

Persistence of Porcine Reproductive and Respiratory Syndrome Virus (PRRSV) in GB pig herds: A mathematical study



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Introduction

Impact of PRRS

- Inability of sows and gilts to conceive
- Abortion if sows infected early in gestation
- Premature farrowing
- Birth of weak-born and dead piglets
- Respiratory disease in finishing pigs

Hypotheses

- Fadeout of virus is possible
- Persistence of virus is likely to be influenced by:
 - Reintroduction
 - Isolation of purchased stock
 - Recirculation by vertical and horizontal transmission

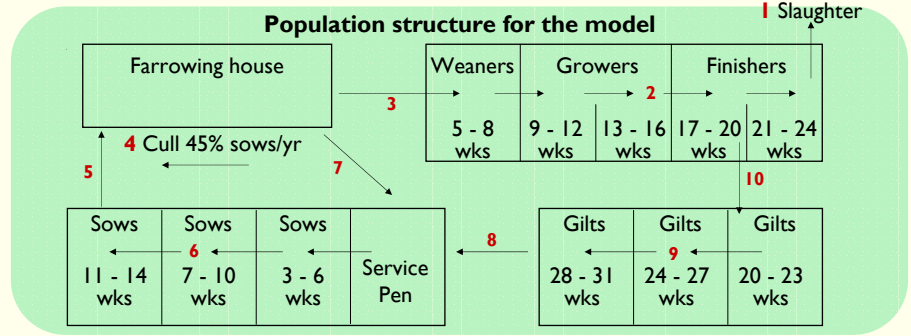
Aims

- Develop a population structure of a pig herd
- Use the dynamics of the pathogen to:
 - Investigate fadeout
 - Investigate persistence e.g. gilt purchasing practices
 - Investigate the effect of herd size

Model structure

Deterministic processes that happen every month:

- 1 = 24 week old finishers are slaughtered
- 2 = Rearing groups move each month (as a batch)
- 3 = Piglets are weaned into weaner pen
- 4 = 9 sows are culled every month (45% every year)
- 5 = Sows enter farrowing house at week 15 of gestation
- 6 = Sows move each month
- 7 = Weaned sows return to service pen
- 8 = 32 week old replacement gilts enter service pen
- 9 = Gilts move each month
- 10 = New gilts randomly selected from 20 week old finishers

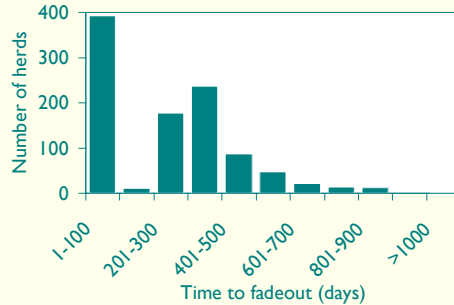
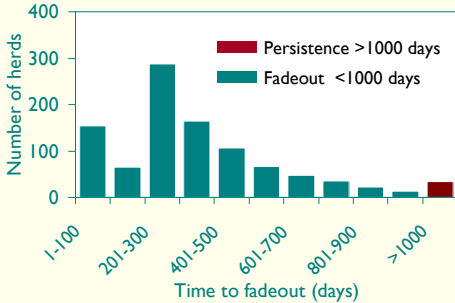


Stochastic processes each day:

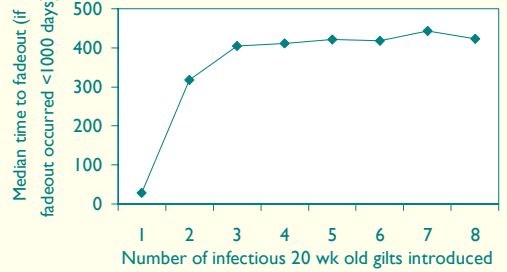
- Infection (density independent; transmission parameter 0.05)
- Recovery (exponential with mean duration 18 days)
- Decay of maternal immunity (exponential with mean duration 6 weeks)
- Model run for 1000 days for 1000 iterations. 250 sow herd

Simulation results - Introduction of 1 viraemic 20 week old gilt

Gilts housed in dry sow house until service (left) or separate gilt house (right)



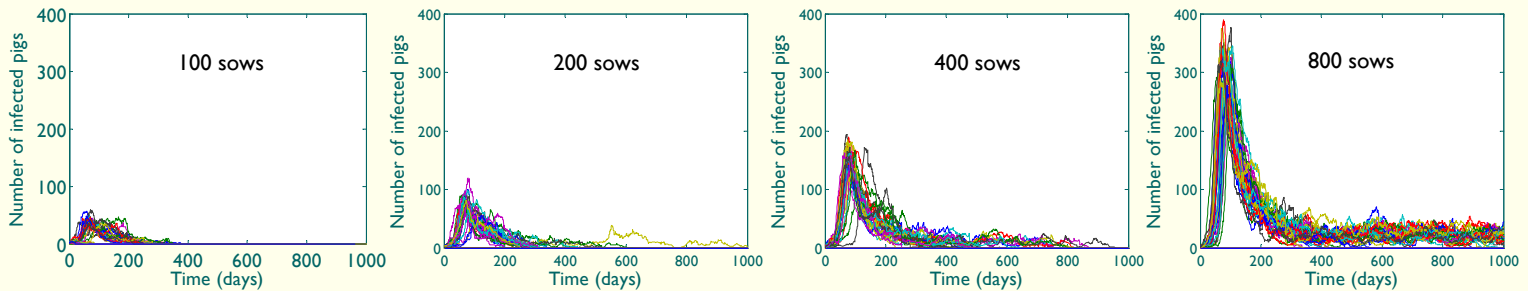
Number of infectious gilts introduced



- The probability of persistence increases when gilts are housed with sows until sexually mature (left)
- In ~50% of cases, the introduction of virus into a separate gilt house does not reach the rearing herd approx. 300 days later (right)

- Introducing more infectious gilts into 20 wk old gilt pen increases the median time to viral fadeout
- Proportion of herds that persisted for >1000 days ranged from 0.10 for 1 infectious gilt to 0.19 when 8 infectious gilts were introduced

Effect of sow numbers on the total number of infected pigs in the herd following the introduction of a viraemic gilt



- Increasing the herd size increases the number of infectious pigs in the herd and the probability of virus persisting for longer

Discussion

- Following introduction of virus into the gilt group, isolating gilts from sows reduces the probability of virus reaching the rearing herd
- The number of infectious gilts introduced increases the median time to fadeout
- Increased herd size increases the probability of virus persisting in the herd
- Further work:
 - Parameterise and validate the model using existing cross-sectional data
 - Explore other control strategies
 - Explore metapopulation dynamics

Acknowledgements

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