including abortions, stillbirth, and premature farrowings. In growing pigs, it can cause increased mortality and decreased growth performance and increased number of cull pigs. The economic impact of an acute PRRSv outbreak in the breeding herd was estimated at USD $255 per sow and at USD $6.25 to 15.25 per growing pig (Holck and Polson, 2003). Neumann et al. (2005) estimated the annual cost for the US swine industry to be $560 million dollars. Losses in the breeding and farrowing phase accounted for 12% of the total annual economic loss whereas the nursery and grower-finisher phase accounted for 36% and 52%, of the loss respectively.

Diagnostic tests exist such as PCR for detecting virus, virus sequencing for epidemiological investigations and ELISA for quantifying antibody as a reflection of previous infection. Serum is the traditional sample of choice for diagnostic investigations. A recent development is collecting saliva by hanging ropes in a pen and Zimmerman and co-workers (Wang et al, 2010) have described this as a highly sensitive sample for PCR detection of virus. This being the case, when compared to sampling serum, one can effectively increase sensitivity of detection by increasing sample size of pigs tested with the same diagnostic costs. Or, one can choose to achieve the same sensitivity of detection with lower diagnostic costs. In either case, pen-based saliva samples offer an innovative approach to PRRS virus detection. The assays for testing saliva for ELISA antibody are under development.

PRRSv has been documented to mutate constantly by changing its genetic appearance (Murtaugh et al. 1995) and this presents an important challenge for herd-level and regional control. But despite this challenge, significant progress has been made in understanding biosecurity measures for
preventing PRRSv entry into swine herds, transmission routes and PRRSv control and elimination strategies.

- **Keeping the Virus Out**

Infected pigs are the highest risk source of virus to infect a herd. PRRSv has been detected in oral fluids, mammary gland secretions, nasal secretions and semen. However, indirect routes such as contaminated boots and coveralls, transport vehicles, needles, and houseflies are also important. PRRS virus has been detected in water and swine lagoon effluent for 11 and 7 days, respectively.

Recently, aerosol transmission (Otake et al., 2010) has been implicated after detecting PRRSv in aerosols as far away as 9.2 km from the source. To address this risk, some sow farms and boar studs have installed air filters for all incoming air. Results to-date indicate profound success (Dee 2010). As experience continues to evolve, cost of installation has decreased such that current costs are in the order of US $150 / sow space. Given the cost of a clinical PRRSv outbreak, payback can be less than a year if at least one clinical outbreak is prevented. An important caveat is that the biosecurity program for a sow farm is only as strong as its weakest link and filtering incoming air will not be a wise investment unless all other routes of viral introduction are eliminated.

- **PRRS Control at the Herd Level**

The first objective in controlling PRRSv within infected sow herds is to produce PRRSv negative (not infected) weaned pigs. Several management strategies have been reported to assist in achieving this goal.

**Semen**

Based on the fact that PRRSv can be transmitted to sows via semen, it is imperative to avoid introducing contaminated semen into the sow herd. Presently, most boar studs in the US are PRRSv negative and are routinely tested for PRRSv in order to detect and eliminate the virus should an infection occur. PRRSv may not be detected by PCR in boar serum or semen until 24 or 96 hours post-infection respectively (Reicks et al., 2006) suggesting there is a window of time during which the virus will not be detected. Serum continues to be the most sensitive sample for boar stud monitoring.
**McRebel**

McCaw (2000) introduced the McRebel concept to control spread of pathogens in suckling pigs. The acronym McRebel stands for "Management Changes to Reduce Exposure to Bacteria to Eliminate Losses". Measures such as decreasing cross-fostering to a minimum, eliminating poor doing non-responsive pigs, changing needles between litters or pens and taking extra care of the smallest pigs are included. Breeding farms that undergo a PRRSv elimination process that did not include thorough and continued McRebel management practices have had recurrent recirculation of the virus in the piglet population (Polson et al, 2010) highlighting the importance of these management practices.

**Gilt Acclimation**

Once a breeding herd has become infected with PRRSv, gilt introduction becomes one of the most important factors for PRRSv control. Gilts are susceptible to PRRSv infection and recirculation if they have not developed protective immunity prior to introduction into the breeding herd. If gilts become viremic during the breeding period, they will be a source of virus for the herd which could result in transmission to the neonatal pigs. Gilts that are infected with PRRSv in their growing phase will create future breeding animals that once introduced into the breeding herd could be at least partially immune to reinfection. Therefore, the goal in a PRRSv acclimation program is to expose gilts at a young enough age to the same strain of virus that is resident in the herd into which they will be introduced such that they are immune and non-viremic before entering the breeding herd. Early in the acclimation program, gilts can be exposed to PRRSv using different programs. One way is to expose gilts to viremic nursery pigs which may transmit the virus to the gilts. A second method is to intentionally expose incoming gilts to the resident PRRSv by live virus injection (Batista et al., 2002). Potential risks with this method are the spread of other pathogens, increased mortality and possible generation of PRRSv aerosols posing a risk for neighboring herds. One important advantage to this method is that the actual exposure date will be known and theoretically all gilts will develop immunity against the resident PRRSv at about the same time, thereby providing the basis for the elimination of the virus at the population level. A third acclimation option is to vaccinate gilts during the acclimation period. With this option, gilts receive one or two immunizations using a modified live vaccine prior to entering the breeding herd. The younger that gilts are vaccinated, the more time they will have to mount a solid immune response and will be better prepared if exposed to a field strain of PRRSv.

