Strategic use of control tools in swine medicine

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Introduction

Porcine pleuropneumonia, enzootic pneumonia, porcine circovirus associated diseases (PCVAD) and porcine reproductive and respiratory syndrome (PRRS) are among the most important swine diseases in North America. This paper illustrates some of the ways that can be used to improve the control of these conditions, either by allowing to better prevent, treat or eliminate them.

Porcine pleuropneumonia

Treatment

After graduation, I worked for a company that was buying 15 kg piglets from producers and raising them under contract in finishing units. The piglets that were mixed in these finishing units usually came from between 25 and 60 different sources. As can be imagined, mixing pigs from that many sources was a good strategy to get into health problems, and porcine pleuropneumonia associated with *Actinobacillus pleuropneumoniae* (APP) was the most important. The majority of the strains we had to deal with at that time were of serotype 1, which were usually the most virulent. Table 1 shows the results of two different strategies that were used to treat acute cases of pleuropneumonia in finishing units of that company.[1] The first strategy consisted in putting antibiotics in the feed and water and to only inject pigs that were the most severely affected. The results to this strategy were very poor (11.4 % mortality) even if in retrospect, both the choice of products and the dosages used were probably not optimal. The second strategy tested was to inject the sick pigs with the right product, the right dose at the right time. It quickly became obvious that APP was responding very well to such an approach, and that few pigs would die if treated that way. This was true even when dealing with very acute and severe cases of the disease. In very severe cases pigs showing dyspnea or polypnea were injected twice a day, until they stopped showing clinical signs. This was particularly true if the product used had a short half-life. Once an APP outbreak was diagnosed, it would usually last between 2 and 5 weeks in a given barn. After that the clinical signs stopped, as most animals would have come in contact with the organism and become immune.

Table 1: Results obtained with two different strategies to treat acute cases of pleuropneumonia in finishing units of a Quebec integration company.

Strategy	# units	# pigs	% mortality	Drug cost (Can $)
Feed & water	3	3613	11.4	4.79
Injections	35	46,059	2.34	3.03
Controls*	62	84,599	1.92	1.97

* Finishing units where no clinical signs of pleuropneumonia were observed

I must admit here that these positive results with the injection strategy were obtained at a time when most of the finishing units of that company were using a feeding system where pigs were fed on the floor twice a day or more. This made detection of sick pigs easier. I must also admit that in hot conditions, sometimes all pigs are breathing abnormally and it then becomes difficult to determine which pigs are not breathing normally because of APP, or because of the heat. The fact remains that to be successful in treating acute cases of pleuropneumonia, a few points must in my opinion be kept in mind. The first one is that pigs affected with the acute form of this condition don't eat much. This would be widely accepted, and has been proven experimentally.[2] The second point, which is not widely recognized, is that they don't drink much either. Pijpers et al[2] showed that pigs infected experimentally could see their water consumption temporarily drop to as low as 10% of what it was before infection. A third one is that if the pigs have the right concentration of the right antibiotics in the lungs at the time they become infected, they should not get sick. This was demonstrated again by Pijpers et al[3] in a nice experiment. An APP strain with a MIC for oxytetracycline of 1 μg/mL was used in a challenge experiment. Pigs were fed for 6 days a ration containing either no antibiotics, or 400, 800 or 1600 ppm of oxytetracycline, then challenged with the APP strain. The pigs were then euthanized 2 days after infection and their lungs examined. The average concentration of oxytetracycline obtained in homogenized lung tissue was 0.25, 0.57 and 0.83 μg/g of lung tissue for the three levels of medication. All pigs treated with 1600 ppm were totally protected (0% lung lesions) while for those receiving 800 and 400 ppm, 8 of 11 and 2 of 6 were protected. The authors stated that complete protection was obtained at 1600 ppm because it produced concentrations of the drug in the lung tissue that were equal to the MIC of the strain. The main message is that APP is an organism that responds well to treatment, if the right concentration of the right antibiotic gets to the lungs at the right time.

