Transmission and mitigation of ESBL-producing E. coli from broiler production to the environment

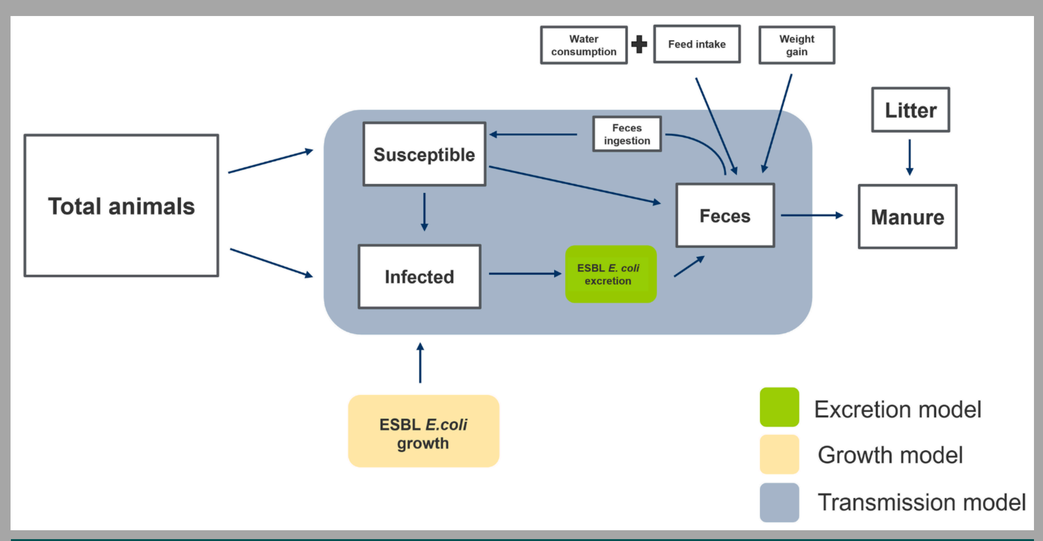
Nunzio Sarnino, Subhasish Basak, Lucie Collineau, Roswitha Merle

Background

Goals

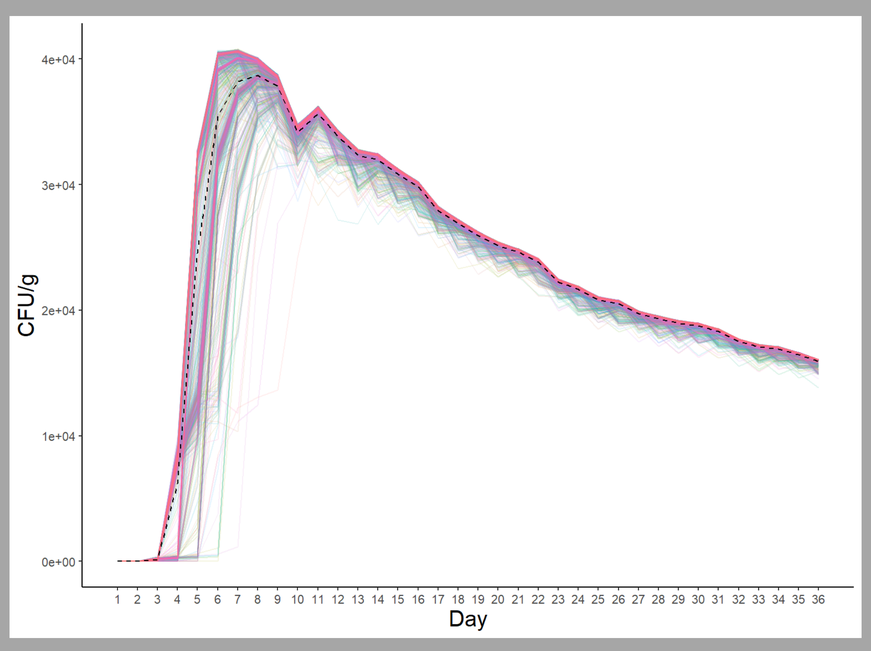
1. Quantify the ESBL *E. coli* in broiler manure
2. Identify the *E. coli* transmission pathways from animal manure to the environment
3. Estimate the environmental human exposure to ESBL *E. coli* from broiler production
4. Assess the effectiveness of several inteventions to reduce the exposure

