Transition from one commercial porcine reproductive and respiratory syndrome modified-live virus vaccine to another in a breeding herd and impact on productivity

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Summary

Porcine reproductive and respiratory syndrome (PRRS) continues to represent a significant cost to the swine industry and efforts are focused on prevention and mitigation of losses across production phases. Herein describes a PRRS modified-live virus (MLV) vaccinated breeding herd that changed commercial MLV vaccines to improve post-weaning performance. Two whole-herd vaccinations with a new PRRS MLV vaccine, administered 4 weeks apart, occurred without breeding herd production disruptions and with limited changes in diagnostic results. Replacement gilts tested PRRS virus negative 10 weeks post vaccination with the new MLV vaccine. Diagnostics were intermittently positive in the breeding herd and early nursery.

Keywords: swine, breeding herd, modified-live virus vaccine, porcine reproductive and respiratory syndrome virus, prevention

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Resumen - Transición de una vacuna comercial de virus vivo modificado contra el síndrome reproductivo y respiratorio porcino a otra en una piara y su impacto en la productividad

El síndrome reproductivo y respiratorio porcino (PRRS) continúa representando un costo significativo para la industria porcina, hoy los esfuerzos se centran en la prevención y mitigación de las pérdidas en todas las fases de producción. En este artículo se describe un hato reproductor que vacunaba con un virus vivo modificado (MLV) de PRRS, y que cambió de vacuna comercial MLV para mejorar el rendimiento post-destete. Se hicieron dos vacunaciones en todo el hato de hembras con la nueva vacuna MLV contra el PRRS, éstas se aplicaron con 4 semanas de diferencia, sin problemas en la producción del hato, y con cambios limitados en los resultados de diagnóstico. Las primerizas de reemplazo fueron negativas al virus del PRRS 10 semanas después de la vacunación con la nueva vacuna MLV. Hubo resultados de diagnóstico intermitentemente positivos en el hato reproductor y en las primeras etapas de producción.

Résumé - Transition d'un vaccins vivant modifié contre le virus du syndrome reproducteur et respiratoire porcin vers un autre dans un troupeau reproducteur et impact sur la productivité

Le syndrome reproducteur et respiratoire porcin (SRRP) continue de représenter un coût important pour l'industrie porcine et les efforts sont orientés vers la prévention et une réduction des pertes tout au long des phases de production. Nous décrivons ici le cas d'un troupeau reproducteur utilisant un vaccin vivant modifié (VVM) contre le SRRP qui changea de vaccin commercial afin d'améliorer les performances post-sevrage. Deux rondes de vaccination de tout le troupeau avec un nouveau VVM contre le SRRP, administrés à 4 semaines d'intervalle, ont eu lieu sans interruption de la production du troupeau reproducteur et avec des changements limités dans les résultats diagnostiques. Les cochettes de remplacement se sont avérées négatives pour la détection du virus SRRP 10 semaines post-vaccination avec le nouveau VVM. Les diagnostics étaient positifs de manière intermittente dans le troupeau reproducteur et tôt en pouponnière.

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Porcine reproductive and respiratory syndrome virus (PRRSV) is a significant pathogen in swine and continues to contribute significant cost to the global swine industry each year.[1-3] Even with coordinated efforts by the industry to focus on prevention strategies and methods to mitigate production losses, wild-type PRRSV (WT-PRRSV) outbreaks continue across all production phases. One mitigation effort to decrease the clinical impact of WT-PRRSV is use of porcine reproductive respiratory syndrome (PRRS) modified-live virus (MLV) vaccines.

Several publications have reported on breeding herd and growing pig vaccination programs to mitigate losses incurred from a WT-PRRSV introduction.[4-6] Both breeding herd and post-weaning WT-PRRSV risk and production performance results influence herd health programs. Because of this, veterinarians may suggest changes to MLV vaccines in advance of potential WT-PRRSV exposure. However, producers and veterinarians may be hesitant to change commercial PRRS MLV vaccines. In utero PRRSV transmission demonstrates the need for a PRRS MLV vaccine change in both the breeding herd and their offspring.[7,8] The hesitation may also come from reports in the literature demonstrating the risk of recombination between vaccine-like and WT-PRRSV strains or between two vaccine-like strains.[9-11] Herein describes the process and supporting diagnostics from a vaccinated breeding herd that changed to a new commercial lineage 1 MLV PRRS (LN1MLV) vaccine (Prevacent PRRS; Elanco Animal Health) without production disruptions.

