Brief Communication Communication brève

Comparison between the 2013–2014 and 2009–2012 annual porcine reproductive and respiratory syndrome virus epidemics in a cohort of sow herds in the United States

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Abstract — The purpose of this study was to describe the 2013/2014 porcine reproductive and respiratory syndrome virus (PRRSV) epidemic in the United States and compare it with the previous 4 y of data from 2009 to 2012. A total of 371 herds participated in the study, representing nearly 1.2 million sows in 15 States. There were significantly fewer PRRSV cases during this study period and the onset of the annual epidemic was delayed approximately 3 wk. Cluster analysis revealed a pattern similar to previous years. The roles of spurious observations, increased awareness of PRRSV epidemics, and porcine epidemic diarrhea virus detection in the United States swine herd are considered.

Résumé — **Comparaison entre les épidémies 2013–2014 et 2009–2012 du virus du syndrome dysgénésique et respiratoire porcin dans une cohorte de troupeaux de truies aux États-Unis.** Le but de cette étude consistait à décrire l'épidémie 2013–2014 du virus du syndrome dysgénésique et respiratoire porcin (SDRP) aux États-Unis et de la comparer aux quatre années antérieures de 2009 à 2012. Au total, 371 troupeaux ont participé à l'étude, ce qui représente près de 1,2 million de truies dans 15 États. Il y avait significativement moins de cas de SDRP durant cette période étudiée et l'apparition de l'épidémie annuelle a été retardée d'environ 3 semaines. Des analyses de regroupements ont révélé une tendance semblable aux années précédentes. Les rôles des observations erronnées, d'une sensibilisation accrue aux épidémies de SDRP et de la détection du virus de la diarrhée épidémique porcine dans le cheptel porcin des États-Unis sont considérés.

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Porcine reproductive and respiratory syndrome virus (PRRSV) continues to cause major production losses in the United States with a recent cost estimate of $640 million annually (1). Despite efforts from the veterinary community to control the virus between 2009 and 2012 the annual epidemics showed: a consistent date of onset, no significant change in the annual cumulative incidence of new cases, a repeatable location of clustered disease distribution, and a pattern of infection in herds with previous infection (2). The same study (2) showed the onset of the PRRSV epidemic was in the middle week of October and annual cumulative incidence ranged from 29% to 38%. In the fall of 2013, the same cohort of sow herds failed to signal the epidemic during this time period for the first time in 4 y, instead signaling the onset approximately 3 wk later. The annual cumulative incidence was lower than expected based on the previous 4 y of data. Therefore, the objective of this paper was to report and describe apparent differences in the onset of the epidemic in 2013 compared to previous years, including estimates of annual cumulative incidence, associations with reporting PRRSV cases in consecutive years, and identification of any changes in the spatial distribution of incidence in the 2013/2014 PRRSV monitoring season. These results will contribute to understanding the dynamics of PRRSV transmission, which ultimately may help to mitigate the impact of the disease in the US.

The study cohort consisted of a convenience sample of 371 farms in 14 unique production companies representing 1.2 million sows in 15 States. Herds were enrolled in the study between 2011 and 2013. Data for PRRSV status were provided retrospectively from 2009 until the date of enrollment, and then weekly thereafter. New cases were reported weekly via e-mail by the veterinarian or health manager. New cases were diagnosed based primarily on positive results of polymerase chain reaction (PCR) testing of at least 30 weaning age piglets on the sow farm. Veterinary professional judgment was used to determine if detection of PRRSV within a previously infected herd was new based on sequence heterology (commonly a cut off of 2%

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Table 1. Weeks to epidemic onset (starting from July 1) and cumulative incidence (with 95% confidence interval) comparison between the average of the first 4 monitoring years (2009 to 2013) and the 2013/2014 monitoring year

	4 year average (95% CI)	2013/2014	*P*-value
Number of weeks until epidemic:	15.3	18.3	—
Cumulative incidence (count of cases)			
July–Sept (Q1)	8 (7.74–8.26)	5	0.3284
Oct–Dec (Q2)	60 (58.25–61.75)	31	0.0046
Jan–Mar (Q3)	30 (28.30–31.70)	15	0.0221
Apr–Jun (Q4)	14 (13.35–14.65)	11	0.7702
July–Dec (Q1–Q2)	68 (66.24–69.76)	36	0.0045
July–Mar (Q1–Q3)	98 (96.15–99.85)	51	0.0018
July–Jun (Q1–Q4)	112 (109.79–114.21)	62	0.0039

or greater difference was used) compared with historical strains (if any), as well as clinical signs in sows or piglets. Producers were responsible for costs associated with all diagnostic testing. Of the 371 herds, 300 (81%) produced piglets for commercial production, 48 (13%) provided genetic multiplication, and 23 (6%) were involved in genetic nucleus production. There were 14 production companies, referred to as systems.

