



Modelling the spread of ESBL-producing bacteria in the Dutch broiler production pyramid

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Background

- Extended spectrum beta-lactamases (ESBLs) confer resistance to beta-lactam antibiotics
- The Broiler production pyramid provides a large reservoir for ESBL-producing bacteria
- In 2016 95% of farms and 38% of broilers in the Netherlands were positive¹

Objective

To design a stochastic metapopulation model that describes horizontal and vertical transmission dynamics on the prevalence of ESBL-producing bacteria in the broiler production chain

Model structure

- Dynamics of bottom two levels of the production pyramid (figure 1)
- SIIS-E model
- Flocks are free from antibiotic use
- Pseudo vertical transmission from parents to offspring via eggshell surface
- In- and outflow of animals in the PS, such that the populations constant to ensure stable egg production
- A broiler production round of 6 weeks is followed by 1 week of broiler farm vacancy
- I2 birds have a higher transmission value and shed more bacteria into the environment than I1 birds

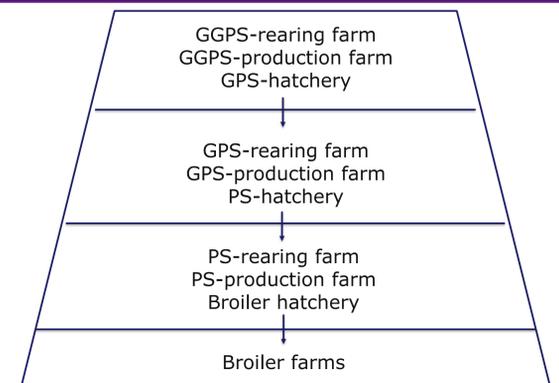


Figure 1. Broiler production pyramid
The pyramid consists of 4 generations: Great-Grandparent Stock (GGPS), Grandparent Stock (GPS), Parent Stock (PS) & Broilers

