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Quantification of extended spectrum beta-lactamases producing *Escherichia coli* in broilers manure



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Introduction

- Chicken manure is commonly utilized as fertilizer in agriculture due to its rich nutrient content, which benefits plant growth.
- If the manure originates from a flock carrying bacteria resistant to antimicrobials, it can contribute to the spread of antimicrobial resistance (AMR) in agricultural produce, potentially affecting human health.
- This model quantifies the amount the extended spectrum beta-lactamases producing *Escherichia coli* (ESBL *E. coli*) in broiler manure and represents the first step of a broader Quantitative Microbial Risk Assessment model (QMRA) with the aim to estimate the environmental human exposure to AMR from broiler production.

Material and Method

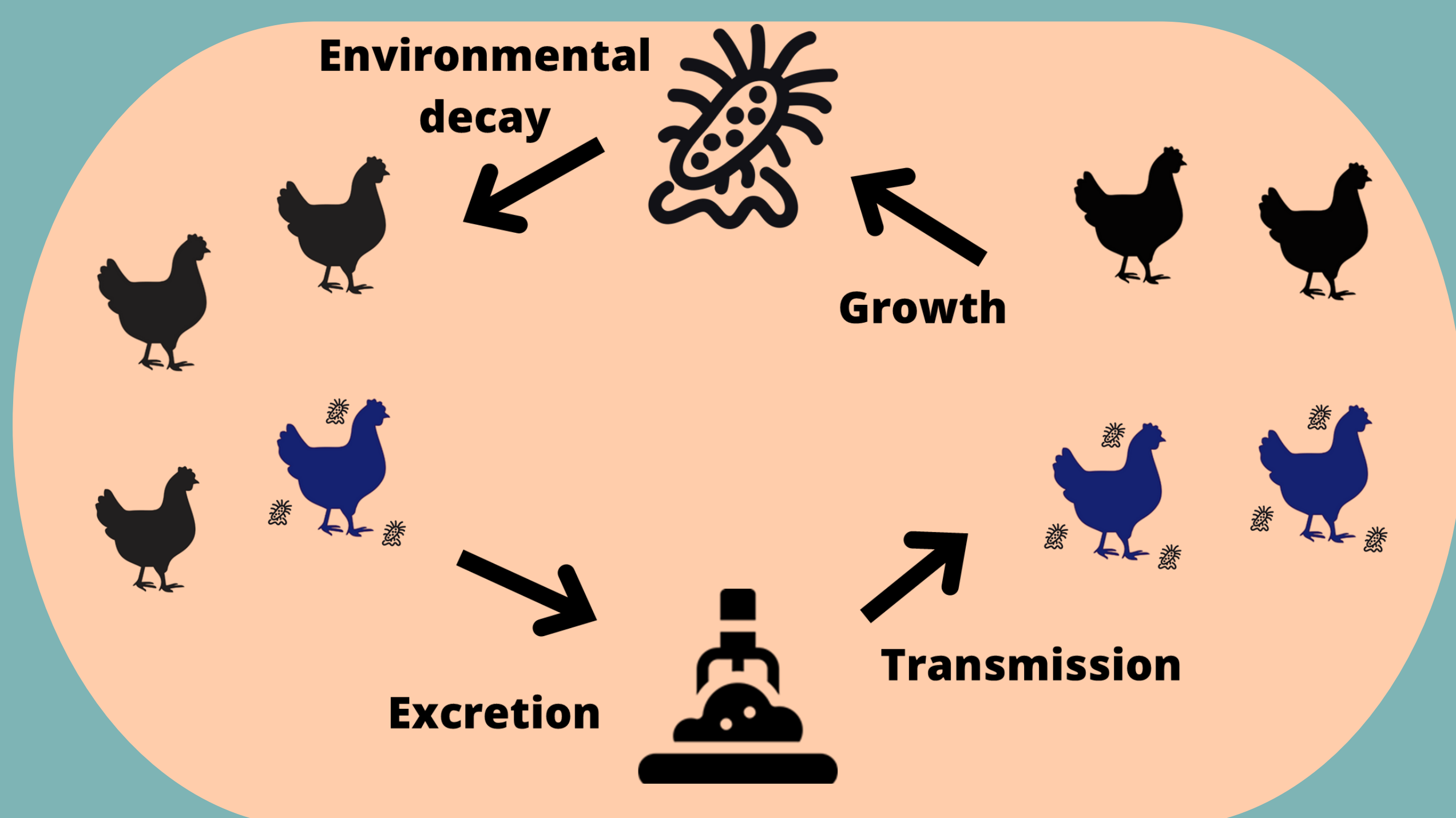


Fig 1. Quantitative model general scheme

The model simulates a broiler flock during 36 days of production, from arrival to the farm to slaughter (fig 1). The simulated flock has a maximum **stocking density** of **39 kg/m²**, a starting **prevalence** of **1%**, and an initial intestinal **bacteria concentration** of **10 CFU** per positive broiler. The **manure** is calculated as feces + 1 kg of litter per m². The model employs a **stochastic** approach, conducting 1000 parallel iterations.

