

Modelling the transmission and vaccination strategy for porcine reproductive and respiratory syndrome virus

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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

The objective is to develop a stochastic epidemiological model calibrated on weekly PRRSV outbreaks accounting for the population dynamics in different pig production phases (breeding herds, gilt development units, nurseries and finisher farms) in a study area where three hog producer companies coexist in close proximity. The model was designed to examine the effectiveness of vaccination strategies and complementary interventions such as enhanced PRRSV detection and vaccination delays, and to forecast the spatial distribution of PRRSV outbreak.

Materials and methods

Data from three non-related U.S. pig production systems were obtained from the Morrison Swine Health Monitoring Project (MSHMP). Data from each farm included their national premises identification number, production type, pig spaces per farm, geographic coordinates, between-farm movement data, and PRRSV outbreak data. We developed a stochastic model in discrete-time with a weekly time step. Our model accounted for indirect contacts by the close distance between farms (named local transmission), between-farm animal movements (pig flow), and reinfection of sow farms (re-break).

Results

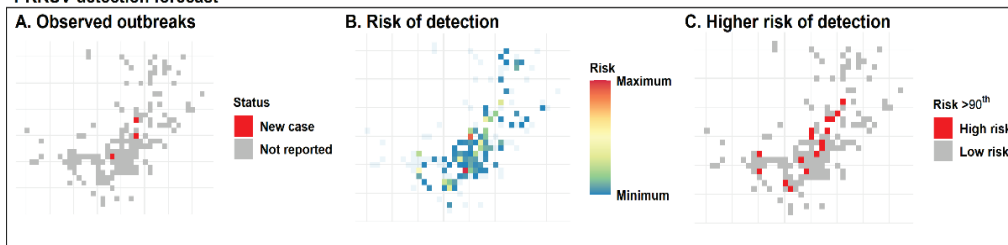
The highlights of this project are listed below:

1. The results of our analysis indicated that for sow farms, 59% of the simulated infections were related to local transmission which could be explained by airborne, feed deliveries, shared equipment, whereas 36% and 5% were related to animal movements and re-break, respectively. For nursery farms, 80% of infections were related to animal movements and 20% to local transmission; while at finisher farms, it was split between local transmission and animal movements.
2. Assuming that the current vaccines are 1% effective in mitigating between-farm PRRSV transmission, weaned pigs vaccination would reduce the incidence of PRRSV outbreaks by 3%, indeed under any scenario vaccination alone was insufficient for completely controlling PRRSV spread. Our results also showed that intensifying PRRSV detection and/or pig vaccination at placement increased the effectiveness of all simulated vaccination strategies.
3. Our model was able to reproduced the incidence and PRRSV spatial distribution (Figure 1).

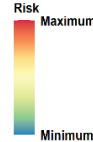
Conclusions and implications

The understanding of PRRSV transmission routes has the potential to inform targeted strategies. The result of this model could be used to map current and future farms at-risk and evaluate different vaccination interventions to control PRRSV spread. For more details please read the full paper here (<https://onlinelibrary.wiley.com/doi/10.1111/tbed.14007>).

PRRSV detection forecast



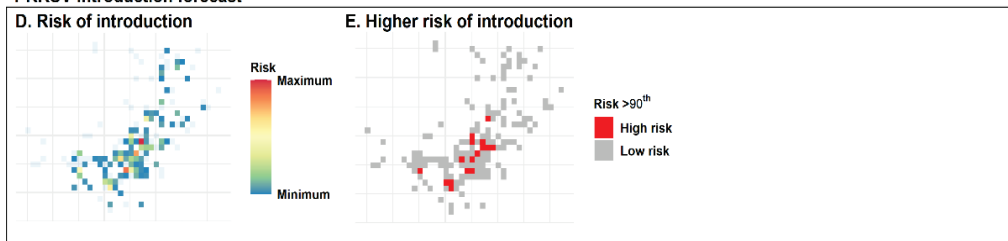
B. Risk of detection



C. Higher risk of detection



PRRSV introduction forecast



E. Higher risk of introduction



Figure 1. Predicted spatial distribution of PRRSV in sow farms for one target week (03–09 November 2019). (a) cells with observed sow farms infected; (b) estimated risk of PRRSV detection over 100 model simulations; (c) cells with risk for PRRSV detection above the 90th percentile; (d) estimated risk of PRRSV recent introduction; and (e) cells with risk for PRRSV introduction above the 90th percentile. Model performance was evaluated comparing observed outbreaks shown in A with predicted high-risk cells shown in C.