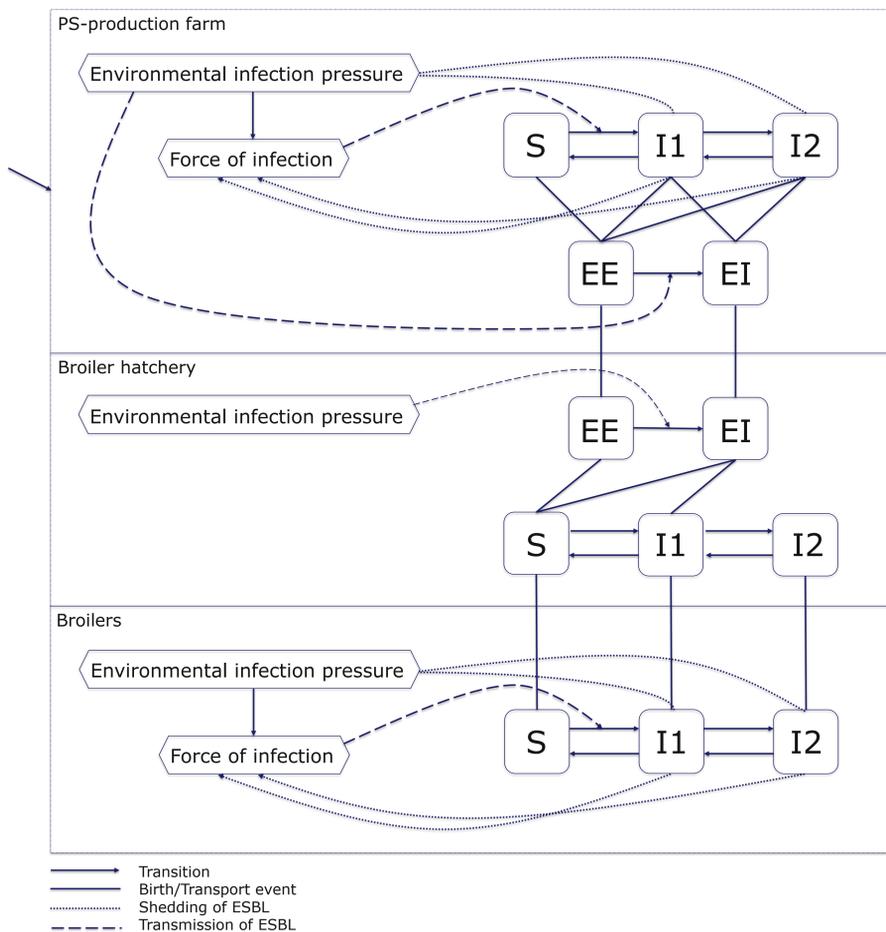


Figure 2. Schematic model

Simulation result inside a single broiler farm

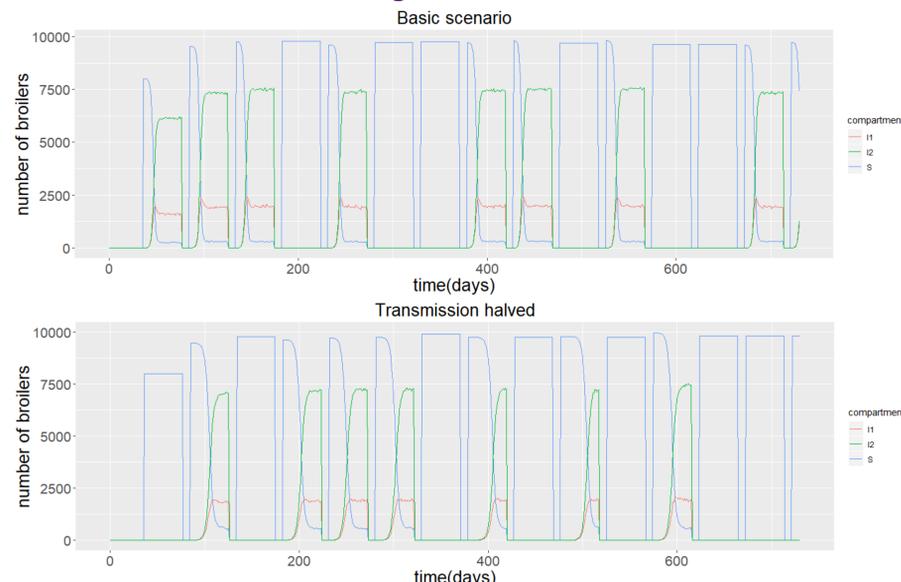


Figure 3. Simulation results within a single farm
Basic scenario b1=0.41 b2=1.33; Transmission halved b1=0.2 b2=0.67

Simulation results broiler farms

Basic scenario
B1=0.41 b2=1.33

Transmission halved
B1=0.2 b2=0.67

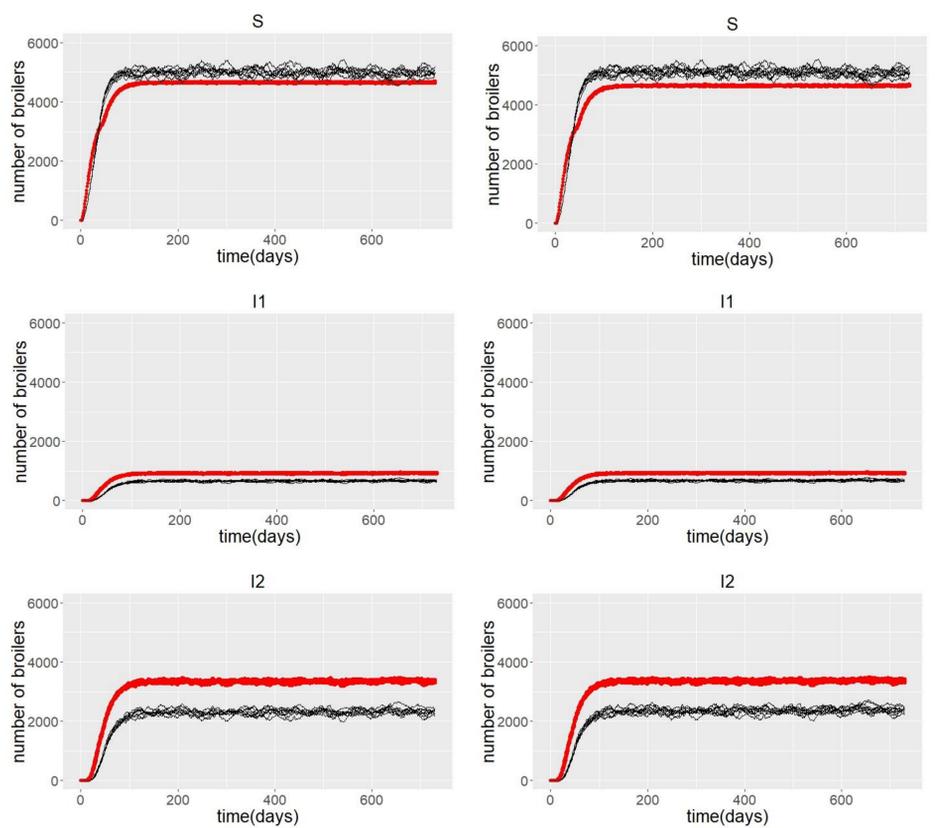


Figure 3. Simulation results for each compartment

■ mean
■ standard deviation
Broiler farms were modelled to hold approximately 10.000 birds

Main results

- Once a contaminated chick enters a broiler farm ESBL contamination spreads rapidly within that farm
- Halving the transmission coefficients reduces the speed of spread of ESBLs in a flock, but does not decrease the overall number of contaminated birds in the flock
- No relevant reduction in the number of contaminated birds is observed by halving the transmission coefficients

Conclusion & Discussion

- Monitoring of hatcheries should be carried out to prevent the initial contamination of a flock
- All parent stock production farms were highly contaminated, in further development of the model this should be made to include more variation in contamination

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