Eradication

There have been some successes at eradicating APP, particularly from smaller herds, but it has not been an easy thing to do and there have been many failures. In Quebec we have used in the early 80s a strategy that was developed in Switzerland.[4] The idea was to give the sow herd a medication which was assumed to limit the risk of new animals becoming infected, while testing the whole sow herd serologically, and eliminating seropositive animals. In most cases the medication used has been a mix of trimethoprim and a sulfonamide, either in the feed or in the water. In some situations the whole sow herd had to be tested several times before all animals remaining were finally found to all be seronegative. A prerequisite of this strategy was to have a limited number of seropositive animals to start with (e.g. ≤ 25%), otherwise it was felt that depopulation and repopulation was a more logical alternative since it usually allowed to get rid of other pathogens at the same time, with an opportunity to introduce improved genetics as well.

Most of the attempts to eliminate APP from sow herds using only medication have failed, or been only partly successful in the sense that one serotype could be eradicated, but not another one. However recently Baekbo[5] reported a program where the organism was convincingly eliminated from three herds (410, 525 and 940 sows) by vaccinating

breeding animals against APP, removing from the herd all pigs less than 10 months of age, a stop in farrowings for 5 days and two injections of all sows and gilts with marbofloxacin (4 mg/kg) on days 1 and 4. No introduction of replacement stock was done for three months after the medication period. Finally Lowe et al[6] also reported a program that was successful in eradicating serotypes 1, 5 and 7 in a 12,500 sow herd. Piglets received long duration ceftiofur (7.5 mg) at 7 days and were weaned off site at less than 19 days of age. Introduction of gilts was stopped for 5 months. Tilmicosin was provided in the feed at a rate of 400 ppm in gestation and 200 ppm in lactation for 3 weeks, and the sows were vaccinated with a killed APP vaccine when the site was closed to new introductions. While the main herd was closed to new introductions, an off-site location was use to breed PRRS and APP-negative gilts. After negative gilts were introduced in the sow herd, a serological program confirmed that they remained negative and that the program had been successful. This impressive result must be balanced with studies suggesting that sows can remain carriers of APP for at least 8 months, and that tilmicosin at 400 ppm reduced, but did not eliminate APP from carrier animals, or prevent its shedding.[7,8]

Production of negative pigs from infected sow herds

It is much easier to produce APP-negative pigs out of positive sow herds than to eliminate the organism from an infected population. And actually the pigs can also become free of other bugs present in the sow herd. Following is a spectacular example of such a program in a small pure bred herd of 100 sows that was selling replacement gilts and boars.[9] The herd was infected with atrophic rhinitis, mange and enzootic pneumonia, for which there were clinical signs, and with pleuropneumonia, for which there were no clinical signs, but positive serological reactions. Two successive PRRS outbreaks decided the owner that it was time to do something about the health status of his herd.
Since the buildings were old and would have needed major repairs anyway, it was decided to build a new farrow to finish barn on the same site, about 75 meters (250 feet) from the existing facilities. The strategy was to use vaccination and medication programs in sows to increase maternal immunity and reduce as much as possible the possibility for sows to shed organisms to their piglets, and medication of piglets, to help them either remain free, or eliminate these organisms if they became contaminated. Young piglets born in the old barn were to be early weaned (oldest pigs were 10 days old) in the new one, and become the sows and boars of the new « clean » herd. The vaccinations and medications used were the following :

Vaccinations :

- All sows and boars were vaccinated twice, one month apart, with a modified live PRRS vaccine; all sows and boars were vaccinated twice against APP (*Actinobacillus pleuropneumoniae*), MH (*Mycoplasma hyopneumoniae*) and HP (*Haemophilus parasuis*); two weeks before farrowing, each sow was vaccinated against APP, MH, HP and toxigenic *Pasteurella multocida* (rhinitis vaccine containing both *Pasteurella multocida* and *Bordetella bronchiseptica*, as well as a toxoid of the *Pasteurella multocida* dermonecrotoxin). In this farm the regular vaccination program included two

doses of rhinitis vaccine for gilts at introduction, and then one dose before each farrowing thereafter.

Medications

- One week before farrowing, each sow was injected with doramectin, at the recommended dosage; the day of farrowing, each sow was injected with ceftiofur sodium, at the recommended dosage; about 6 weeks before the first transfer of piglets, the sow feed was medicated with 110 ppm of lincomycine. This medication was kept in the sow feed until all sows were culled; all growing and finishing pigs present in the old barn received the same feed medication; all suckling piglets were injected with ceftiofur sodium (16 mg/pig) every two days, including the weaning day; all piglets were injected with doramectin (0.2 mL) at weaning; all piglets received water medicated with tiamulin (180 ppm) for the first 5 days post weaning.