Animal care and use

Diagnostic samples were collected and vaccines administered per the disease prevention and health monitoring program for the herd. Hence, the procedures conducted on farm were considered within normal animal health monitoring and husbandry practices conducted under the advisement of the herd veterinarian.

Herd description

The herd was a 6000 head, MLV-vaccinated breeding herd with off-site nursery and gilt development unit (GDU) located in Indiana. Every 4 weeks, 9-week-old replacement gilts entered into 2 off-site, 1000-head GDU barns. Gilts were transported to the breeding herd every 4 weeks when they were approximately 23 weeks of age. Each GDU barn was emptied prior to entry of the next group of replacement gilts. Nursery sites were all-in-all-out with unidirectional flow from a single breeding herd. Three nursery sites were single-barn sites with 4 rooms in each barn; two of which had a total capacity of 8800 pigs, and one with a capacity of 7200 pigs. The fourth site had 2 barns, each with a capacity of 2200 pigs.

For approximately 2 years prior to this herd observation, previous MLV (PMLV) vaccine (PRRS Ingelvac MLV; Boehringer Ingelheim) was administered to the breeding herd quarterly, to replacement gilts at entry to the GDU and 4 weeks later, and to suckling pigs ready to wean at approximately 21 days of age. The last WT-PRRSV infection in the breeding herd was approximately 2 years prior to the change from PMLV to LN1MLV vaccine. Circulating WT-PRRSV strains from the breeding herd and growing pigs were classified by a veterinary diagnostic laboratory. Two lineage 1 clusters, a lineage 1C and a lineage 1B cluster, were detected on open reading frame (ORF) 5 sequence with 85% similarity to PMLV vaccine (Figure 1). The lineage 1C labels circled in Figure 1 indicate WT-PRRSV detected in growing pigs.

Replacement gilts awaiting transport to the breeding herd historically had PRRSV-positive oral fluid (OF) samples when measured by quantitative reverse transcriptase-polymerase chain reaction (RT-qPCR). Positive results caused delays in transport due to the additional molecular diagnostics required to differentiate a PRRSV-positive RT-qPCR result as wild-type versus vaccine-like.[12] These delays often impacted farm breeding targets. The owner and veterinarian aimed to confirm vaccinated gilts negative for PRRSV using RT-qPCR before moving them into the breeding herd.

