Antimicrobial resistance in dairy slurry tanks: a critical point for measurement and control

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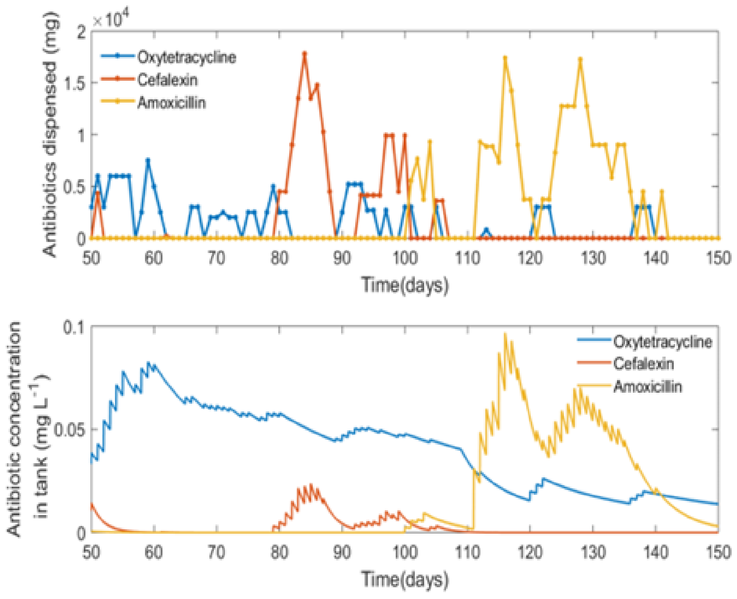
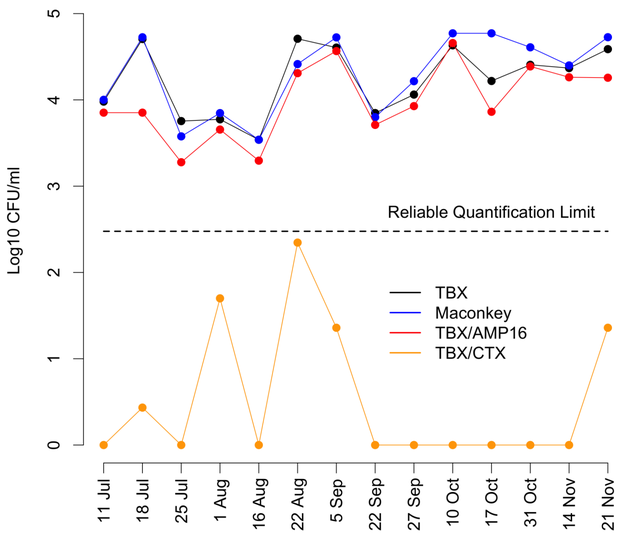
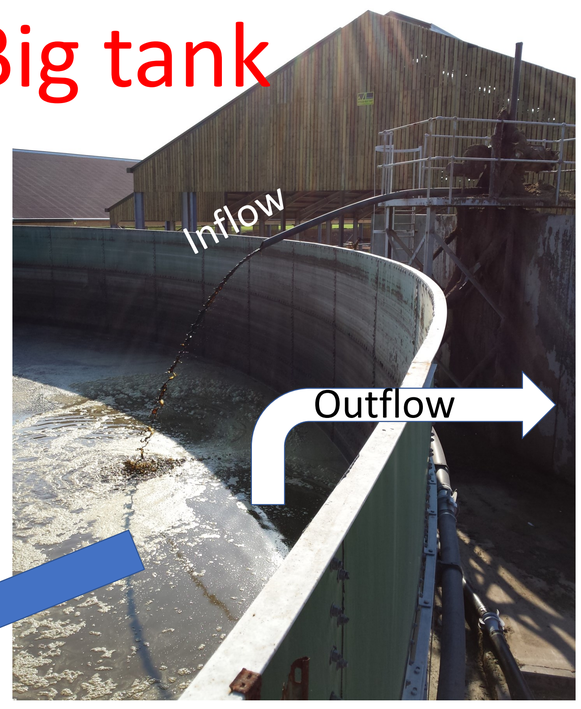
Simplified multidisciplinary workflow: From big tank to mini tank to modelling and then back to big tank