Annual and quarterly cumulative incidence were calculated from July 1st, 2013 to June 30th, 2014 at the aggregated level (all 14 systems combined) and at the system level (each of 14 systems considered separately) and compared with the average cumulative incidence between 2009 and 2012 using a Chi-square test (and Fisher's test when needed) (Win Episcope, Version 2.0; Universidad de Zaragosa, Zaragoza, Spain). The effect of reporting new PRRSV cases in consecutive years was estimated using logistic regression, where, for each farm "*j*," the response and explanatory variables were infection status in year "*i*" (yes, no), and year "$i - 1$" (yes, no), respectively (Statistix, Version 9.0; Analytical Software, Tallahassee, Florida, USA).

An exponentially weighted moving average (EWMA) was used to monitor the weekly incidence of PRRSV cases. An upper confidence limit was calculated such that when the EWMA was greater than this limit, the PRRSV epidemic was signaled.

Spatial scan statistic (3) was used to identify clusters of PRRSV cases in excess of a random process using a Bernouli model. The model was fitted for the observation period scanning for areas with high rates that would include a maximum of 50% of the population at risk, using a circular spatial window and no geographical overlap. Significant clusters were identified at $P < 0.05$ as estimated by the comparison of the observed results with 999 random scenarios generated using Monte Carlo simulation (SaTScan, Version 8.0; Information Management Services, Calverton, Maryland, USA).

The results of this analysis showed that overall there was a significant decrease in the incidence of new PRRSV cases during the 2013/2014 year (Table 1). The average number of weeks between July 1st and the onset of the PRRSV epidemic was 15.3 for the years 2009 to 2012 as opposed to 18.3 for 2013 (Table 1). There was no significant difference in the cumulative incidence for the first quarter of the year ($P = 0.3284$). There were 32 fewer cases at the end of the 2nd quarter ($P = 0.0045$), 47 fewer at the end of the 3rd quarter ($P = 0.0018$), and 50 fewer at the end of the 4th quarter (Table 1). Additionally, there were 29 fewer cases reported during the 2nd quarter ($P = 0.0046$), 15 fewer during the 3rd quarter ($P = .0221$); however, the same number of cases were reported in the 4th quarter ($P = 0.7702$) (Table 1). These data suggest the PRRSV epidemic was similar to that of the previous 4 y during the summer months (Q1), but different in fall and winter months (Q2 and Q3, respectively). The number of cases reported in the spring and early summer was the same.

Of the 14 production companies represented in the database, 12 reported numerically fewer new PRRSV cases during the 2013/2014 year compared to the previous 4-year average, and for 4 of them, the decrease was significant. One system reported the same number of infections, and 1 reported 3 additional infections. Reasons for these observations may be due, in part, to geographic location and regional PRRSV risk, as well as management factors that may have influenced the results.

The odds of reporting a PRRSV case in 2013/2014 were not significantly associated with reporting a case in the previous year [odds ratio (OR): 1.7, 95% confidence interval (CI): 0.93 to 3.13, $P = 0.0848$]. This is different from the first 4 y of the study where having a case in the current year (*i*), was significantly associated with having a case in the previous year (*i–1*) (2).

A significant cluster of cases was identified in 2013/2014, with the centroid in a location similar to the previous 4 y of data in Iowa (2). Also similar to the previous 4 y of data, the cluster had a radius of 164.93 km and 2.08 times the number of expected cases.

There was a decrease in the number of new PRRSV infections in 2013/2014 in the cohort of sow herds and a delay in the onset of the epidemic. Interestingly, PRRSV cases were still spatially clustered in the same geographical region in which they were clustered in previous years and 2013/2014 systems reported a low incidence of the disease. Those features suggest that the decrease in PRRSV incidence observed in 2013/2014 was associated with a background decrease in risk in the region, rather than with a decrease in PRRS virus frequency in high incidence areas or systems.