Per each day of production, the model determines:

- The **feces** produced, excreted and ingested by a broiler
- The **amount of CFU** of ESBL producing *E. coli* excreted per broiler
- The **bacteria growth** in broilers gut
- The **number of positive animals** (>0 CFU) per each production day (fig. 2)
- The **bacteria concentration** in the manure and the environmental decay

The model can be also used to compare the bacteria concentration at different stocking densities (fig 3).

In the **transmission model**, the infected broilers (I) excrete feces carrying resistant bacteria (Σ) and spread the infection to susceptible animals (S). The new amount of positive birds is calculated as:

$$S (1 - e^{-(\text{Log}_{10}(\Sigma) \times \beta) \times \Delta t})$$

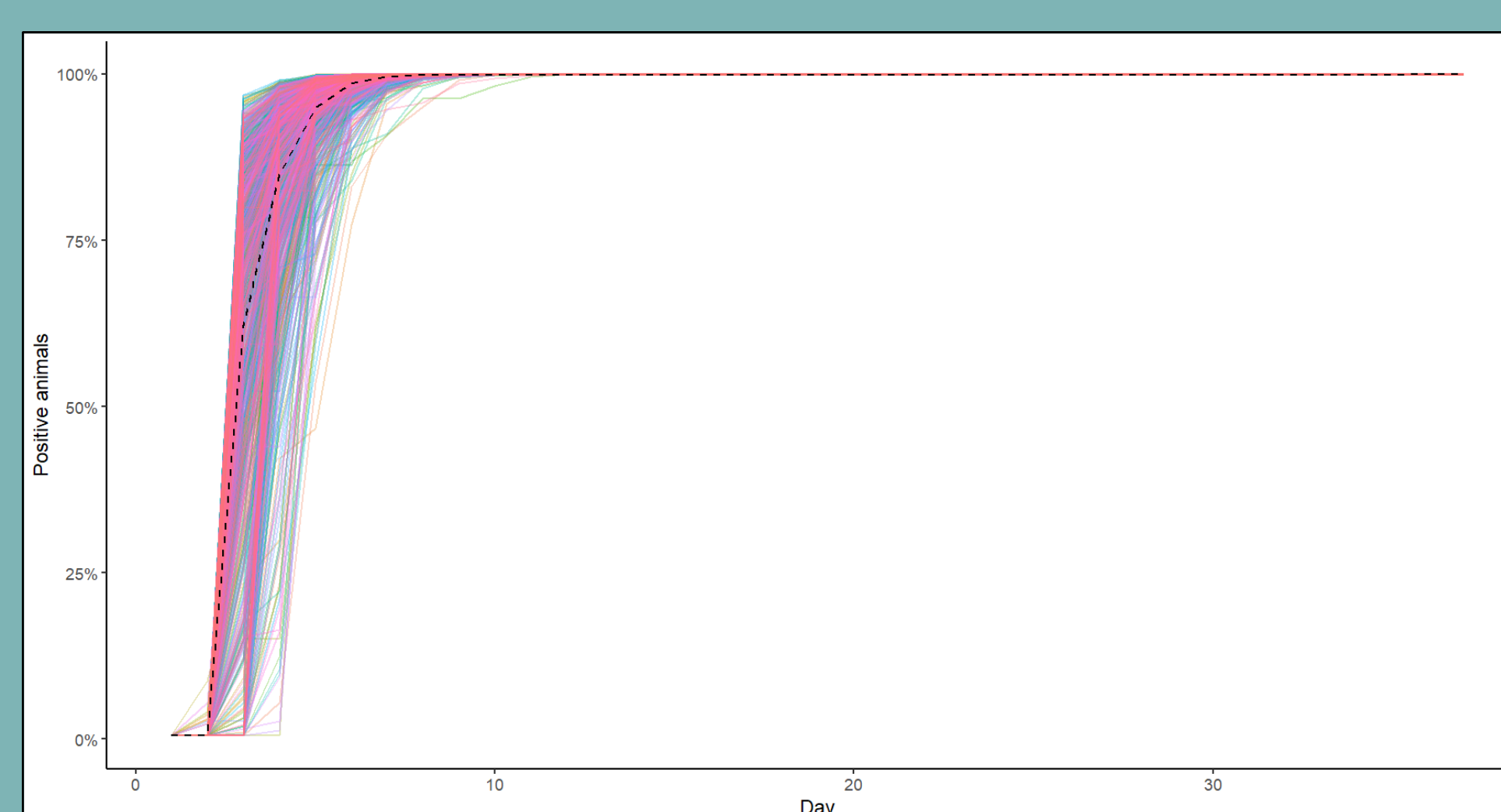


Fig 2. Percentage of positive animals (CFU > 0) per day

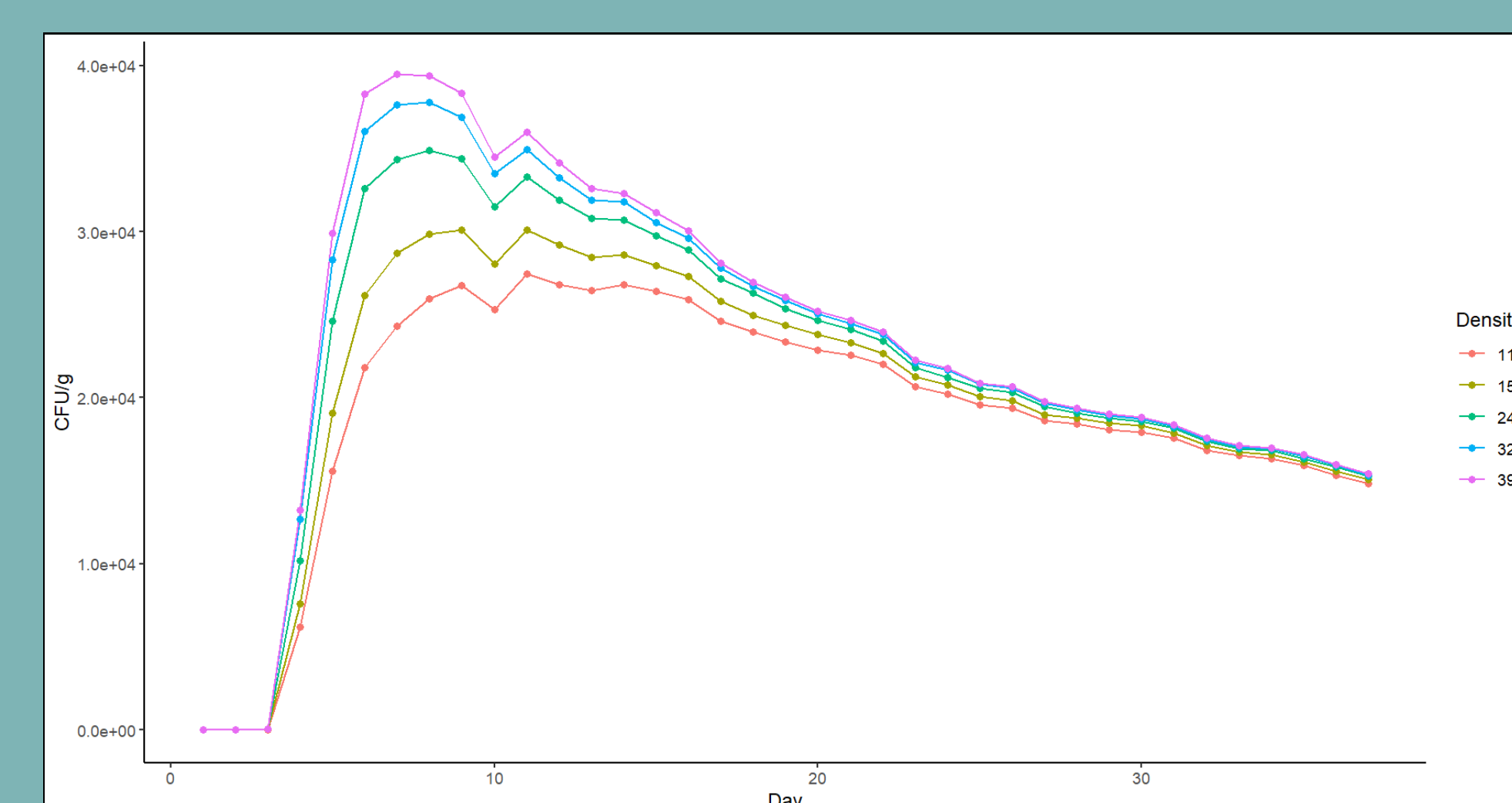


Fig 3. Concentration of ESBL *E. coli* in broiler manure at different stocking densities

Results and Conclusion

- At 39 kg/m² stocking density, the model quantified an average ESBL *E. coli* concentration of **1.5 * 10⁴ CFU/g of manure** (sd 0.1 * 10⁴) (fig 4) after 36 days of production.
- The **100% positivity** of the flock was obtained by the 7th production day in most of iterations.
- The model will be further developed, applying the interventional studies from the **ENVIRE project**.

