

## Transport Biosecurity and PRRSV Disease Transmission Risk – Literature Review

### Introduction

Porcine Reproductive and Respiratory Syndrome Virus (PRRSV) was first identified in North America in 1987. It is a pandemic disease that causes reproductive failure in swine breeding herds and respiratory tract illness in young pigs. It is estimated that the disease costs the U.S. hog industry in excess of \$600M annually (www.thepigsite.com, Feb 2011). The same source states that more than one-fifth of all U.S. breeding herds and more than half of all commercial farms with more than 500 sows have been affected by PRRSV, meaning the disease is a major economic threat to commercial pig breeders as well as a significant animal welfare and global food security issue. Published reports have documented losses of U.S. \$229 per inventoried sow over a 12-month period on 34 farms affected by PRRSV (Dee et al, 1997). Waddilove (2008) states that in acute PRRSV outbreaks it has been calculated that the average cost per sow in the first year is U.S. \$255, with an annual ongoing cost of U.S. \$76 per sow.

It is well documented that the viability of PRRSV outside the host (hog) is poor if the carrier is allowed to dry or is exposed to chemical disinfection or heat (Pirtle and Baren, 1996 – quoted by Dee et al, 2002). Benfield et al (1992) reported that the virus is unable to survive beyond 6 to 20 minutes at 56 °C. However, it has also been reported that the virus can be viable for up to 9 to 11 days at temperatures as high as 25 °C if moisture is present and it can be preserved for several months if kept frozen (Dee et al, 2002).

Schneider et al (2011) state that understanding how pigs are exposed and preventing PRRSV transmission is critical for successful control and elimination of the virus. Over the years, PRRSV has proven to be a difficult disease to consistently control over time and across farms (Dee et al, 2004) despite the fact that much is known about the routes of transmission of the virus. Over the last 10 years, there has been a large quantity of information published on biosecurity practices designed to reduce the risk of PRRSV transmission between farms, resulting in an enhanced level of vigilance throughout the industry. Whereas initially much of the biosecurity information was directed at on-farm practices, more recently, attention has been focused on reducing the risk of PRRSV transmission via routine transportation of hogs. Deen et al (2004) stated that with the advent of multi-site hog production as well as a centralization of hog finishing and slaughter facilities due to favourable economics in some parts of the U.S., transport vehicles carry hogs with increasing frequency.

Every day in North America, hundreds of hog transportation vehicles (trailers) are engaged in the process of moving various classes of hogs including iso-weans, feeder pigs, market hogs, cull sows and boars and breeding stock. Poumian (1995) stated that the process of transport has long been considered an important risk factor for pathogen entry into swine farms through the contact of naïve pigs with contaminated transport vehicles. Dee et al (2002 and 2003) have reported that transport vehicles can act as fomites (inanimate object capable of carrying an infectious organism) resulting in the possibility of long-distance spread of PRRSV. Transmission of other pathogens via transport vehicles including *Salmonella* spp., *Actinobacillus pleuropneumoniae*, *Streptococcus suis* and classical swine fever,

has also been demonstrated. However, the current project uses PRRSV as the model so the scope of this review will be limited to a discussion of how transport vehicles affect the transmission of this disease.

Much of the published work in the area of transport-vehicle transmission of PRRSV has been conducted by Dr. Scott Dee and associates at the University of Minnesota. From 2002 to 2005, they published a series of six papers ranging from the role of the transport vehicle as a source of transmission to an assessment of sanitation protocols and disinfectants in both warm and cold weather. The basic experimental unit of all their studies was a model transport vehicle designed by the University of Minnesota Department of Biosystems and Agricultural Engineering. The models were replicas of full-size weaned-pig trailers built to a 1:150 scale. The scale of the trailers was such that the model trailer accommodated two 5 kg pigs compared to a full-size weaned-pig trailer capable of transporting three hundred 5 kg pigs. The advantage of the trailer models was that they allowed for frequent replication of treatments which would have been extremely challenging using full-size commercial transport vehicles. In the majority of studies, virus detection was accomplished through polymerase chain reaction (PCR) on swabs collected from the trailer interior followed by housing of naïve pigs in the treated trailers to determine the infectiousness of the virus. This was normally followed by testing of the organic debris collected from the interior of the trailers by swine bioassay to further validate the infectiousness of the virus.