Within flock model

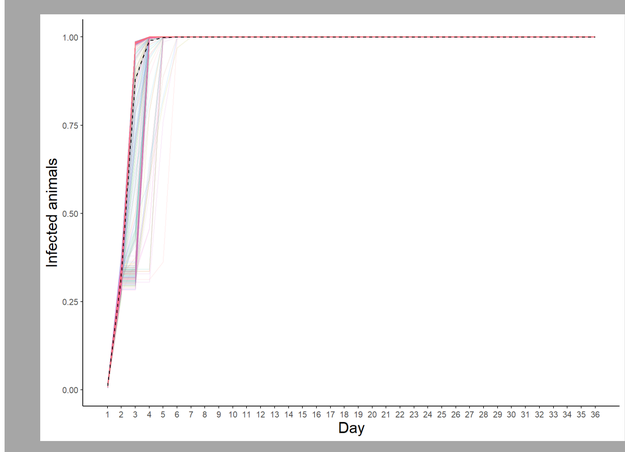


Per each day of production, the model determines:

- 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
- The **bacteria concentration** in the manure (main output)



At 39 kg/m² stocking density, the model quantified an average ESBL *E. coli* concentration of 1.6 * 10⁴ CFU/g of manure (sd 0.02 * 10⁴) after 36 days of production.



In the **transmission model**, the infected broilers (I) excrete feces carrying resistant bacteria (Σ) and spread the infection to susceptible animals (S) (Dame-Korevaar, 2019). The new amount of positive birds is calculated as:

$$S\,(1-e^{-(Log10(\Sigma)\times\beta)\times\Delta t})$$

Literature review

3 main pathways identified

Soil contamination | **Crop contamination** | **Water contamination**

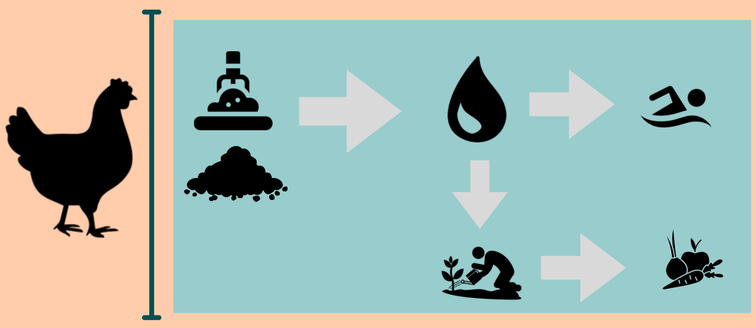
Key findings

- **Surface water** contamination due to **runoff** is the most **critical pathway**
- The **persistence** of *E. coli* in **soil** is influenced by **manure type, treatment, and environmental factors**. Treated manure reduces contamination risks
- **Direct contamination of crops** from manure poses a **minor risk**, whereas **irrigation** with contaminated water is a more significant concern