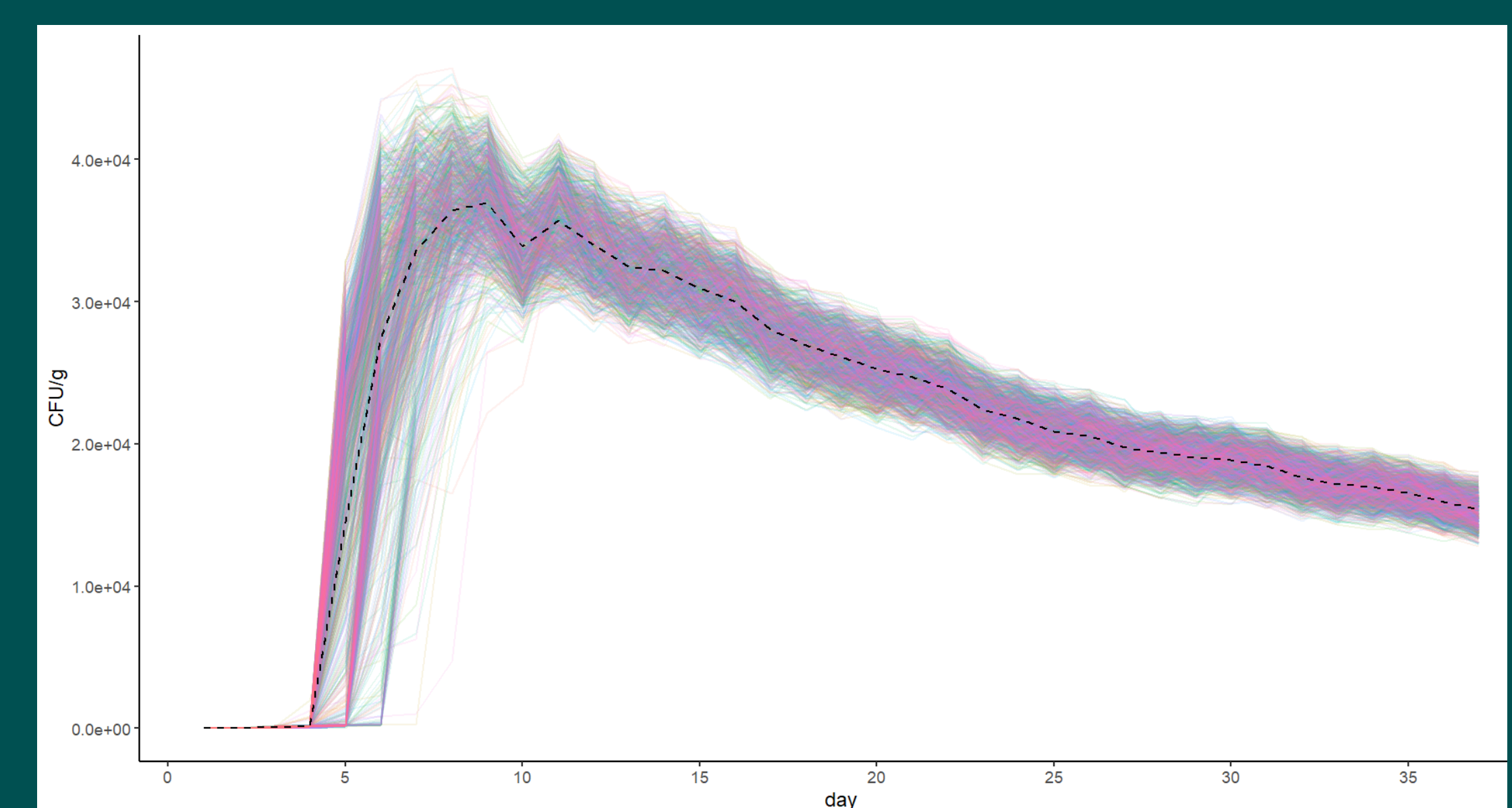


Fig 4. Concentration of ESBL *E. coli* in broiler manure at 39 kg/m² stocking density