#### Cold versus Warm Weather

In the first two papers in the series (Dee et al, 2002 and 2003) the authors developed a field model to test the mechanical transmission of PRRSV into a simulated farm setting using a coordinated sequence of events during warm (defined as between 10 and 20 °C) and cold weather (defined as < 0 °C). The studies were based on the hypothesis that mechanical transmission of the virus is a frequent event during cold weather. It was also hypothesized that while mechanical transmission of PRRSV can occur during warm weather, it is not considered to be a frequent event. During earlier visits made to commercial swine operations from 1987 to 2001, the investigators had made a number of assumptions which were tested in the field model. These assumptions were:

- 1) PRRSV can survive outside the host for extended periods, thereby enhancing mechanical transmission from site to site.
- 2) Livestock transport vehicles, veterinary vehicles and other fomites such as boots can contact PRRSV at potentially contaminated sites such as infected farms, commercial truck washes or slaughterhouses.
- 3) The introduction of PRRSV-contaminated fomites (animal health products, semen, etc.) into the farm office can result in infection of the swine population.

In the cold weather study, a total of 10 replicates were conducted over a 5-day period. Two replicates were conducted each day along with 2 control replicates (positive and negative). Temperatures on the five sampling days ranged from a low of -9 °C to a high of -2 °C. In 8 of the 10 replicates, PRRSV nucleic acid was detected by PCR at multiple sampling points (truck wash floor, boots and floor mats in the cab of the truck as well as various containers including semen coolers, employee lunch pails, pharmaceutical

boxes and an electrician's tool box). The virus originated at the contamination site (commercial truck wash facility) and continued through to some or all of the containers that were placed into the simulated farm anteroom (the area encountered immediately upon entering the front doorway of a swine farm that has a shower in-shower out procedure). In the two replicates where PRRSV was not detected by PCR, it was concluded that transmission was interrupted from the truck wash floor into the vehicle cab and from the vehicle cab into the simulated farm anteroom. Infectious PRRSV was recovered from at least 1 sampling point in 5 of the 10 replicates. As further verification of the infectiousness of the virus, six pigs were inoculated with the virus collected from containers found to be PCR-positive. Samples from all 6 were positive for PRRSV RNA by PCR testing on day 7 and PRRSV-antibodies by ELISA testing on day 14 post-inoculation. The authors concluded that under the proper conditions (cold weather), daily practices to improve the hygiene of vehicles (i.e. utilization of a commercial truck wash facility) may actually result in accidental contamination of the vehicle's cab and can enhance mechanical transmission of viable PRRSV onto a farm site. They also warned that livestock transport vehicles frequently accumulate ice and snow in their undercarriage area during the winter and speculated that samples from these areas could harbor the virus but no attempt was made to test samples from the undercarriage of trucks in this study.

The warm weather study essentially mimicked the cold weather study but was conducted during a time of the year when temperatures were between 10 and 20 °C. The only other difference between the two studies was in the choice of "carrier" of the virus – i.e. snow vs soil. Actual temperatures on the 5 sampling days ranged from 10 to 16 °C. The authors concluded that the differences in environmental conditions (choice of carrier and environmental temperature) resulted in strikingly different outcomes and proved their hypothesis that during periods of warm weather, mechanical transmission of PRRSV is an infrequent event. Whereas successful transmission of PRRSV to containers was observed in 8 of the 10 replicates in the cold weather study, it was observed in only 1 replicate of 10 in the warm weather study. In 9 of the replicates in the warm weather study, it appeared that while PRRSV was present on the floor of the commercial truck wash or in the cab of the vehicle, it was not possible to transfer the virus to the containers at the simulated farm site, although in two of the replicates the virus was found on the anteroom floor. The authors concluded that even though results varied significantly between the cold and warm weather studies, the warm weather study still demonstrated that during springtime conditions, mechanical transmission of viable PRRSV onto a farm site and into a swine facility can occur, albeit at a much lower rate. They warned that strict biosecurity measures should be maintained throughout the year.