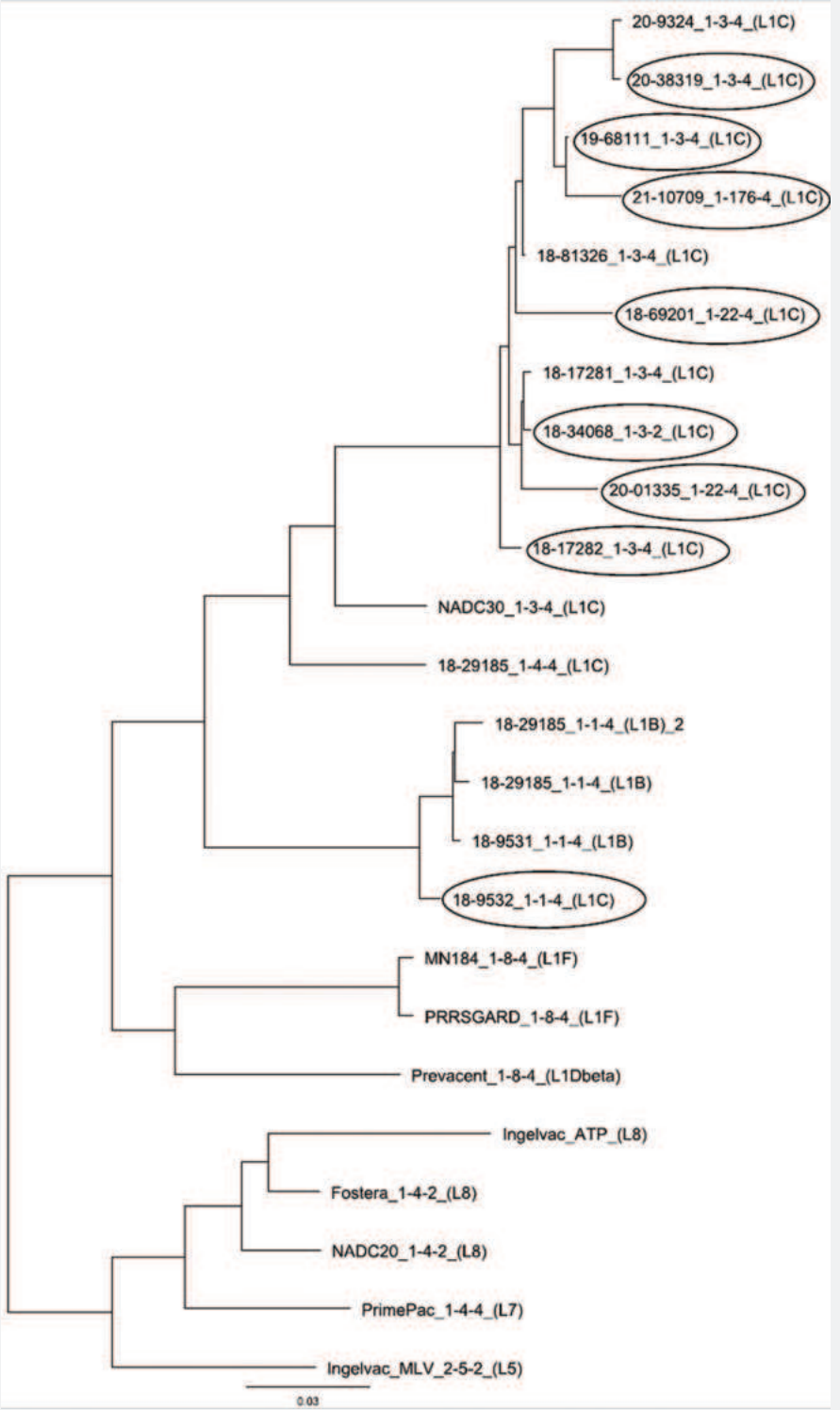
The owners also reported dissatisfaction with piglet growth and performance post weaning with WT-PRRSV diagnosed in repeated groups of pigs. During October 2020, the owner decided to change from PMLV to LN1MLV vaccine. The decision was based on the higher sequence similarity of LN1MLV to circulating wild-type strains. Existing information indicating LN1MLV reduced viral shedding, spread, and viremia also was taken into consideration.[13-19]

The change in MLV vaccine used occurred when the breeding herd was scheduled for a quarterly vaccination. A dose (1 mL) of LN1MLV vaccine was administered to all sows, replacement gilts in the breeding herd, and replacement gilts at the off-site GDU. Suckling piglets received 1 mL LN1MLV vaccine 1 to 3 days prior to weaning (at approximately 21 days of age) beginning within a week of breeding herd vaccination. All administration of PMLV was discontinued in the breeding herd, replacement gilts, and suckling piglets. Four weeks later, a second whole-herd vaccination with LN1MLV vaccine was administered to all sows, replacement gilts in the breeding herd, and replacement gilts at the off-site GDU.

A sampling protocol was put in place by the herd veterinarian 6 weeks prior to the first LN1MLV whole-herd vaccination to assess PRRSV circulation through the change of MLV vaccines (Table 1). Externally sourced selected gilts were tested every 4 weeks prior to transport from the continuous-flow, off-site GDU to the breeding herd. Five OF samples were collected from pens (approximately 60 gilts/pen) and pooled into 1 sample/pen at each collection timepoint. Processing fluid (PF) samples from all the gilt (approximately 55) and sow (approximately 220) litters were collected separately and pooled by week.[20,21] Family oral fluid (FOF) samples were collected 3 days prior to weaning from 5 gilt and 5 sow litters and pooled by week.[22] Gilt litter samples for PF and FOF were kept separate from sow litter samples to monitor diagnostic differences as sows would have received multiple doses of PMLV vaccine prior to the change in commercial MLV vaccines. Five OF samples, one per pen, were collected at the beginning (week 1 of placement) and at the end (weeks 5-6 of placement) of the nursery period. Sample collection was distributed across the air space at the front, middle, and back of the room. These 4 sampling timepoints were aligned by birth week for longitudinal analysis of PRRSV status. All samples were submitted to the Iowa State University Veterinary Diagnostic Laboratory. Samples were analyzed by RT-qPCR and both the mean cycle threshold (Ct) value and the frequency to achieve a Ct value > 37 were evaluated.

