Characterization of changes in productivity parameters as breeding herds transitioned through the 2021 PRRSV Breeding Herd Classification System

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Summary

Using retrospective data from 6 breed-to-wean herds over 4 years, porcine reproductive and respiratory syndrome virus (PRRSV) statuses were assigned by week according to the 2021 American Association of Swine Veterinarians PRRSV classification. Productivity changes were characterized as herds transitioned through status categories. Overall, productivity improved as farm status improved.

Keywords: swine, classification, American Association of Swine Veterinarians, productivity, monitoring

Resumen - Caracterización de los cambios en los parámetros de productividad a medida que las piaras reproductoras hicieron la transición a través del sistema de clasificación de granjas reproductoras para el PRRSV 2021

Usando datos retrospectivos de 4 años de 6 hatos de gestación-maternidad, los estatus del virus del síndrome respiratorio y reproductivo porcino (PRRSV) se asignaron por semana de acuerdo con la clasificación del PRRSV de la Asociación Americana de Veterinarios de Cerdos de 2021. Los cambios de productividad se determinaron a medida que las piaras pasaron por las diferentes categorías de estatus. En general, la productividad mejoró a medida que mejoró el estatus de las granjas.

Résumé - Caractérisation des changements dans les paramètres de productivité lors de la transition des troupeaux reproducteurs dans le système de classification du PRRSV 2021 des troupeaux reproducteurs

À l'aide de données rétrospectives de six troupeaux de type saillie-au-sevrage sur une période de 4 ans, les statuts du virus du syndrome reproducteur et respiratoire porcin (PRRSV) ont été attribués par semaine selon la classification PRRSV 2021 de l'American Association of Swine Veterinarians. Les changements de productivité ont été caractérisés comme les troupeaux passaient d'une catégorie de statut à l'autre. Dans l'ensemble, la productivité s'est améliorée à mesure que le statut de l'exploitation s'améliorait.

The American Association of Swine Veterinarians (AASV) classification of breeding herds for the porcine reproductive and respiratory syndrome virus (PRRSV) helped facilitate PRRSV prevention, control, and elimination efforts. The standard terminology aided better information interchange between producers and veterinarians as to herd health status and intervention decisions, facilitated strategic biosecurity planning and execution, furnished researchers with standardized data, helped with assigning PRRSV infection status to herds, and helped to better understand market value of weaned pigs.[1]

Considering the emergence and widespread adoption of population-based sampling methods in the United States[2] and certain drawbacks associated with the classification scheme in use, for example, inconsistently weaning truly negative pigs from herds classified as PRRSV stable, the AASV proposed a modified PRRSV status classification scheme for breeding herds, hereafter defined as the AASV 2.0 PRRSV Classification System.[3]

The modified classification system relies solely on laboratory evidence. Therefore, there is no guarantee that there would be significant productivity differences between any 2 statuses, or how significant these differences would be. There has not been any study characterizing productivity differences between the PRRSV-positive unstable low-prevalence status just introduced (status 1B) and status 1A or 2vx.

The objective of this study was to characterize the changes in productivity of breeding herds as they transitioned between PRRSV status categories as defined by the AASV 2.0 PRRSV Classification System.

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Animal care and use

An animal use protocol was not required as this was a retrospective cohort study that used available laboratory diagnostic data, PRRSV outbreak information, and weekly productivity parameters.

Materials and methods

Overview

Six breed-to-wean farms belonging to a single production system in the southeastern United States were conveniently selected for the study. These sow farms were routinely exposed to PRRSV modified live virus (MLV) vaccines. Two of these six farms had no laboratory evidence of wild-type PRRSV shedding all through the study period (2017 to 2020). The remaining 4 farms had laboratory evidence of PRRSV shedding at one point or another, sufficient for herd placement into any of the AASV 2.0 PRRSV categories (1A, 1B, or 2vx). The reverse transcription polymerase chain reaction (RT-PCR) tests on samples to determine shedding status were carried out in an accredited veterinary diagnostic laboratory located in the United States. The following weekly productivity parameters were obtained from the system's production records:

- Total pigs born per litter (TBL)
- Pigs born alive per litter (BAL)
- Pigs weaned per sow (PWS)
- Preweaning mortality percentage (PWM)
- Neonatal losses per litter (NL; derived by subtracting BAL from TBL)

The farms used multiple sample types for RT-PCR testing to monitor PRRSV shedding including processing fluids, ear blood swabs, family oral fluids, fetal tissues, pig tissues, and sow tissues. The farms used these sample types individually or in combination.