Based on both studies, the authors suggested that some very basic cost-effective solutions could be adopted to reduce the risk of PRRSV transmission. These included the use of disposable plastic boots during vehicle washing and enhanced hygiene of the interior area (cab) of vehicles.

#### Transport Vehicles as Transmission Routes

Waddilove (2008) states that field experience and a series of studies have implicated live hog transport as an important method of spread of the PRRS virus onto farms and within hog flows. Much earlier, Poumian (1995) stated that all trucks, trailers and other vehicles used for transporting animals, animal

products, by-products, feed, offal and contaminated equipment are a potential risk in the spread of disease.

The previously-reported University of Minnesota studies had evaluated the cab of the truck as a transmission route for PRRSV from the commercial truck wash facility to the simulated farm site, however the driver of the vehicle was the source of virus transmission. No pigs were used in the warm and cold weather field studies. In a later study (Dee et al, 2004), the University of Minnesota team used the experimental model trailer to assess the role of the transport vehicle as a source of transmission of PRRSV. This study had several objectives including 1) determining the concentration of PRRSV required to infect susceptible pigs in a model trailer, 2) assessing the ability of contaminated model trailers to transmit PRRSV to susceptible pigs, and 3) evaluating transport vehicle sanitation processes including scrape only (S), wash and disinfect (WD), wash, disinfect, freeze and thaw (WDFT) and wash, disinfect and dry (WDD). All pigs used in the study were 16 to 18 days old and had been previously blood-tested to ensure that they were PRRSV-naïve prior to the start of the study. With respect to objective 2, infection of at least one sentinel pig was observed in both model trailers on each of the 5 contamination days. The authors concluded that if PRRSV-infected pigs contaminate a trailer and no effort is made to clean the interior, transmission of the virus to naïve sentinels can occur.

#### Sanitation Protocols for Livestock Transport Vehicles

As early as 1995, the importance of disinfection of livestock trucks and trailers was recognized. In a scientific paper, Poumian (1995) provided an outline of the basic procedure for cleaning and disinfecting livestock transport vehicles. He noted that in addition to properly cleaning and disinfecting the trailer, special attention must be paid to cleaning and disinfection of the wheels of the vehicle as well as the cab. He acknowledges that cleaning and disinfecting the wheels may be difficult to accomplish and in view of the importance of this process, he suggest that it may be convenient to use an existing vehicle-cleaning facility provided with high-pressure equipment. He further stated that the interior of the cab must be washed with clean water and all surfaces washed with a sponge previously soaked in an approved disinfectant.

Sanitation protocols for livestock trailers typically range from a scrape-out to a full wash, disinfect and dry. It is reasonable to assume that different classes of hogs have varying transport vehicle sanitation requirements depending on their health status and the reason for transport – i.e. iso-weans, feeder pigs and breeding stock require a higher standard of sanitation during transportation than market hogs and culls. Realistically, prolonged breaks for hygiene control are seldom achievable in transport scheduling (Waddilove, 2008) which can make a full wash, disinfect and dry protocol challenging.