Reproductive performance, livability, and growth metrics obtained from production databases for the breeding herd and weekly nursery groups were collected and retrospectively analyzed. Three periods of performance data were compared in the breeding herd: PMLV (6 weeks prior to the first whole-herd vaccination with the LN1MLV vaccine),

Figure 1: Phylogenetic tree of porcine reproductive and respiratory syndrome commercial modified-live virus (MLV) vaccines, reference strains, and those wild-type strains detected in the breeding herd and growing pigs 2 years prior to transitioning to Prevacent (new lineage 1 MLV PRRS [LN1MLV]) and through the change of MLV vaccines. Each are labeled with either the vaccine brand name, reference strain name, or an abbreviated case number. The label also includes restriction fragment length polymorphism cut pattern, lineage, and sublineage for lineage 1 strains. Depicted are 2 lineage 1 clusters, a lineage 1C and a lineage 1B cluster. The circled labels indicate wild-type viruses detected in growing pigs.



transition (4-week period between the first and second whole-herd vaccinations), and LN1MLV (6 weeks after the second whole-herd vaccination). The timeframe evaluated for the breeding herd occurred from October 2020 through February 2021 (16 weeks) as directed by the quarterly vaccination schedule. The data analysis focused on these 16 weeks due to other changes in the herd health program that confounded the results. Breeding herd production metrics were recorded weekly and included conception rate, farrowing rate, incidence of stillborn and mummified piglets, preweaning mortality, and pigs weaned per sow farrowed. Growth performance data from barn closeouts were compared for different nursery groups administered the respective vaccines, PMLV or LN1MLV. The nursery performance data evaluated included nursery exit weight, average daily gain (ADG), average daily feed intake, feed conversion rate (FCR), and mortality.

Results

Following each whole-herd vaccination of the breeding herd with LN1MLV vaccine, owners did not report adverse clinical signs such as sows off-feed, fever, or elevated rate of abortions. Breeding herd production parameters remained within expected and historical farm ranges throughout evaluation. The PMLV, transition, and LN1MLV periods had numerically similar variation, as shown by standard deviation, in mean conception rate, farrowing rate, incidence of stillborn and mummified piglets, preweaning mortality, and pigs weaned per sow farrowed (Table 2). Nursery pig productivity did not decrease with the LN1MLV vaccine compared to the PMLV vaccine (Table 2). Nursery exit weight was 1.5 kg greater while nursery ADG increased 0.03 kg/day and FCR improved by 0.02 for LN1MLV vaccinated pigs compared to the prior vaccine program. However, nursery mortality was 1.5% higher after the transition to LN1MLV vaccine (Table 2).

Replacement gilts sampled after 2 vaccinations with the LN1MLV vaccine tested negative at the time of transport to the breeding herd, approximately 10 weeks after the second LN1MLV vaccination. Aligned by birth week, piglet diagnostics from PMLV, transition, and LN1MLV periods are presented in Table 3. Processing fluids from gilt litters were intermittently PRRSV positive within 2 weeks of the whole-herd vaccination (Table 3). Piglet processing fluids from sow litters

Table 1: A sampling protocol for PRRSV detection using RT-qPCR at various timepoints through a PRRSV vaccine transition*

Sampled pigs	Sample type	Sample frequency	No. pooled samples collected
Replacement gilts	OF	Monthly	5 pens
Piglets			
3-5 d of age	PF	Weekly	~55 gilt litters ~220 sow litters
~18 d of age	FOF	Weekly	~5 gilt litters ~5 sow litters
Early nursery (~4 wk of age)	OF	Weekly	5 pens
Late nursery (~9 wk of age)	OF	Weekly	5 pens

* Replacement gilt samples were collected prior to transport from an off-site gilt development unit to the breeding herd. Piglet sample collection points were aligned by birth week for 16 groups of pigs (1 group/wk).

PRRSV = porcine reproductive and respiratory syndrome virus; RT-qPCR = quantitative reverse transcriptase-polymerase chain reaction; OF = oral fluids; PF = processing fluids; FOF = family oral fluids.

