

Modelling PRRSV dissemination dynamics to quantify the contribution of multiple modes of transmission

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Learn more about our work at <https://machado-lab.github.io/>

Background: Many aspects of the porcine reproductive and respiratory syndrome virus (PRRSV) between-farm transmission dynamics have been investigated, but uncertainty remains about the significance of farm type and different transmission routes on PRRSV spread.

Objective: We have developed a stochastic mathematical model of PRRSV transmission to mimic how PRRSV is known to spread between farms. The model considered between-farm propagation such as between farm transmission due to proximity (distance between farms), animal and vehicle movements (feed, personnel, shipment of live pigs between farms and to slaughterhouses), quantity of pig feed related animal by-products restricted (e.g. fat, meat and bone meal) in pig feed ingredients, and PRRSV break history (previous outbreaks occurrence).

Materials and methods: Data for three U.S. non-related pig production systems were obtained directly from producers and the Morrison Swine Health Monitoring Project (MSHMP). Data for each farm included their national premises identification number, production type, pig spaces per farm, geographic coordinates, between-farm movement data and PRRSV outbreak data.

The model developed was a stochastic model in discrete-time with a weekly time step. The model accounted for (1) contact network of discrete pig movements; (2) the local transmission events between neighboring farms driven by distances between farms; indirect contact by vehicles coming into farms, including for (3) feed, animal delivery to (4) farms and (5) market, and (6) vehicles used by personnel (crew) involved in the loading and unloading of pigs; amount of (7) fat and (8) meat and bone meal in feed formulation delivered to farms; and (9) re-break by a previous exposure to PRRSV.

Results

1. Our results demonstrate that pig movements and local transmission were the main transmission routes, regardless of farm type (sow, nursery, and finisher) (Figure 1). However, the contribution of transportation vehicles used to transfer pigs to farms explained a significant number of infected farms as follows, 20.9% of sow farms, 15% of nurseries and 20.6% of finisher farms.
2. As expected, vehicles transporting pigs to market were more important for PRRSV introduction into finisher farms (3.8%), while vehicles transporting feed showed the highest transmission contribution to sow farms (12%), while the vehicles transporting farm crews had limited contribution in the propagation of the virus regardless of farm type.
3. Finally, fat and meat and bone meal delivered via feed contributed to 2.5% and 0.03% of sow farm infections, respectively.

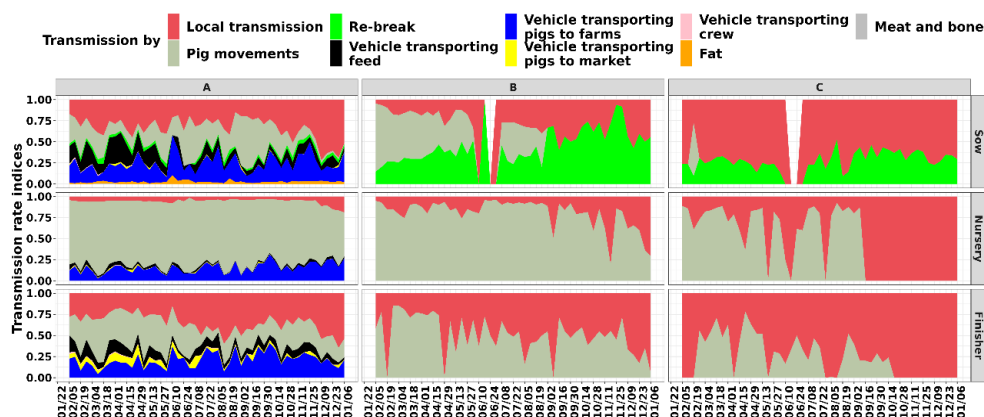


Figure 1. Farm infection contribution for each transmission route of each company (columns) and farm types (rows). The y-axis represents the proportion of transmission by each transmission route, while the x-axis shows each week in the simulation. Weekly proportions of transmission were calculated by dividing the number of simulated infected farms for each transmission route by the number of simulated infected farms by the total number of routes combined. White areas represent weeks without farm infections.

Conclusions and implications: This study provides a better understanding of the role of several transmission routes that have not yet been considered while modelling PRRSV dissemination. More importantly, we highlighted to the swine industry which routes are more likely associated with propagation so that producers and companies can focus their attention on routes that bring more return to their disease control programs, such as vehicle cleaning and disinfection.

For more details, please read the full available paper here - <https://www.biorxiv.org/content/10.1101/2021.07.26.453902v2>