Among other things that were done, the two buildings became two different entities : different people were working in them and different equipment was used in each of them as long as the old barn was not totally emptied, washed and disinfected.

The first piglets coming from the program were transferred in January 1999. The last « contaminated » finishing pigs and adult breeders from the old barn were removed from the site in June and December 1999 respectively. This means that for periods of 5 and 11 months, infected animals were present 75 meters from the « clean » herd. Yet the program has been a total success since all five diseases have been successfully eliminated, and as of April 2009 the herd has remained free of these five pathogens.

Enzootic pneumonia

Eradication on a herd basis

Eradication of *Mycoplasma hyopneumoniae* (MH) has been initially described in Switzerland and then in several countries, including Sweden, Norway, Denmark and Canada.[10-14] It has been successful in a great number of cases, mainly in small herds, but now also in others of 1000 sows or more. The most popular technique currently used involves the removal of all animals on the farms that are 10 months of age or younger, a break in farrowings of about 14 days and a medication program of the breeding herd.[10] Tiamulin has been used in many of these programs, but other products like enrofloxacin and lincomycin have also been utilized successfully.[15,16]

A variant of this technique has been used successfully in large herds of Western Canada. Briefly summarized, the procedure requires that the herd be closed to new breeding stock replacements and that all animals in the breeding herd reach a minimum age of 10 months at the start of the program. The breeding herd is vaccinated at least twice with a mycoplasma vaccine and put on medication prior to the eradication phase. All grower pigs over 11 days of age are removed from the farm. During the eradication phase the medication continues, litters are weaned at 11 days of age or less and the entire barn is

washed and disinfected. This strategy has been used successfully in several herds of western Canada (Schneider P, personal communication, 2000). Three interesting features of this strategy are that it was found to be successful even for large herds, there was no break in the farrowing schedule and, finally, piglets that are 11 days or younger were kept on the farm. More recently other strategies involving the use of products like tilmicosin in the feed and/or tulathromycin by injection have also been used successfully, and this even in situations were herds had become infected very recently.[17,18]

Eradication on a country basis

Realizing that MH is an organism that can get transmitted by area spread and that there is an increasing body of evidence suggesting if not proving that aerosol transmission of this organism is possible on distances of kilometers, and that an individual eradication program may not last long if infected pigs are present in neighboring farms, some countries have adopted a regional or country-wide eradication program.[19,20] Since these programs have been successful, it is likely that they may trigger more regions and countries to consider these larger scale eradication programs. Basically the idea is to have, at the same time period, an eradication program in all herds of a given area or country, so that once the program is over, there are no more herds from which negative herds can become infected with MH.

Production of negative pigs from infected sow herds

Several techniques have been described to produce MH-negative (non-infected) pigs from MH-infected herds. Most of them depend on early weaning, various medication programs of the sows, suckling (long acting injectable tetracycline, tiamulin) and weaned piglets (feed medication with tiamulin, tetracycline or a combination of both) and off site rearing of the pigs, away from infected stock.[21-23] Others have added vaccination of the dams before farrowing, in an effort to increase the immunity that piglets receive in their colostrum. There is one report of negative pigs produced from a positive herd where piglets were weaned as late as 5 weeks of age, where sows were vaccinated before farrowing and both sows and piglets were medicated.[24] There is also some evidence that at least in small scale experiments, it is possible to produce negative pigs using early weaning and segregated rearing without the use of medication.[25,26]

For about 10 years two MH-infected farrow to finish herds have produced MH-negative pigs by using a segregated and MEW program. The barrows, which remained on site, were infected with MH, but the gilts, which were weaned off site, and received an injection of an anti-Mycoplasma antibiotic at birth, 3-5 days and weaning (7-10 days) remained negative. This status was based on absence of clinical signs, lung lesions and serological results. Sows were also vaccinated twice before farrowing with an MH vaccine (Bonneau M, personal communication, 2003).