Table 2: Production metrics during the transition of a vaccinated PRRSV-vaccinated breeding herd to an LN1MLV vaccine

Production metrics*

Breeding herd	PMLV	Transition	LN1MLV
No. production weeks	6	4	6
Conception rate, %, mean (SD)	92.9 (1.1)	92.0 (0.8)	91.7 (1.1)
Farrowing rate, %, mean (SD)	89.0 (1.9)	89.7 (1.8)	88.4 (2.2)
Stillborn and mummified piglets, %, mean (SD)	6.4 (0.6)	6.7 (0.7)	6.7 (0.5)
Preweaning mortality, %, mean (SD)	15.0 (2.1)	15.2 (1.1)	13.1 (1.1)
Pigs weaned/sow farrowed, No., mean (SD)	10.8 (2.09)	10.4 (0.75)	10.9 (0.99)

Nursery, mean	PMLV	LN1MLV	Difference
Nursery entry weight, kg	6.3	6.2	- 0.1
Nursery exit weight, kg	23.0	24.5	+ 1.5
Overall ADG, kg/d	0.37	0.40	+ 0.03
Overall FCR	1.50	1.48	- 0.02
Days on feed	46.1	46.4	+ 0.3
Mortality, %	3.2	4.7	1.5

* Production metrics were calculated as follows: conception rate = the percent of sows pregnant of those serviced 35 days prior; farrowing rate = percent of sows farrowed of those serviced 114 days prior; stillborn and mummified piglets = percent pigs stillborn and mummified of total pigs born in period; Pigs weaned/sow farrowed = total pigs weaned in period/total sows farrowed in period; ADG = pounds body weight gained/day in period; FCR = pounds of feed consumed/pound body weight gained in period.

PRRSV = porcine reproductive and respiratory syndrome virus; LN1MLV = new lineage 1 modified-live virus PRRS vaccine; PMLV = previous modified-live virus PRRS vaccine; ADG = average daily gain; FCR = feed conversion rate.

Table 3: Changes in breeding herd and nursery PRRSV diagnostics measured by RT-qPCR before, during, and after changing from a PMLV vaccine to an LN1MLV vaccine

Breeding herd sample period	Ct values by sample type*				Nursery sample period	Ct values by sample type*	
	PF		FOF			Nursery OF	
	Gilt litters	Sow litters	Gilt litters	Sow litters		Early	Late
PMLV	> 37	> 37	> 37	> 37	PMLV	> 37	28.7
	> 37	> 37	> 37	> 37		> 37	27.7
	> 37	> 37	> 37	> 37		> 37	28.3
	> 37	> 37	> 37	> 37		36.2	30.2
	33.4	> 37	> 37	> 37		33.3	28.6
	> 37	> 37	> 37	> 37		> 37	31.2
Transition	> 37	> 37	> 37	> 37		31.7	28.9
	35.7	> 37	> 37	32.4	LN1MLV	34.7	31.1
	> 37	> 37	35.1	34.9		31.8	36.5
	> 37	> 37	> 37	34.0		33.8	32.5
LN1MLV	> 37	> 37	> 37	> 37		34.3	30.0
	> 37	> 37	> 37	36.6		> 37	32.4
	31.6	> 37	> 37	> 37		> 37	> 37
	> 37	> 37	> 37	> 37		> 37	29.8
	> 37	> 37	> 37	35.6		> 37	35.6
	> 37	> 37	> 37	> 37		> 37	30.2

* Samples were considered PRRSV negative (gray shading) when Ct ≥ 37. Samples were considered PRRSV positive when Ct < 37.

PRRSV = porcine reproductive and respiratory syndrome virus; RT-qPCR = quantitative reverse transcriptase-polymerase chain reaction; PMLV = previous modified-live virus PRRS vaccine; LN1MLV = new lineage 1 modified-live virus PRRS vaccine; Ct = cycle threshold.

remained PRRSV negative throughout the PMLV, transition, and LN1MLV periods. The FOF from gilt and sow litters were intermittently PRRSV positive following the change to LN1MLV vaccine. Neither PF nor FOF samples were sequenced during the PMLV, transition, or LN1MLV periods due to the high Ct values. Early-nursery OF samples were PRRSV positive but tested PRRSV negative after sows received the second whole-herd vaccination with the LN1MLV vaccine. Positive early-nursery OF samples were not sequenced during the PMLV or LN1MLV periods due to the high Ct values. In late-nursery OF samples, PRRSV was detected in all but one group throughout the PMLV, transition, and LN1MLV periods (Table 3). The herd veterinarian reported that the late-nursery PMLV OF were positive for WT-PRRSV. The late-nursery LN1MLV OF with a Ct of 29.8 was Sanger sequenced as WT-PRRSV and is labeled "21-10709_1-176-4_(L1C)" on the phylogenetic tree (Figure 1).