**Vaccination**

Modified live virus (MLV) vaccines have been used in gilts, sows and growing pigs for the control of PRRSv. In controlled challenge experiments, MLV
vaccine has reduced mortality and poor growth when vaccinated pigs were challenged with either the parent strain from which the vaccine had been prepared or a heterologous strain (Roof, 2008). MLV vaccine has also been administered repeatedly within an infected population of growing pigs and the number of persistently infected and shedding pigs was reduced (Cano et al., 2007). Spronk et al (2009) reported that vaccinated pigs weaned from stable sow farms and exposed to multiple field strains performed better than previously weaned batches that had not been vaccinated. MLV vaccines also have been reported to aid in the control and elimination of field virus from infected breeding herds.

Inactivated PRRSv vaccines have been reported by some to improve farrowing rate, return to estrus and piglets weaned per sow in endemically infected populations (Alexopoulos et al., 2005). However, others have reported that inactivated commercial vaccines have not conferred protection (Zuckermann et al., 2007) when administered alone or in conjunction with MLV vaccine to gilts which were subsequently experimentally challenged (Reicks et al 2010).

### PRRS Elimination from Sow Herds

Different methods have been described for eliminating PRRSv from sow herds including test and removal, whole herd depopulation/repopulation and herd closure. Herd closure and rollover has become the most widely used and least expensive method. This method was first described by Torremorell et al. (2003) and consists of interrupting the introduction of incoming replacement females into the breeding herd for at least 6 months plus the elimination of seropositive animals over time. The objective of stopping the introduction of new animals into the herd is to decrease the number of susceptible animals in which the pathogen can replicate, thereby favoring the elimination of the virus. Breeding herd performance may improve after the elimination plan has been completed (Schaefer et al 2008). Planned exposure of the breeding herd with homologous virus or MLV vaccine as a last step before stopping the introduction of the last infected replacement animals, increases herd immunity when closure is initiated. The objective of exposing all breeding animals at once is to ensure that all sows have been exposed and had an opportunity to mount an immune response. Once all sows have mounted an immune response transmission should decrease. Although persistently infected individuals may exist temporarily, if there are no susceptible animals remaining in the herd, the ability of the virus to circulate within the herd will be significantly reduced or eliminated. Following intensive testing that confirms that the herd is PRRS negative, future animal introductions must be with PRRSv negative gilts and semen to maintain the herd free of the virus.
Regional Control / Elimination of PRRS Virus

Due to the economic impact of PRRSv on swine production and the many routes that the virus can spread between herds, regional elimination programs may be the best method for effectively controlling and eliminating the virus from all herds within an area. In addition, the epidemiological features of PRRSv highlight the need for regional, geographically defined or national collaborative control and elimination programs.

As we contemplate a regional effort, it’s important to establish the goal. A regional control program might be defined as:

- reduction of disease incidence, prevalence, morbidity or mortality to a locally acceptable level as a result of deliberate efforts. Continued intervention measures are required to maintain the reduction.

In contrast, a regional elimination program would be:

- reduction to zero incidence of a pathogen in a defined geographical area as a result of deliberate efforts. Continued measures to prevent re-establishment of transmission are required.

(http://www.cdc.gov/MMWR/preview/mmwrhtml/su48a7.htm)

In a voluntary program, we cannot assure 100% participation, and therefore, we cannot know if we have achieved the goal of 100% regional elimination.

In the U.S., a regional program was started in Stevens County in west central Minnesota. During 2004, a group of pork producers and local veterinarians decided to seek regional PRRSv control. The producers and veterinarians organized structured meetings inviting all producers in the county to discuss the feasibility and interest in initiating a county wide elimination program. Since the start of the project, 87 farms have been located as well as one hog-buying station and one truck cleaning facility. As of today, 83 farms have participated of which 19 farms have at least one sow, 8 farms having only nursery pigs, 2 farms are boar studs, 3 being boar stud isolation units and the remaining 51 sites housing nursery and/or finishing pigs. Of the 19 sow sites, 4 are herds that produce replacement animals and the remaining 15 are commercial sow herds. The estimated number of sows in Stevens County in 2010 was 17,844 sows, with 16,700 (93.5%) sows owned by 5 entities. Most of the pigs weaned from these sow farms either stayed at the same location or were moved off-site within the county. Eight of the 51 finishing farms receive pigs from neighboring counties of which 4 are owned by Stevens County producers.