Porcine circovirus associated disease (PCVAD)

PCVAD, which is caused by porcine circovirus type 2 (PCV2) has been studied tremendously over the last 10 years, and particularly for the last five in North America because of the major problems associated with that condition that have surfaced on this

continent since 2004-2005. Fortunately PCV2 vaccines, which have become available, have proven to be very successful and in fact are among the most effective and reliable control tools in swine medicine. This part of the paper will look at two questions regarding the practical use of these vaccines that are among the most frequently asked.

At what age should pigs be vaccinated against PCVAD?
Table 2 shows the mortality results that were obtained in pigs vaccinated between 19 and 59 days of age with a one-dose PCV2 vaccine in a study conducted in Quebec.[27]

Table 2: Mortality rates in four different finishing units of a Canadian system for controls and pigs vaccinated at different ages.

Barn	Treatment	No. of pigs introduced	Age at vaccination (days)	Mortality (%)	*P*
1	Control	647	45-59	9.6	< .001
	Vaccinate	633	45-59	3.0	
2	Control	260	38-45	8.1	< .01
	Vaccinate	286	38-45	2.1	
3	Control	745	22-36	10.6	< .001
	Vaccinate	717	22-36	2.8	
4	Control	275	19-22	7.6	< .001
	Vaccinate	274	19-22	0.4	
Weighted average	Control	1927	19-59	9.5	< .001
	Vaccinate	1910	19-59	2.4	

As can be seen good results were obtained in pigs vaccinated as young as 19 days of age, or as old as 59 days of age. In this system the first clinical signs were observed at about 95 to 100 days of age. While this particular vaccine has shown experimentally that protection could be obtained as early as two weeks post vaccination, we can probably assume that optimal protection is obtained 3 to 4 weeks or more after administration of the vaccine. In experimental infections where it was possible to produce clinical signs after inoculation of PCV2 alone, clinical signs were often first observed about 2 to 3 weeks post infection. If we put the two pieces of information together, so three weeks before infection for proper immunization and two weeks for clinical signs to occur after infection, it suggests that pigs should be vaccinated at least 5 weeks before clinical signs are observed in the field. And in field situations good results are usually obtained when this recommendation is followed.

For several swine diseases there can be maternal interference when pigs are vaccinated at a young age. In the case of PCV2, we have examples where it was possible to vaccinate the pigs in presence of some maternal immunity. In the Canadian study reported above about 70% (65% by ELISA and 79% by IFA) of the pigs vaccinated at 26 days of age were seropositive at the time of vaccination. These were maternal antibodies since virtually all pigs had a drop in their antibody titres when tested 30 days later. Obviously an even greater percentage of the younger pigs vaccinated between 19 and 22 days of age would have been seropositive at the time of vaccination, and these were the pigs which had to have the greatest level of maternal immunity when they were vaccinated. When

looking in Table 2 at the mortality results of these pigs, one notes that vaccinated pigs of that age had 19 times less mortality than controls (0.4 vs 7.6%), indicating that they were fully protected. Obviously the presence of maternal antibodies did not interfere with the efficacy of the vaccine in this case. Interestingly the vaccine was found to be efficacious even though it elicited little or no seroconversion. Two different serological tests (ELISA and IFA) were conducted on days 1, 30 and 58 post vaccination, in 20 pigs each that were vaccinated at 26, 40 or 52 days of age. A similar number of control pigs were tested at the same times. Using either test, none of the pigs vaccinated at 26 days of age had seroconverted by day 30 post vaccination. Yet the mortality in the group of pigs vaccinated at that age was almost 4 times lower than for controls (2.8 vs 10.6%).

Finally, although pigs can be vaccinated in the presence of maternal immunity, the results obtained when pigs have been vaccinated at processing (3 to 5 days) are so inconsistent that vaccination at that age is not recommended. While pigs are still vaccinated at that time in some herds where the results appear to be holding, most of those who used that strategy in Canada have switched to later vaccination. Whether it is due to maternal interference that would be too strong at that age, to the fact that pigs may not be as immune competent when they are that young, to a combination of both or to something else is not known and remains a matter of discussion.

Should we vaccinate gilts and sows?