Discussion

The breeding herd described here changed commercial MLV vaccines to 2 whole-herd vaccinations with an LN1MLV vaccine administered 4 weeks apart without production disruptions and limited changes to diagnostic results. To the authors' knowledge, this is the first report to describe a vaccinated breeding herd and its suckling piglets changing to a new commercial PRRS MLV vaccine. Others have reported a breeding herd vaccination program that alternated quarterly between 2 commercial PRRS MLV vaccines with no negative impact on reproductive performance as measured by conception rate.[23]

Prior to commercial availability of the LN1MLV vaccine in the United States, a retrospective epidemiological study enrolled 8 breeding herds that routinely administered commercial MLV vaccines to assess the productivity impact of vaccination.[4] For each breeding herd, a 6-week period prior to whole-herd vaccination was established as the baseline. This was compared to a 6-week period following whole-herd vaccination. There was no significant impact on breeding herd productivity from the aggregated data analysis.[4] This is mentioned here to provide the reader with an indication of the impact of other commercial PRRS MLV vaccines on breeding herd productivity.

This breeding herd is only one vaccinated herd observed for a short duration prior to and following the change of commercial MLV vaccines. These observations did not determine if the process is specific to the commercial MLV vaccine administered, or the long-term impact of the change from one MLV vaccine to the other. A future study may consider enrollment of multiple breeding herds using different production management practices and vaccination programs with other commercial PRRS MLV vaccines. Those studies may want to consider a longer duration of monitoring within the breeding herd to encompass the persistent phase of PRRSV,

detect instability of viral swarm, recurrence and persistence of vaccine-like viremia, and recombination events.[8,24] Monitoring pigs through the finishing phase would allow observation for changes in production results (eg, ADG, FCR, and mortality) through the time of marketing.

In the herd described here, we observed a shift of PRRSV shedding in the replacement gilts after the change in PRRS MLV vaccines. Historically, this herd's replacement gilts awaiting transport to the breeding herd had PRRSV-positive OF samples as measured by RT-qPCR. Although the virus detected was often vaccine-like, positive results caused entry delays and impacted farm breeding targets. Following the 2 vaccinations, gilt movements and production targets were more predictable. Existing information about the LN1MLV vaccine indicates reduced viral shedding, spread, and viremia,[13-19] which may explain the consistent PRRSV-negative gilts observed with this herd. The same results may be achievable with other management practices, such as a decrease in the frequency in which gilts enter and exit the off-site GDU.

Processing fluids, FOF, and early-nursery OF tended to show more negative results following the second whole-herd vaccination. This suggests a second whole-herd vaccination with the new MLV vaccine is warranted to aid in the reduction of clinical PRRSV. In late-nursery OF samples, PRRSV was detected in all but one group throughout the herd observation. However, all the FOF samples collected 3 days prior to weaning and OF samples collected in the early and late nursery were pen-based pooled samples. The PF, FOF, and early-nursery OF PRRSV RT-qPCR Ct values were all > 30. Pooling of samples was a limitation in this study. Baker et al[25] reported that herds with a low viral load should avoid pooling pen-based oral fluid samples. Future herds may want to consider a larger sample size or fewer number of pen-based OF samples pooled for PRRSV RT-qPCR.

With PRRSV whole-genome sequencing, Trevisan et al[11] reported that administration of 2 commercial PRRS MLV vaccines in the same flow (breeding herd and respective growing pigs) can lead to recombination events. This supports the need for a deliberate process to change commercial MLV vaccines in both the breeding herd and their offspring. This vaccinated breeding herd and its suckling piglets changed commercial PRRS MLV vaccines. Two whole-herd vaccinations with LN1MLV vaccine administered 4 weeks apart occurred without breeding herd production disruptions. In addition, the change in PRRS MLV vaccine allowed replacement gilts to be available for transport to the breeding herd from the off-site GDU in a timely manner post vaccination.

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Conflicts of Interest

Risser and Jordon are employed by Elanco Animal Health, which manufactures and markets Prevacent PRRS vaccine. Puls was employed by Elanco Animal Health at the time of herd observation and manuscript submission. Ackerman and Lape declare no conflict of interest.

Disclaimer

Dr Arruda, a member of this journal's editorial board, was not involved in the editorial review of or decision to publish this article.

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