Modelling the between-farm transmission of African Swine Fever in Madagascar

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Introduction and objective

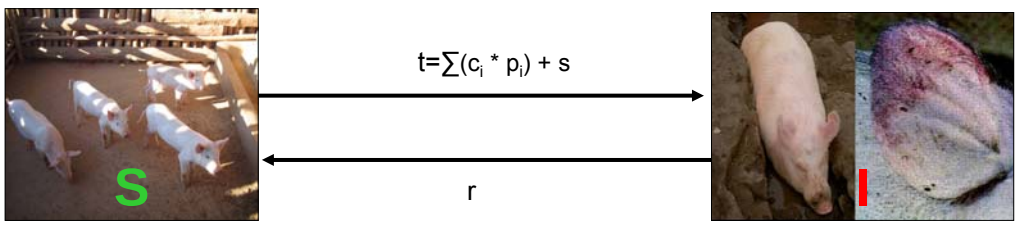
In Madagascar, African Swine Fever (ASF) causes important economic losses for pig farmers and constrains local pig production. Currently, investigations are under way to better understand the epidemiology of ASF, with the final objective to develop tools to inform control measures.

A model of the dynamics of transmission of ASF is being developed in this context, and will allow to simulate the impact of different control strategies. Movements of pigs and pork products are believed to be the main reasons for the transmission of ASF. Visits from actors of the pig production sector are also suspected to be an important risk factor for the introduction of the disease to farms. Therefore, our work aims at modelling the transmission of ASF as a result of interactions between pig farms.

Model description

1) State variables

Our unit of interest is the pig farm, and the deterministic model uses a time-step of one week.
Two reversible states are considered: farms can be Susceptible (S) or Infected and infectious (I).
If an infectious contact occurs (t), susceptible farms (S) become clinically infected and infectious (I). Farms then remain infectious until diseased animals are either killed (death or culling) or sold (r).



2) Transmission parameters t

We assume that ASF transmission is mainly due to network interactions within the pig production sector. We thus consider two additive types of transmission parameters for the model:

Distance-independent transmission parameters

Network contacts: introduction of pigs into farms or visits from other actors of the pig production sector (collectors, vets, feeds suppliers, etc.).

The transmission rates associated with network contacts are characterized by the number of contacts per week (c_i) multiplied by the probability of infection per contact (p_i).

Input values are derived from a currently on-going questionnaire survey. The collected data will allow the quantitative description of the pig production contact network. Information on working methods and bio-security measures combined with expert opinion will inform probabilities of infection for the different network contacts.

Distance dependant transmission parameters

Spatial transmission: contacts between free-ranging pigs, interactions with wild hosts (soft ticks and bushpigs), informal visits by people contaminated in the neighbourhood, contamination of farm material on local markets, movements of contaminated pets or poultry between farms, etc. These factors constitute a risk for the maintenance or re-introduction of the disease.

The associated transmission rate is characterized by a constant (s), equivalent to an additional risk of ASF infection for a proportion of farms.

The impact of the distance dependent transmission on the model outcome will be assessed by assuming different levels of local transmission (low, medium and high values for s).

3) Recovery rate r

The farm recovery rate (r) depends on herd characteristics: herd size, prevalence, sales and culling rates.

Discussion and outlook

The model does not include within-herd dynamics as the main objective of the model is the evaluation of the external sources for ASF infection. Currently, c_i are assumed to be independent of herd size and farm type. Once results from the questionnaire survey are analysed, the model can be stratified according to the different farming systems, as it seems likely that contact patterns, and thus transition probabilities, vary between farming systems.

Based on the deterministic model, a stochastic model using appropriate distributions for c_i and p_i will be developed.

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