Mathematics and Decision Making for Control of *Salmonella* on UK Pig Farms

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Introduction

Abattoir studies demonstrating that approximately 25% of finisher pigs may carry *Salmonella* initiated the industry in taking action. With the introduction of the Zoonoses Action Plan (ZAP) by the British Pig Executive (BPEx) in 2002, and more recently the Zoonoses National Control Programme (ZNCP), there is now a focus on a whole chain risk based approach to tackling *Salmonella*.

This project aims to use mathematical models to improve understanding of *Salmonella* dynamics on UK pig farms. We propose to create a stochastic model of *Salmonella* transmission within an *n* group finishing unit (Figure 1), as this is the greatest public health risk.

Methodology & Results

A susceptible – infected – recovered – susceptible (SIRS) model of a UK pig finishing unit was developed. Two rows of *n* pens separated by a corridor was modelled (Figure 1). Cross infection is incorporated as shown (Figure 1), with a decreasing rate the further apart the infected and susceptible pig are.

We have assumed a closed system and the only source of infection are the pigs themselves. Parameter values have been estimated in order to obtain a realistic prevalence.

The model predicts an equilibrium prevalence of $\approx 26\%$ (Figure 2). A histogram (Figure 3) shows that there are two possibilities; the infected pig could recover immediately, or there will be a large outbreak. The basic reproduction number (R_0) for this model is ≈ 6, thus the presence of a large outbreak is to be expected.

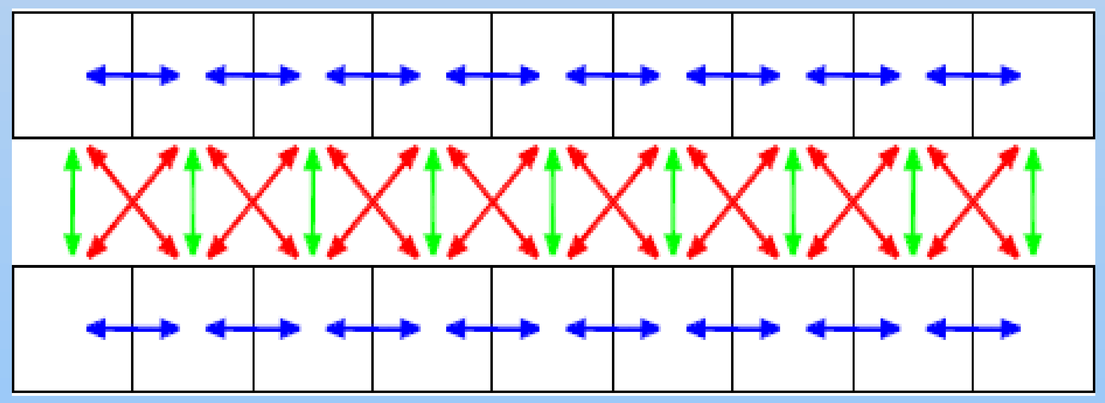

Figure 1: Pig herd structure with cross infection transitions

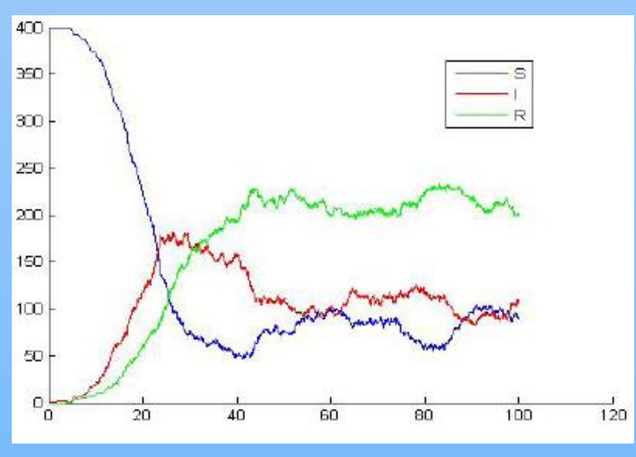

Figure 2: Trajectories of *S*, *I* and *R*

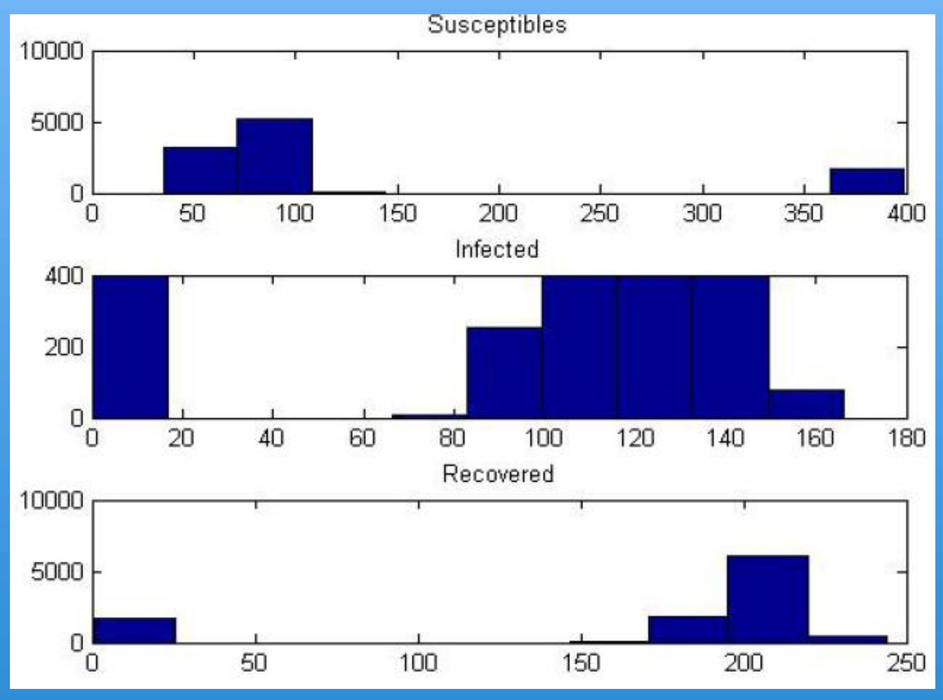

Figure 3: Histogram of S, I and R for 10,000 simulations

Discussion

The model presented here is thought to be a good basis for extension, by incorporating other farm characteristics. Currently, the model has been extended to a susceptible – excretor – carrier – recovered – susceptible model (similar to [1]) and incorporates bacteria in the environment (SECRS/W; as in [2]).

The model also has to be extended in order to allow movement of pigs and allow disinfection of pens between these movements. Data shall be used to accurately estimate parameter values used within the model. Data permitting, rodent/bird effects might be incorporated and analysed to see what effect this has on *Salmonella* dynamics. Furthermore, mathematical analysis of the model will be studied in more detail.

References

[1] A. Hill, E. L. Snary, M. E. Arnold, L. Alban & A. J. C. Cook, Dynamics of *Salmonella* transmission on a British pig grower-finisher farm: a stochastic model. Epidemiology and Infection, 136(03): 320-333, 2007

[2] Y. Xiao, R. Bowers, D. Clancy & N. French, Dynamics of infection with multiple transmission mechanisms in unmanaged/managed animal populations. Theoretical Population Biology, 71:408-423, 2007