1. Antibiotic prescription records of farm, farm flow model and some measured decay rates fitted to model allowed us to predict antibiotic concentrations in the big slurry tank

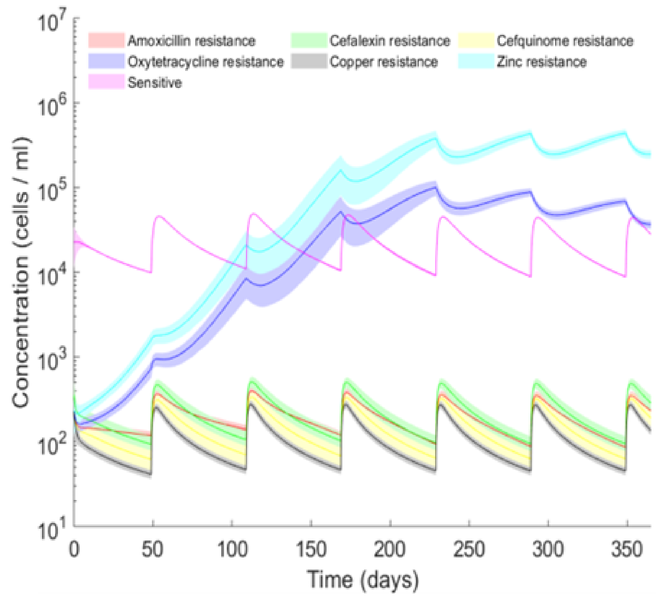




Big tank



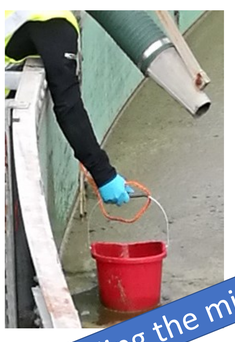
Model predicts big tank



4. Finally, calibrated model can predict dynamics in big tank to complete the cycle: Resistance to persistent antimicrobials (Oxytet and Zinc) increases, resistance to β-lactams remains low. Saw-tooth pattern caused by periodic emptying of tank.

Mini tanks (12)

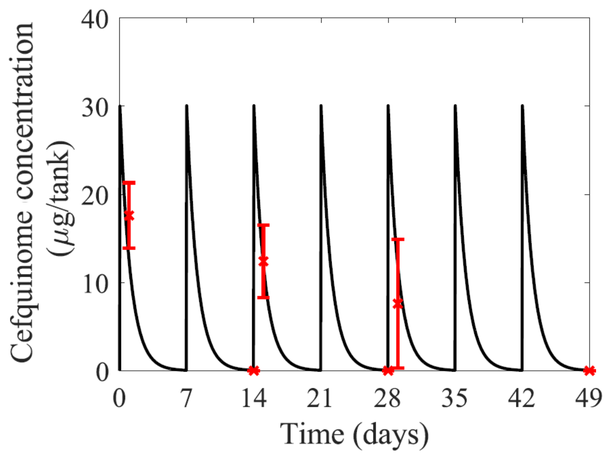
2. Because mini tanks (mesocosms) are isolated, without the inflow and outflow of the big tank, it was possible to fit our model to these data