In a study carried out in 2004, Dee and his associates at the University of Minnesota conducted an assessment of different sanitation protocols on model trailers. Sixteen to eighteen day old pigs were infected with the PRRSV virus. Four different sanitation procedures were carried out on the model trailers on five different contamination days. A total of 10 replicates on two different model trailers were conducted to assess the four different sanitation procedures. All procedures were based on current U.S. swine industry standards (Genetiporc). The sanitation procedures consisted of:

- 1) *Scraping only* – the trailer interior was manually scraped to remove soiled bedding before placement of sentinel pigs.
- 2) *Wash and disinfect* – the bedding was removed and the trailer was power-washed using 80 °C water delivered at a pressure of 3000 psi, then disinfected for 10 minutes using Tek-Trol, a phenol-based disinfectant. Sentinel pigs were then placed in the trailers.
- 3) *Wash, disinfect, freeze and thaw* – this process consisted of procedure 2 followed by freezing of the model trailer overnight at -20 °C, then thawing before placing of the sentinel pigs.
- 4) *Wash, disinfect and dry* – this process consisted of procedure 2 followed by a 12-hour drying period at room temperature before placement of the sentinel pigs.

This study clearly showed that drying (procedure 4) is an essential component of a PRRSV-biosecurity program for hog transport vehicles. Although procedures 2 and 3 resulted in a decreased number of PRRSV-positive replicates, only procedure 4 approached the level of cleanliness of the negative control group. However, researchers warn that while drying and heating has an important role to play in top-level transport vehicle biosecurity, it should be seen as an additive to good disinfection and not a replacement for it.

A follow-up study done by the same group in 2004 and reported by Waddilove (2008) assessed a rapid (< 2 hours) sanitation protocol involving cold-water washing and disinfection using fumigation. In this study the protocol was evaluated on the model trailers used in previous experiments. The rapid protocol tested in this study was selected to more closely match what could be practically implemented by transport companies as it was assumed that prolonged breaks for hygiene control are often not achievable in routine transport scheduling. A maximum turn-around time on trailers of 2 hours was selected for the study to accomplish this objective. Even the choice of disinfectant for this study was guided by what would most likely have been encountered in practice under field conditions. Virkon S was chosen as the disinfectant for the rapid protocol because it has been shown to have no significant long-term corrosive effects on trailers and it has proven effective against a broad range of pig pathogens. The level of infective virus used in this study was 500 times greater than the levels that were previously determined necessary to infect pigs in model trailers. A total of 150 sites in the trailer were inoculated with the virus. The sites were chosen to intentionally include areas difficult to access, clean and disinfect and personnel charged with cleaning and disinfection were not told where the virus had been applied. Following the cold water wash and application of disinfectant (both applied by a low-pressure foaming system), the researchers swabbed the contaminated sites, both immediately as well as 120 minutes after application of the foaming disinfectant. At 120 minutes post-treatment, all sites were negative for infective PRRSV. Waddilove (2008) quotes the authors as saying “the procedure produced good inactivation of PRRSV within the target time when cold water was used and disinfection applied by foaming”. They further stated that the foam allowed for better and more accurate application of disinfectant under repeated commercial usage and ensured that personnel could see where they had applied the disinfectant.

The University of Minnesota group then compared the rapid protocol against well-established, more robust protocols including overnight drying and disinfection with Synergize, a disinfectant that combines the germicidal ability of glutaraldehyde with the detergency and penetrating action of quaternary

ammonium chloride. Glutaraldehyde disinfectants require less contact time than formaldehyde and are less affected by organic matter (Dee et al, 2004).

A total of 4 different protocols were assessed as follows:

- 1) Washing only (cold water)
- 2) Washing plus formaldehyde fumigation
- 3) Washing plus glutaraldehyde-quaternary ammonium chloride (Synergize) fumigation
- 4) Washing plus 8-hour drying at 20 °C (no disinfection)