In Canada most gilts are vaccinated as piglets, so the question is to determine if they should be vaccinated again before they are introduced in sow herds. There seems to be no conclusive evidence yet that vaccinating gilts a second time should be recommended, but since the cost is minimal many producers and veterinarians prefer to play safe and do so. The question of sow vaccination is more complex. First one could ask if sow vaccination alone could protect pigs against PCVAD in pigs up to slaughter weight. As far as Canada is concerned the answer has been a clear no. In other words vaccinating gilts and sows, without vaccinating piglets, has not produced good enough results to compete with pig vaccination in the field. Table 3 shows the results of a US study that seem to go in the same direction.

Table 3: Performance of PCV2-vaccinated or non-vaccinated pigs from PCV2-vaccinated or non-vaccinated sows.[28]

	V-V*	N-V	V-N	N-N
Pigs	393	491	396	483
Death %	0.51[a]	2.04[a]	6.57[b]	5.18[b]
Cull %	1.53[c]	1.63[c]	6.82[d]	6.63[d]
ADG, Kg	0.81[e]	0.81[e]	0.77[f]	0.77[f]

* V-V for vaccinated dams and pigs; N-V for non-vaccinated dam, vaccinated pigs; V-N for vaccinated dams, non-vaccinated pigs; N-N for non-vaccinated dams and pigs

In this study, sow vaccination did not improve the performance of pigs compared to the non-vaccinated pigs from non-vaccinated sows.

What is less clear is whether we should vaccinate gilts, sows and pigs. There the answer is not as clear since some practitioners feel that there are some situations where vaccinating gilts and sows may have improved the results they were getting from pig vaccination, while other results don't seem to go in that direction. Table 4 shows results obtained in one company where the mortality of vaccinated pigs that were or not born from vaccinated sows are compared.

Table 4: Mortality results obtained in pigs of a Canadian Company that received either no vaccine, one full dose of vaccine A, two full doses of vaccine A, or one full dose of vaccine B, and that were born from sows vaccinated or not with vaccine C (Cardinal F, 2008)

Pig vaccine	Sow vaccination			
	No		Yes	
	# pigs	Mortality %	# pigs	Mortality %
No pig vaccine	80,799	10.4	18,101*	10.7
Vaccine A, 1 full dose	12,023	7.0	Not done	Not done
Vaccine A, 2 full doses	24,041	3.9	26,415**	3.8
Vaccine B, 1 dose	7,872	3.1	14,226***	3.4

* All pigs born from sows vaccinated with vaccine C
** 72% pigs born from sows vaccinated with vaccine C
*** 89% pigs born from sows vaccinated with vaccine C

While pig vaccination clearly improved mortality rates, whether vaccinated pigs were born from vaccinated dams or not did not seem to make a difference. The pigs involved in the results of this particular company however were vaccinated about 3 to 7 weeks post weaning. It could be that if the pigs had been vaccinated earlier, the results could have changed. Results from another Canadian company showed that 23,201 pigs vaccinated once with vaccine A and born from non vaccinated sows had a mortality rate of 5.7%, while 93,613 pigs vaccinated the same way but born from sows vaccinated with vaccine C had a mortality rate of 4.7% (Germain MC, 2008). So in this case there appeared to be a slight numerical advantage for pigs born from vaccinated sows.

In the US study described above (Table 3), pigs born from vaccinated sows and vaccinated themselves had a 0.51% mortality rate, while those vaccinated but born from non vaccinated sows had 2.04%, and the controls had 5.18%[28]. The difference between the two groups of vaccinated pigs was not statistically significant and the authors concluded that pig vaccination was the key to PCVAD prevention, and that dam vaccination did not improve or interfere with the vaccination of pigs. In Canada, and more particularly in Quebec, there is an increased interest recently in sow vaccination in cases where pig vaccination was perceived to be somewhat less efficacious than it was initially. So in some farms both sows and piglets are vaccinated. It is a bit early to see if the results obtained with that strategy are good or not.