Producers were contacted to enlist their participation and schedule a visit for sample collection. Blood samples were drawn from sows and/or finishing pigs.
Samples were then tested using ELISA and possibly PCR. Farms that tested positive through PCR and/or ELISA were classified as positive. Farms that had >0% and <10% positive ELISA results had those positive samples tested again through indirect immunofluorescent antibody (IFA) assay, and if there were no positive results, farms were classified as negative. Owners of farms that tested PCR positive were encouraged to pursue a PRRSv elimination program. Three producers with 200, 3000 and 3400 sows eliminated the virus by herd closure and one 1200 sow farrow-to-feeder operation conducted depopulation / repopulation. These 4 sow farms provided pigs to 24 sites in Stevens County and all of these downstream sites eliminated the virus by partial or complete depopulation. Presently there are 4 herds that have unknown status and the remainder are thought to be negative.

Although voluntary surveillance has decreased since most, and possibly all of farms have eliminated the virus from the region, we are confident that PRRS prevalence has remained low. Most producers are aware of the high risk of re-infection in the county and maintain biosecurity protocols. Four sow herds and 2 boar studs sell breeding stock and have active surveillance. Most of the commercial sow farms have regular veterinary visits through which diagnostic investigations are regularly conducted. And finally, testing at the county summer fair and at a local collection point for cull stock has not detected any positive samples.

In part because of the apparent success of the Stevens County project, a USDA funded research project was approved with a portion of the funds directed at initiating other regional projects. The intent is to involve projects around the country with each project addressing a unique challenge to PRRS control / elimination. Currently supported regions and their corresponding control challenges are:

<table>
<thead>
<tr>
<th>Region</th>
<th>Challenge</th>
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<tbody>
<tr>
<td>N212MN</td>
<td>Surveillance and monitoring in low dense region</td>
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<tr>
<td>W Michigan</td>
<td>Getting 100% participation within a region</td>
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<tr>
<td>Carthage, IL</td>
<td>Large integrated producers working with small independents</td>
</tr>
<tr>
<td>Bethany, IL</td>
<td>Farrow to finish single site herds &amp; eliminating MLV vaccine</td>
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<tr>
<td>Pennsylvania</td>
<td>How to best define the region</td>
</tr>
<tr>
<td>Iowa</td>
<td>Understanding risk of pigs entering a region</td>
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<tr>
<td>Nebraska</td>
<td>Using sequence data to understand spread</td>
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Although the regional projects are relatively early in their development, the experience of Stevens County suggests that regional control and possibly elimination of the virus is possible. In United States, the National Pork Producers Council (NPPC) conducts public-policy outreach on behalf of its 43 affiliated state associations, and works closely with the National Pork Board. NPPC recently passed a motion endorsing regional elimination of PRRS.

**MOTION:** The National Pork Producers Council recommends working towards a united goal of eliminating the PRRS virus and eliminating the PRRS (Porcine Respiratory and Reproductive Syndrome) disease from the U.S. swine herd. The policy should support and identify resources and investments for accomplishing this goal. The policy must not make eradicating the PRRS virus a government mandate. **Action:** Passed as Amended

The importance of accomplishing this goal through a voluntary program is emphasized in the motion. With this in mind, the US is cautiously pursuing a producer-led, voluntary program. Time and experience will determine whether regional elimination is possible when voluntary involvement does not assure 100% participation. Regional projects are focusing in the lower density areas of the country and one can imagine the perimeter of the country becoming PRRS free. The experience to date with filtered sow barns and boar studs is also encouraging and could lead to coalescing bubbles of PRRS free regions in hog dense regions.

### Conclusion

While research continues to reveal new diagnostic tests, biosecurity priorities and control methods, we have adequate knowledge today to cost effectively eliminate the virus from sow herds. Furthermore, we know that regional programs can effectively decrease the risk of infection. And, we know that we can cost effectively insulate the herd from neighboring herds by filtering incoming air. With this knowledge and experience, the North American industry will no doubt move down a path of eliminating PRRS virus.

### Acknowledgements

This paper is a revised and condensed version of a manuscript accepted for publication in Virus Research and is published here with permission.

Many colleagues are involved with the regional control project in Minnesota including local producers, veterinarians, and Drs. Enrique Mondaca, Spencer Wayne, Cesar Corzo, Montse Torremorell, Scott Dee and Peter Davies at
UMN. Financial support has been received from USDA (55 591 7996) and by PRRS CAP (USDA NIFA Award 2008-55620-19132).

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