Treatment 3 was the most effective with all trailers subjected to this protocol proving to be PCR-negative, non-infectious to sentinel pigs and swine-bioassay negative. Similar results were observed with treatment 4, suggesting that a minimum of 8 hours of drying time at 20 °C following a cold-water wash is as effective as disinfection with Synergize following a cold-water wash. Treatments 1 and 2 were considerably less effective with PRRSV RNA being detected in 20 out of 20 swabs collected at both 60 and 90 minutes following treatment. The researchers stated that the efficacy of formaldehyde fumigation appeared to be very poor since it did not reduce infection levels in the trailers beyond what a basic scrape and cold-water wash had accomplished. They also concluded that the use of cold water for washing had little impact on eliminating the virus from trailer interiors and was not effective for the complete removal of organic debris from the trailer interior, since small amounts of residual bedding were visible in all of the trailers after washing, a frequent observation under field conditions. Poumian (1995) stated that the efficacy of water can be increased by two additives, namely energy (in the form of temperature, time and force) and cleaning agents. He further stated that an increase in water temperature weakens the bond between soilage and the surface to which it adheres.

A further study done by the University of Minnesota group served as an evaluation of various commercially-available disinfectants for the sanitation of PRRSV-contaminated transport vehicles at warm and cold temperatures. A total of seven different disinfectants were evaluated in this study as follows – Synergize, Aseptol 2000, Biophene, Sentramax, Virkon, Tek Trol and DC & R. All of the products were applied to the model trailers at 4 °C. A total of 9 different treatments consisting of 12 replicates per treatment were conducted as follows:

- 1) Washing only – treatment 1
- 2) Washing plus disinfectant fumigation - treatments 2 to 8
- 3) Washing plus overnight drying - treatment 9

Disinfection is a process which aims to destroy infectious agents (Poumian, 1995). He further defines the process of disinfection as a chemical reaction between the infectious agent and the disinfectant. Without proper cleaning prior to disinfection, most pathogens remain protected from the disinfectant by soilage (i.e. soil, bedding, fecal matter, etc.). Pre-rinsing is an important step to remove soilage and increase contact between the infectious agent and the disinfectant.

In the initial phase of the disinfectant study, their efficacy was evaluated at 4 °C. In this phase, PRRSV RNA was not detected by PCR in any of the replicates where trailer models were treated either with



Synergize and those allowed to dry for 8 hours. Due to limited sample sizes, it was not possible to determine if differences between Synergize, Sentramax, Aseptol 2000 and Virkon were statistically significant but it was pointed out that infectious PRRSV was found in trailers treated with Sentramax and Virkon, but not in the trailers treated with Synergize and Aseptol 2000. Based on the results of phase 1, Synergize was the only disinfectant selected for testing in phase 2. In this phase, the disinfectant was tested at -20 °C using water only, a 40 % methanol solution or a 10 % propylene glycol solution. The latter two solutions were added in an attempt to prevent freezing. The trailers that were treated with 40 % methanol or 10 % propylene glycol did not freeze and were negative for PRRSV RNA and infectious virus after thawing, however the trailers treated with disinfectant and water froze within one hour and decontamination was not successful with PRRSV RNA being detected in 19 out of 20 replicates and infectious virus being detected in 3 of 4 sentinel pig replicates. It was speculated that the addition of the methanol and propylene glycol solutions prolonged the activity of the disinfectant at temperatures that would normally result in freezing. This study verified once again that Synergize is an effective disinfectant against PRRSV and it also reinforced the value of drying commercial livestock trailers. However, for any disinfection program to be effective, it is essential that organic material be removed first which requires a comprehensive washing program using a heavy-duty detergent.