A last issue on gilt/sow vaccination concerns the impact it could have on the reproductive performance of the herd. In other words is it possible that by vaccinating gilts and sows, one might improve farrowing rate, pigs born alive, pre-weaning mortality, or any other reproductive performance parameters? We know for a fact that PCV2 can produce acute reproductive problems since these have been reported from different countries. These problems were observed mainly in gilt start-up herds, but occasionally in mature sow herds as well. In a small field survey I have conducted in Quebec six practitioners, responsible for about 100 herds where sow vaccination had been applied, felt that it did not seem to improve reproductive performance, but accurate and reliable data were not specifically compared. At the last IPVS meeting in Durban there were several papers reporting an improvement in sow productivity following vaccination of herds in Denmark, France and Germany. All of them were with the vaccine licensed for use in sows. In one such study involving 277 German herds most reproductive parameters were improved after the use of the vaccine, and pigs/sow/year went from 21.2 before vaccination to 22.4 after vaccination.[29] While most of these studies on sow vaccination are before and after studies with no controls, which limits a bit the interpretation that can be made out of them, at the very least they suggest that we should probably look more closely at the potential for dam vaccination to improve reproductive performance.

Porcine reproductive and respiratory syndrome (PRRS)

Eradication on a herd or system basis

It has been shown that it is relatively simple to eradicate PRRS virus from infected sow herds. The reason for this is that sows do not remain infected forever with this organism after infection. For the time being the longest period of time that live, infectious virus has been detected after infection is 175 days, and the longest period of time that pigs were shown to shed the virus and infect other pigs after infection is 99 days. With this in mind if we stop to introduce naïve animals in an infected population, we should eventually get rid of the virus in that population. This was the principle used in early trials of eradication, and given the results obtained it became obvious that it could be used to eliminate the virus from individual herds, and in systems or companies.[30-32]
Success using herd closure has been obtained with closure periods of 23 weeks to 270 days.[30,32] Dubois reported a success rate of 91% for 65 commercial herds remained closed for an average of 183 days, and a success rate of 100% for one nucleus and 17 multiplication herds remained closed for an average of 270 days. In the US today 200 days seems to be the period most frequently recommended by practitioners for elimination of the virus from sow herds. Obviously this strategy makes sense if the herd is not likely to become infected by other sources of contamination in the near future. Indirect transmission of this virus is frequent and one must make sure that good biosecurity measures are in place to limit the risks of recontamination. Aerosol transmission of this organism is now accepted, and live infectious virus has been detected in the air 4.7 km away from the infected population where it was produced.[33] This will be discussed further in the air filtration section.

Eradication on an area or country basis

Once it was found that eradication on an individual or system basis was possible, the table was set for efforts to eradicate the virus from a whole area, or even on a country basis. Both Chili and Sweden became infected with PRRS virus and have managed to eliminate it from their national territory. While admittedly only a few herds were found to be infected in these two cases, it does show that it is possible for a negative country that becomes infected to return to a negative status, if quick and effective measures are taken. In the US a pilot project has been going on in two different counties to better control and possibly get rid of the virus.[34] In this case we are not talking about a situation where only a few herds have been recently infected, but about one where a variable number of herds have been infected for a while, within a country where the majority of herds are PRRS-positive. The researchers identified a whole set of factors, circumstances and considerations to keep in mind before attempting such a project, but the end result has been that in one county efforts to eliminate the virus have been stopped, because the level of involvement from all parties was considered inadequate, and in the other it was judged quite successful. In the latter, as of May 2009, only one sow herd (farrow to finish, about 320 sows) out of about 30 was still PRRS-infected (Morrison B, personal communication, 2009). Some finishing sites are also still contaminated because they have not emptied the sites after the sow herd (3000 sows) supplying them in piglets had eliminated the virus. Finally, a nursery/finishing site became infected this spring through purchase of pigs from outside the region. The authors have concluded that regional eradication is feasible in the "right regions", so areas where important conditions are met and where all producers are going to get involved. In Canada, the US and Mexico, where the national sow populations are predominantly positive, several of these regional eradication programs will likely have to be found successful before eradication on a country basis is considered. One thing sure, cheap and effective ways to avoid infection of herds by aerosol transmission would make it much easier.

Successful use of vaccine

My understanding is that the use of PRRS modified live virus vaccine has been quite successful in Mexico. While not perfect, there appears to be many situations where its usage is found to be cost-effective. In Canada and the US the PRRS vaccines have produced inconsistent results. In some situations the results are excellent, in others disappointing. As far as piglet vaccination is concerned, one of the hypotheses is that maternal interference may sometimes interfere with the efficacy of the vaccine. The end results is that it has been difficult to predict in which situations or circumstances the vaccines will work well, and in which it may not. Over the years though there is one strategy that seems to have produced more consistent results: the vaccination of negative pigs that have to be placed in contaminated finishing sites.