Observational units and eligibility criteria

The observational unit was week, defined as a given calendar week for each study herd. To be eligible each week, the farm had to be void of perceived activity of other disease outbreaks that impact breeding herd productivity, including porcine epidemic diarrhea, transmissible gastroenteritis, and porcine delta coronavirus. Weeks without sufficient diagnostic information for assigning PRRSV status, according to the protocol described herein, were also excluded from the analysis.

AASV 2.0 PRRSV classification

The AASV 2.0 PRRSV Classification System was used to assign a status to each week based primarily on laboratory evidence of PRRSV activity over defined time periods for certain sample types and attenuated PRRSV vaccine use in the breeding herds. The full details of the AASV 2.0 PRRSV Classification System are described by Holtkamp et al.[3]

In summary:

Category 1A included PRRSV unstable, high prevalence herds evidenced by high viremia or viral shedding. A herd falls into this category if it does not meet conditions for any of the other categories.

Category 1B included PRRSV unstable, low prevalence herds evidenced by low viremia or viral shedding. To enter this category, herds required 3 of 4 tests in 90 days for sera or 10 of 13 weekly tests (using population-based aggregate samples) with zero detection of wild-type PRRSV RNA in weaning age pigs.

Category 2vx included PRRSV stable herds that were vaccinated. This is the best-case scenario for vaccinating herds. To enter this category, herds required all tests in a 90-day period have zero detection of wild-type PRRSV in weaning age pigs. Either 6 pools of 10 sera each or 6 pools of 5 sera each together with one pooled processing fluid sample is considered the minimum sample set to be tested for a herd to be promoted to this category.

This study was conducted on herds controlling PRRSV through MLV vaccine exposure. As such, no weeks were eligible for placement into AASV 2.0 PRRSV categories 2, 3 or 4, representing PRRSV stable, provisionally negative, and negative, respectively.

An additional analysis was implemented to characterize trends during the first 10 weeks of category 1A following diagnostic confirmation of a PRRSV outbreak as compared to the rest of the 1A weeks. This was based on a study where the median time to recover baseline productivity for herds using attenuated PRRSV vaccine was 10 weeks.[4]

For this study, any week where multiple samples were submitted, any positive result, regardless of sample type, was considered diagnostic evidence for a positive PRRSV herd test for that week.

Data analysis

A linear mixed regression analysis was performed with each productivity parameter as the response variable, the PRRSV status as a fixed effect, and farm ID and season of the year as random effects. The least-squares mean analysis was performed using the Kenward-Roger degrees of freedom method, 0.95 confidence level, Šidák method for confidence level adjustment, and Tukey method for P-value adjustment. These analyses were performed using the lme4 package[5] in R program.[6] Univariate analyses were chosen over multivariate as there was little to no correlation between most of the parameters measured.

Standardized residuals were plotted against fitted values for each model to assess heteroscedasticity and nonlinearity using the plot() function in base R.[6] The base R qqplot() function was used to evaluate the normality of residuals. There was a log transformation of the response variable to correct for violations in model assumptions wherever observed; this step sufficed. Outliers were assessed and confirmed to be valid data observations; no observations were removed.

Results

A total of 1125 weeks had sufficient information for category placement and data analysis. Overall, productivity improved as weeks improved PRRSV classification status (Table 1).

Discussion

This study aimed to investigate and describe the trends in selected productivity parameters as the study population changed AASV 2.0 PRRSV status categories. Data for 1125 weeks from 6 breed-to-wean farms in a single production system from 2017-2020 were included in the study. Each week was identified with productivity data and PRRSV status according to diagnostic test results, vaccination history, and PRRSV outbreak history. All study herds used attenuated PRRSV-vaccination as a control strategy during this time frame and, therefore, were classified as 1A, 1B, or 2vx. Routine PRRSV vaccination of the breeding female population is a common practice in some US swine herds and the results of this study will be informative to several other systems. There were no statistical differences across groups in the average TBL, which includes the total BAL and NL (mummified fetuses and still births).