In 2005, Dee and his colleagues conducted a further study to validate a new, untested protocol entitled TADD (thermo-assisted drying and decontamination). This protocol was developed by the Pig Improvement Company (PIC) and is based on the principle that enhanced drying of PRRSV-contaminated surfaces results in the elimination of residual virus. During this process, hot air is forced into the interior component of the trailer using a propane heater (or comparable heat source), increasing the temperature to 71 °C. This temperature is maintained for 30 minutes. It was stated earlier that PRRSV can be inactivated if temperatures of 56 °C are maintained for 6 to 20 minutes so the TADD protocol would be expected to inactivate the virus. The protocol was tested against three other processes, including wash only, wash plus air (without supplemental heat) and wash plus overnight drying using model trailers. A total of 10 replicates were conducted for each of the four treatments. Swabs were collected from the trailers at 0, 10, 20 and 30 minutes after treatment and from the trailers dried overnight after 8 hours. Just 20 minutes after the TADD treatment, all swabs were PRRSV negative using PCR testing and the trailer interiors were visibly dry. In addition, all swabs collected from trailers allowed to dry for 8 hours were PRRSV negative by PCR. In comparison, the number of swabs that were PRRSV positive by PCR in the other two treatments ranged from 6 out of 10 for wash plus air only to 10 out of 10 for wash only. Sentinel pig testing also indicated the absence of infectious PRRSV in TADD-trailers and trailers dried overnight. This was further confirmed by bioassay testing. The authors concluded that the efficacy of the TADD system was equivalent to that of the 8 hour drying protocol. Given the fact that many commercial transport companies need to turn trailers around within a short time frame, the TADD protocol offers a viable alternative to overnight drying which may not always be practical given time constraints.

#### Surveys of Livestock Transport Vehicle Decontamination Practices

Other than the project currently being undertaken in Ontario, the only other recent survey of transport vehicle decontamination practices was conducted in Iowa from June, 2010 to March 2011. Iowa State

Researchers (Schneider et al, 2011) conducted voluntary interviews and used a novel environmental sample collection technique to survey livestock transport vehicle decontamination practices for PRRSV in the US. The novel sample technique consisted of using Swiffer Sweeper® pads for sampling purposes instead of cotton-tipped swabs. The technique was able to detect a vaccine virus dilution rate as low as  $10^{-4}$  in 3 out of 4 replicates and as low as  $10^{-5}$  in 2 out of 4 replicates.

The Iowa study covered two different sampling periods - summer and winter and two different sampling sites – namely transport vehicles (77) and sanitation facilities (28). Each transport vehicle and sanitation facility was sampled in 6 different locations. Two of the six transport vehicle sampling sites included sort boards and the interior of the cab (floor mats and foot pedals). A total of 1094 individual samples were collected in the two sampling periods – 536 in summer and 558 in winter. PRRSV PCR results varied between the seasons with only two samples (0.34 %) proving positive in the summer compared to 13 samples (2.34 %) testing positive in the winter. This finding is consistent with the seasonal differences observed in the work done at the University of Minnesota. The first positive summer sample was collected from a transport vehicle that had just hauled feeder pigs, however it had not been cleaned prior to collection of the sample. The second positive summer sample was collected from a vehicle that had just hauled hogs to a packing plant however this vehicle had just been sanitized. Interestingly, the same vehicle had tested negative before sanitation. The wash bay where this trailer was cleaned used recycled water. Winter samples that tested positive included a trailer that had already been sanitized and a tug truck used exclusively by the sanitation facility. Four of the thirteen positive samples (30.7 %) were collected from wash bays leading the researchers to believe that sanitation facilities may serve as vectors for PRRSV. Earlier, Dee et al (2002) had stated that whether PRRSV actually resides in commercial washing facilities and the frequency that vehicles become contaminated while occupying these areas is not known at this time.