At the 2008 Allen D. Leman Swine Conference, Drs. Mike Murtaugh and Paul Yeske gave a presentation titled 'Epidemiology of a new PRRS virus isolate and outbreak', which I thought was quite interesting.[35] This presentation looked among other things at how the 1-18-2 PRRS strains appeared to spread when they initially hit the Midwest, in the spring of 2007, and at what was done to limit the severe losses associated with them. Basically the spread appeared to be associated mainly with the movement of animals and with aerosol spread. For example the pigs from a recently infected sow herd would be

moved into nurseries and finishing units in a given area. From there the virus would get transmitted to neighboring herds through aerosol contamination, and the cycle would continue that way. Since these strains were very different from those identified previously in the area, and produced very severe losses, it was easier to follow their tracks. One of the strategies used to reduce the problems seen in finisher pigs was to vaccinate them with a modified live PRRS vaccine at introduction in the finishing units. While the mortality rates in nonvaccinated pigs that became infected with these strains were usually 10% or more, sometimes as high as 50%, those in vaccinated pigs were much reduced, and in some cases close to what was considered normal for the systems involved. There were in fact situations where it was possible to isolate 1-18-2 strains in vaccinated pigs that had very few clinical signs. So the pigs did get infected, but were seemingly well protected by the vaccine.

We have similar examples in Canada. In a large 6000 sow farm using a multi-site system, there were no problems on the nursery site where the mortality rate was usually around 1%, and where pigs tested at the end of the nursery period were serologically negative. However, these pigs had to be introduced on a different 10,000 place finishing site that became infected with PRRS in 2004. An option was to totally depopulate the site, but since this would have been a very costly alternative, it was decided to try vaccination of pigs first, and evaluate the results that would be obtained. The pigs were vaccinated with a commercial modified live virus vaccine about 2 weeks prior to their introduction on the finishing site, so at approximately 8 weeks of age. Each building on that site has a capacity of about 2600 pigs. Table 5 shows the results obtained in the finishing buildings before and after vaccinated pigs were introduced (Bonneau M, personal communication, 2006).

Table 5: Average performance of finishing pigs for the 17 batches of pigs prior to vaccination, and for the first four batches of vaccinated pigs

	Pigs /batch	**Mortality (%)**	**ADG (g/day)**	**Conversion (kg feed/kg gain)**
Before (17 batches)	2617	6.11	753	2.94
After (4 batches)	2606	2.75	812	2.88

All performance criteria, and mortality in particular, were improved following the introduction of vaccinated pigs. The homology percentage between the PRRS virus strain found in the sick pigs and the vaccine strain was low, at only 87.3%, indicating that the results obtained with vaccination do not correlate well with the level of homology between the vaccine and the field strain targeted.

Recently Dr. Marie-Claude Germain, a well known practitioner from Quebec, reported to me some results that were obtained with vaccination on a finishing site. The site, which includes four finishing units of the same design, is supplied by a single sow herd. This sow herd, which is on a different and isolated site, was populated with PRRS-negative animals and has remained PRRS-negative since its establishment several years ago. The pigs go to a nursery site, which is also well located and has remained PRRS-negative

over the years. However the finishing site became contaminated three times with different strains of PRRS virus. This finishing site is located in an area where swine density is relatively high, and since the level of biosecurity observed is considered to be very good, the current belief is that it most likely gets contaminated by aerosol spread.

The first two times that the finishing site got contaminated, the owner elected to depopulate it completely, and repopulate with the same negative pigs coming from the same sow herd. But given the cost to depopulate and repopulate, and given the risk that the site would likely get infected again if depopulation was undertaken, the third time the site got contaminated he felt that something else had to be tried. Following advice from Dr. Germain, the pigs were vaccinated at arrival in the finishing units with a commercial PRRS modified live virus vaccine. This allowed the sow and nursery sites to remain totally negative to PRRS virus, whether field or vaccine strains. The mortality in the finishing units went from 3.53% before the PRRS contamination (4 batches, 5636 pigs), to 8.14% after the contamination in nonvaccinated pigs (two batches, 2673 pigs), to 3.82% when pigs were vaccinated (6 batches, 8388 pigs). The level of homology between the vaccine strain and the field strain involved in that case was only 84.9%. Thus in this example as well as in the previous one, the results obtained with vaccination were excellent in spite of the fact that homology between the vaccine and the field strains involved was very low. This goes in the same direction than a study conducted by US researchers where they concluded that the level of homology between the vaccine strain and the field strain involved in problems cannot be used to accurately predict the outcome.[36]