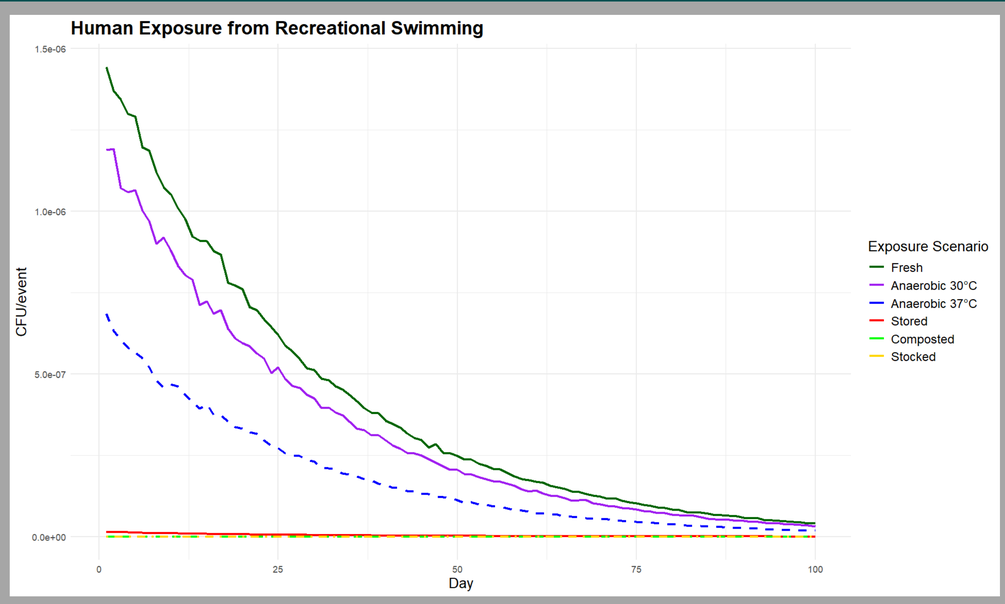
Research gaps

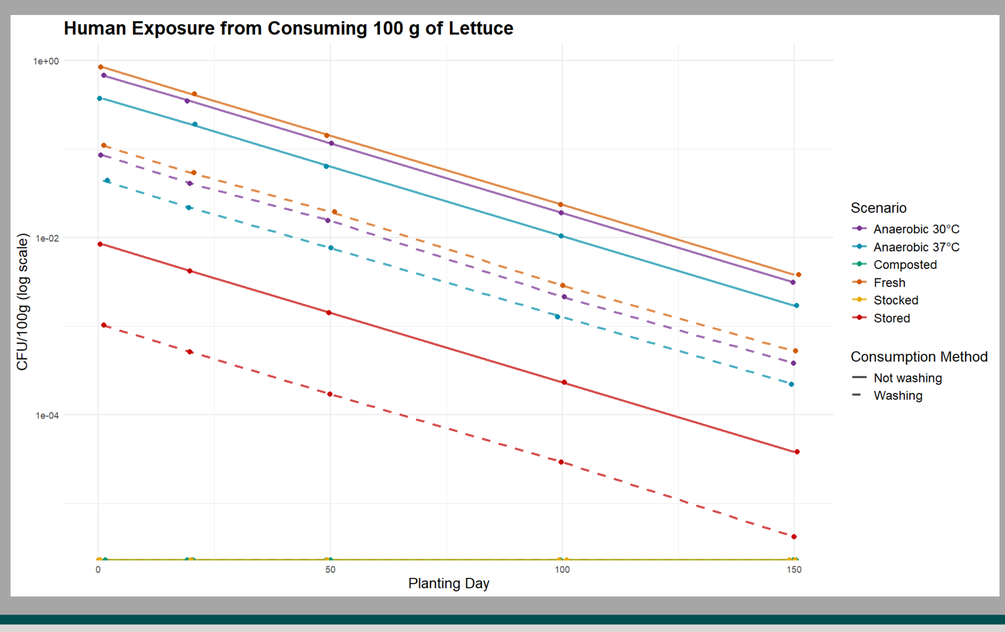
There are **limited** studies on **resistant strains** and on **water systems**, particularly **groundwater contamination**

Environmental model



1. Simulates how **ESBL-producing *E. coli*** in manure is introduced into **soil** via **manure application** and into **water** via **rainfall/leakage**
- Tracks bacterial **survival and decay** in soil and water over time
- Estimates *E. coli* contamination in the **watershed** and on **fresh produce** (e.g., lettuce)
- Quantifies **human exposure** from consuming **contaminated produce** and from **recreational water activities**
- Evaluates the impact of **different manure treatment** on reducing human exposure.





Both **composting** and **stocking** manure for extended periods resulted in a **complete reduction** of ESBL-producing *E. coli* before field application, while **short-term storage** was also highly effective. **Anaerobic digestion** was effective but **temperature-dependent**, with digestion at 37°C leading to greater bacterial reduction than at 30°C

Recreational swimming: Exposure peaks **right after manure application** and **runoff events**.

Lettuce consumption: Respecting the **waiting period** after manure application is key to reducing contamination risk, as **early planting** leads to **higher exposur**e.

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