A total of 63 voluntary surveys were also completed as part of the study – 37 from truck drivers and 26 from sanitation facility (truck wash) personnel. Sanitation facilities ranged from low traffic (11 vehicles cleaned per week) to high traffic (300 vehicles cleaned per week). Driver surveys showed the following – 73 of the drivers were coming from a slaughter plant with 15% of those going to a breeding herd or nursery after delivering hogs to the slaughter plant. Only 54% of the drivers had their vehicles disinfected every time the vehicle was washed. 50% of trailers were not washed between loads of hogs. Earlier in this review, it was mentioned that in everyday practice, it is critical to minimize down time of commercial transport vehicles – in this study, almost two-thirds (63%) of the vehicles arrived at their next destination within 2 hours following sanitation, confirming that statement. These trailers would not have sufficient time for drying in the winter and possibly not even in the summer. And while hot water was available in 54% of the facilities, it was only requested by 21% of the drivers. On a positive note, more than half (56%) of drivers indicated that they were interested in further biosecurity training. Sanitation facility surveys showed the following results – 54% of them offered hot water while 30% of facilities offered assisted drying of trailers. Private wash bay facilities proved to be maintained more consistently with 58% of private wash bays being washed out between trailers versus only 28.5% of public wash bay facilities. The results also showed that sanitation practices are improved in the winter with 37% of trailers washed with hot water and 69% disinfected in the winter compared to only 5.5%



washed with hot water and 42% disinfected during the summer. While the researchers speculated that this result might be biased by the fact that more private facilities were sampled during the winter, they also questioned whether this is a trend that is standard within the industry.

On the basis of their survey data, the researchers concluded that transportation biosecurity practices could be improved as the industry strives to improve PRRSV control and potentially elimination. More specifically, they suggested increased frequency of vehicle sanitation, standardization and implementation of sanitation protocols, more frequent utilization of proven PRRSV decontamination practices (i.e. disinfection and drying) and enhanced driver education on biosecurity practices. They also stated that although studies have demonstrated the efficacy of techniques including disinfection and TADD to eliminate PRRSV from transport vehicles, it has not been shown to what extent they are employed and how successful they are under commercial conditions to reduce the risk of PRRSV transmission. The current project will attempt to determine the extent to which the various protocols are employed in Ontario.

### Conclusion

The vast collection of work carried out by the University of Minnesota researchers has expanded the scope of knowledge in the area of PRRSV transmission via transport vehicles enormously. This work has led to the development of numerous educational materials and best practices documents for the North American hog industry, however the work is not without its' limitations. The main limitation of the University of Minnesota studies is that they were not conducted in full size trailers carrying large loads of pigs. However, it would be difficult, if not impossible, to conduct this work using full-size commercial livestock trailers. The authors acknowledge that the design and construction of the model trailers does not mimic a commercial trailer that transports market hogs which could impact the level of contamination in the trailer interior and the ease of cleaning. The authors also acknowledge that a high concentration of PRRSV was used to contaminate the trailers in their studies and entire interior of the trailers were contaminated. It is not known if either of these conditions are representative of normal transport conditions. Further, the size of the swab was not proportional to the size of the model trailer which may have impacted the recovery of PRRSV RNA. With specific reference to the TADD system, the authors state the need for further validation of the protocol in full-size trailers using weaned pigs and market hogs. But despite the limitations of this work, it is still the most thorough collection of PRRSV transmission studies that has been done to date and it has provided a lot of valuable information for the North American hog industry to minimize the risk associated with everyday activities that are known to contribute to PRRSV transmission.

Industry standard livestock trailer sanitation protocols consist of:

- Scrape out
- Clean & flush
- Clean wash back end
- Full wash and disinfect
- Full wash, disinfect and dry

Each of these protocols varies with respect to cost, efficacy, time and effort required and practicality but they all have a role in the industry. While washing, followed by disinfection and drying is considered to be the “gold standard” not all trailers may require a protocol this detailed. Previous studies have shown that drying or heating trailers can cause dramatic reductions in PRRS virus levels however this requires costly facilities that many commercial operations cannot bear. The sanitation protocol required for transport vehicles in a specific situation will depend on the type of pig being transported (iso-weans or feeder pigs, breeding stock, market hogs or culls) as well as the health status of the pigs being moved and the health status of the site to which they are being moved. It is also important to note that whatever the sanitation protocol chosen, it is critical to ensure that tools used to move hogs (sorting boards, paddles, etc.) and other trailer components such as deck planks and winter boards are subjected to the same process.

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