Prevention using air filtration

The debate over the possibility for swine pathogens, and PRRS virus in particular, to get transmitted between farms by aerosol has been long and sometimes onerous. This debate is now over as experimental work has now proven what epidemiological data had strongly suggested for years. Two of the questions that remain are how frequently it occurs, and over what distances. In a non scientific survey that I did in 2007, 10 swine veterinarians from Quebec were asked what percentage of PRRS outbreaks occurring in commercial sow herds they felt were caused by the various possible transmission means.[37] It turned out that about 90% of the cases were thought to be associated with indirect transmission means, so anything but the introduction of infected animals. They then had to grade the different possible indirect transmission means. The veterinarians who filled that survey felt that, on average, a minimum of 42% and a maximum of 69% of our cases in Quebec commercial sow herds were associated with aerosol. Since the survey revealed that 90% or so of the cases were thought to be associated with indirect transmission, it means that 38 to 62% of all cases were believed to be caused by infection through aerosol. All the vets surveyed, without exception, have placed aerosol as their most important source of infection. Again this was by no means scientific, but it does show that at least in Quebec, veterinarians involved with swine feel that aerosol is a very important transmission means of the PRRS virus.

As more and more people began to realize that aerosol transmission of this virus, at least in some countries, was something they had to deal with, the interest in air filtration increased. Today there are three main systems that are being used: the HEPA filters, which are the ones that have been used successfully by the French for many years, the DOP 95% system and the Noveko system, which is based on the presence of an antimicrobial within the filter. Because the HEPA filters have been used for a much longer time, they are the ones with which we have the most practical experience. To my knowledge, none of the 25 herds or more that have been equipped with this system have broken with PRRS yet. One of these herds, that I have visited in France years ago, is located in a hog dense area where there are more than 20 swine farms within a radius of 3 kilometers. All these herds are believed to be PRRS-positive, including one that is only about 300 meters away. The herd was equipped with air filtration and populated in 1998, and is still free of PRRS virus today.

This proves that with good biosecurity rules and air filtration it is possible to remain free of that virus on a long term basis, even in very high swine density areas. This is at least true for the expensive system with HEPA (High Efficiency Particulate Air) filters, that uses positive pressure. In that case if a door opens, the air gets out, not in. This is not the case with the other two systems that use negative pressure. In that case any opening by which the air could come in can be introduced if it has not been well taken care of (sealed). The Noveko system is so recent that our field experience with it is very limited. There are barns in Canada that have been equipped with it, and the next few years will tell us more about its efficacy in field situations. Most of the barns that have been equipped with the DOP (dioctylphthalate) 95% system had a MERV 16 value. Recent tests conducted by the team of Dr Scott Dee in Minnesota suggest that a MERV 14 value may also do the job, and this would substantially reduce the costs as the number of filters necessary is then much reduced. There have been some PRRS outbreaks in barns using the DOP system. In some cases it was reported that the filters were damaged, or there was non-filtered air coming through openings (e.g. non sealed fans), or a break in the biosecurity rules had been identified. The years to come will say more about the cost effectiveness of the different systems in place, and the main critical factors to control to obtain a maximum efficacy. One thing sure though is that in hog dense areas where PRRS virus is present, air filtration may be needed if one wants to prevent outbreaks associated with strains that are not already present in the herd. Costs can vary a lot for the different systems available depending on what is chosen as well as on a variety of other factors (existing facilities or new barn, air conditioning included or not, etc.). The system with HEPA filters can go as high as $1000/sow or more, the Noveko system is reported to cost about $20 US per inventoried sow per year over a period of 10 years, and the DOP system seems to range from $1.50 to $2.40 per weaned pig. [38,39]

Conclusion

Control options vary from one important swine disease to another. Knowing which ones are more likely to work for each of these specific conditions is thus very important, and hopefully those described in this paper can be of benefit for some of the producers that Mexican practitioners are servicing.

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