Table 1: Least-squares means (SE) of productivity parameters for each AASV 2.0 PRRSV status classification*

Parameter/wk	AASV 2.0 PRRSV classification			AASV 2.0 PRRSV classification - further categorization of 1A			
	1A	1B	2vx	1A – first 10 weeks	1A – 11th week through promotion to 1B†	1B	2vx
Total born/litter, No. (SE)	14.3 (0.22)[a]	14.4 (0.21)[a]	14.4 (0.22)[a]	14.6 (0.24)[a]	14.3 (0.22)[b]	14.4 (0.23)[ab]	14.4 (0.21)[ab]
Born alive/litter, No. (SE)	12.6 (0.20)[a]	13.1(0.21)[b]	13.2 (0.20)[b]	12.1 (0.22)[a]	12.7 (0.20)[b]	13.1 (0.20)[c]	13.2 (0.19)[c]
Neonatal losses/ litter, No. (SE)	1.58 (0.12)[a]	1.23 (0.01)[b]	1.18 (0.10)[b]	2.46 (0.20)[a]	1.44 (0.11)[b]	1.23 (0.09)[c]	1.19 (0.09)[c]
Pigs weaned/sow, No. (SE)	10.7 (0.20)[a]	11.3 (0.21)[b]	11.5 (0.20)[c]	9.6 (0.21)[a]	10.9 (0.20)[b]	11.3 (0.20)[c]	11.5 (0.19)[c]
Preweaning mortality, % (SE)	14.0 (1.36)[a]	13.0 (1.29)[a]	12.1 (1.16)[b]	19.9 (2.08)[a]	12.9 (1.29)[b]	13.0 (1.32)[b]	12.2 (1.20)[b]

* The AASV 2.0 PRRSV status classification[3] categories assigned to herds in this study include 1A = positive unstable, high prevalence; 1B = positive unstable, low prevalence; 2vx = positive stable with vaccination.

† This period begins on the 11th week of a herd being classified as 1A status post-PRRSV outbreak and ends when the herd was promoted to 1B status.

a,b,c Different superscripts on compared statuses for each productivity parameter indicate statistical differences (α = .05).

PRRSV = porcine reproductive and respiratory syndrome virus

Provided there is not significant early gestation reproductive failures attributable to PRRSV, this parameter is expected to be about the same across categories. Differences between statuses would lie in the proportions of the component parameters that make up TBL. Records of other productivity parameters such as breeding repeats and number of aborts were not available for analyses; we therefore could not characterize reproductive disorders or prenatal losses attributable to PRRSV.

Neonatal losses per litter, BAL, PWS, and PWM improved as these herds improved PRRSV status. These results are similar to those observed in Torrents[7] where BAL and PWM had relatively better numbers when herds were PRRSV stable. Torrents[7] study was conducted in Spain with farms naturally exposed to PRRSV-1, while the farms in this study were naturally exposed to PRRSV-2.

As seen from the first few weeks following a PRRSV outbreak, the impact on productivity can be short lived relative to the time the virus is actively being shed and susceptible animals infected in herds. This demonstrates that productivity levels should not be used as a proxy of PRRSV circulation. It would also be economically beneficial for vaccinated herds to keep implementing best practices until their herds attain and maintain PRRSV stability; a low PRRSV-prevalence status should not be a comfortable destination for herds aiming to control PRRSV.

Considering that the parameters measured in this study are only a subset of those important for measuring productivity losses attributable to PRRSV, this study does not attempt to fully characterize the economic differences between PRRSV statuses, rather, to characterize differences in the averages of the mentioned parameters. Some liberty was taken in promoting herds from 1B to 2vx, in that, even though these herds demonstrated a lack of PRRSV shedding for several months using at least three sample types weekly, these samples were not exactly as described in the AASV 2.0 PRRSV classification scheme. To the best of our knowledge, this is the first study that has evaluated changes in productivity parameters as breeding herds transitioned through the AASV 2.0 PRRSV status categories. Therefore, there is a need for similar studies on PRRSV-negative herds and herds targeting elimination to characterize changes in productivity parameters for other AASV 2.0 PRRSV categories not included in this study (ie, categories 2, 3, and 4).

Complementary studies in this line will provide useful data for evaluating and choosing best intervention strategies (control versus elimination) at farm, production company, and regional levels.

Implications

Under the conditions of this study:

- Productivity improved as AASV 2.0 PRRSV classification status improved.
- Productivity can approach baseline even when a herd is actively shedding PRRSV.

Acknowledgments

Conflict of interest

None reported.

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