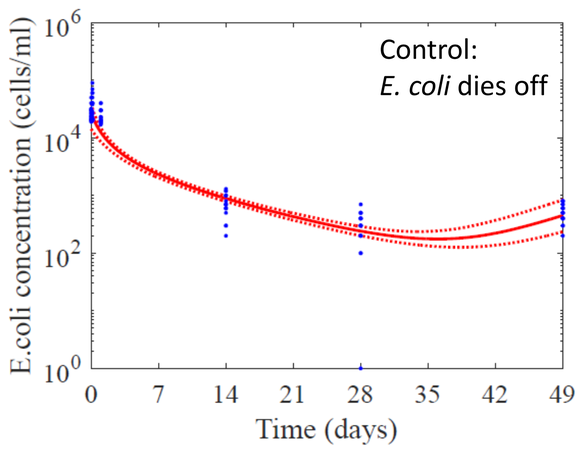
Filling the mini tanks

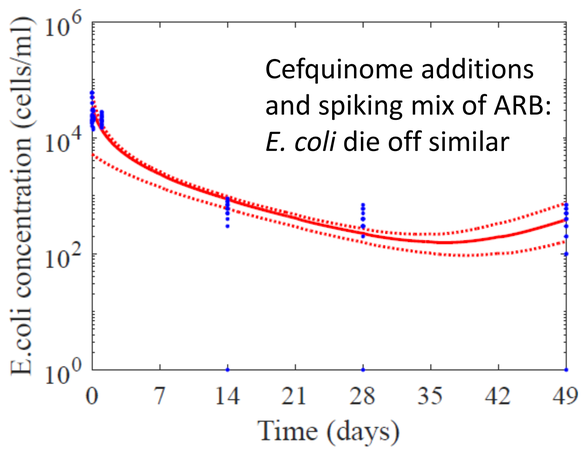
Data from mini tanks

Fitting model to antibiotic spiking and decay



Fitting model to E. coli viable counts

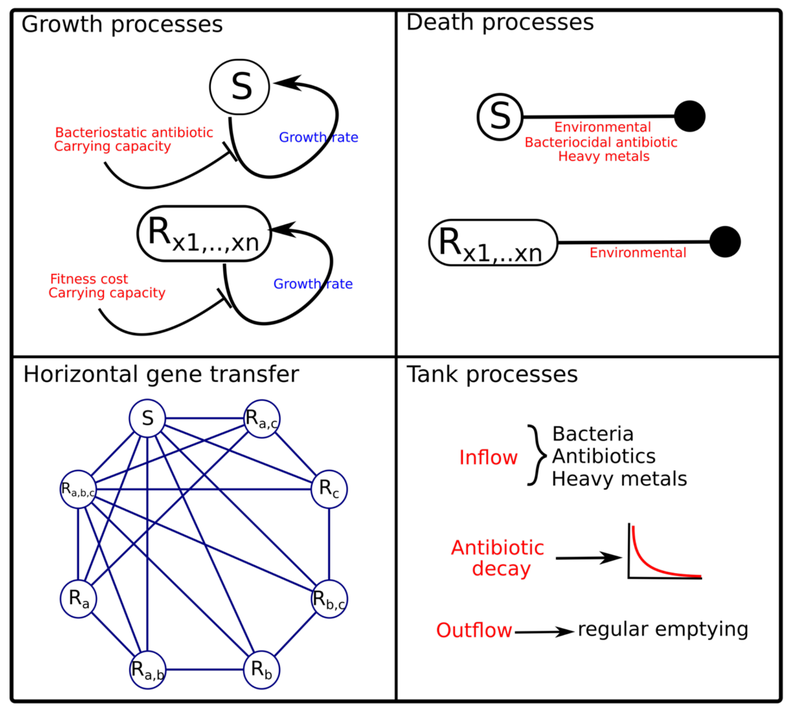




Fitting model

Model

Model is based on growth and death of Sensitive (S) and Resistant (R) bacteria, antibiotic inhibition, fitness costs and HGT



3. Model could be used to infer several parameters from the mini tank experiments, further parameters were obtained by fitting to laboratory growth curves of E. coli isolates.

Conclusions

1. Evidence from various time series (culturing, sequencing, chemistry) was consistent so could be integrated by modelling, to predict dynamics in the big tank quite well
2. For farms with already low antibiotic use, further reductions have little effect on AMR levels
3. Use of rapidly degraded antibiotics helpful
4. Storage of slurry before application to fields is a simple and effective mitigation strategy because resistant bacteria die off over time

No isolation — No resistant bacteria removed

Isolation for 4 days — 50% of cefalexin and amoxicillin resistant bacteria removed

Isolation for 40 days — 99% of cefalexin and amoxicillin resistance bacteria removed

AMR die off is exponential!

Natural Environment Research Council

Just published!

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