There are a number of factors that may explain, at least in part, the findings reported here. The most important change in the epidemiological conditions of the region in 2013/2014, compared to previous years, was the introduction of porcine epidemic diarrhea virus (PEDV) into the US swine herd. For that reason, epidemiological features that may explain the differences in PRRS virus incidence in 2013/2014, compared to previous years, may be divided into PEDV-related and non-PEDV-related factors. For example, due to the fear of PEDV, many producers increased biosecurity measures on their farms aimed at preventing lateral transmission of PEDV. Those biosecurity practices, primarily intended to prevent PEDV introduction, may have also helped to reduce introduction of PRRSV into susceptible farms. It might also be possible that PRRSV-infected herds were more likely to become infected with PEDV than PRRSV-uninfected farms, which ultimately may have resulted in fewer

PRRSV-infected growing pigs and a consequent decrease in lateral transmission of PRRSV.

Several non-PEDV factors may have contributed to the reduction of PRRSV incidence. As data from the first years of monitoring became available, this may have increased the awareness of the annual mid-October PRRSV epidemics. This may have resulted in better bio-security preparation aimed at reducing the introduction of PRRSV into susceptible herds during this time. There may have also been an increase in the application of PRRSV vaccine which could have affected transmission dynamics within the US sow herd. In support of this, the percentage of herds in this database choosing to maintain immunity in their population through ongoing management programs significantly increased during the same time period. Additionally, the application of bio-aerosol control measures (filtration), which has been shown to significantly reduce the number of new PRRSV infections (4), has increased dramatically in the past years. If this technology was applied to farms with high probability of infecting other farms or to a large number of PRRSV-uninfected farms, then transmission may have been mitigated due to either or both reduction in the infectiousness of infected farms or in the number of susceptible farms. If this ultimately resulted in fewer sow farms becoming infected, then it may have led to fewer PRRSV infected pigs entering the growing pig population, which could have decreased lateral transmission of the virus to other farms.

Another potential explanation is that the decrease in incidence was the consequence of secular cycles, which are fluctuations in disease incidence that occur over a 1-year period. Secular cycles may be associated with fluctuations in factors such as immunity, contact rates, or virus virulence and have been studied in foot and mouth disease epidemics in Paraguay (5) and *Neospora* associated abortions in dairy cattle (6). If the decrease here is associated with occurrence of a secular cycle, compared to a decreasing trend, then one may expect the incidence to increase and return to values similar to those observed before, within the next few years.

It may also be possible that the association reported here was spurious and that PRRSV incidence has not truly decreased in the US swine population. Potential causes of a spurious association might include changes in case definition, changes in diagnostic rigor, or changes in ability to detect PRRSV in PEDV-infected herds. Clinical signs of PEDV are often severe on the sow farm, with mortality in piglets often nearing 100%, which may result in having no piglets to test during the peak of the infection. Additionally, some herd managers may have elected to temporarily cease PRRSV testing during the PEDV outbreak. Fortunately, as herds affected with PEDV have recovered and resumed testing for PRRSV, the incidence of PRRSV remained unchanged. Additionally, the participant group remained the same between the 2 study periods of this project, so it is unlikely changes in case definition occurred. Finally, the decrease in PRRSV incidence was observed in 12 of the 14 systems from which data were collected. Together, these observations support the hypothesis that the reduction in PRRSV incidence in 2013/2014 reported here was true and represent the conditions observed in the field during the study period.

There are important limitations of this project that should be considered. First, this was a voluntary cohort which may have imparted some selection bias into the results. Additionally, there was no strict case definition, which may have imparted misclassification bias if some systems reported new breaks differently than others. Spatial scan statistics force a circular shape to the data set, which may not accurately reflect the true nature of irregularly shaped disease clusters.

In conclusion, there was significantly less PRRS reported in 2013/2014 and there was a delay in onset of the epidemic. The decrease was evident in 12 of 14 systems studied, but the spatial cluster of high incidence seen in previous years persisted. Studies in future years may help to elucidate whether the decrease reported here was due to a true decreasing trend in virus incidence, a secular cycle, or a false association, shedding light on the nature and extent to which PEDV-related and -unrelated factors may have affected the results.

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