Modelling antimicrobial fate in the circular food system

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Background & Objective

Excessive use of antimicrobials (AMs) can lead to AM residual contamination in circular food production. At present, most studies quantify separately the fate of AMs in crop and livestock farming. To our knowledge, no studies have yet accounted for its long-term fate.

This study aims to predict potential long-term AM presence in the circular food system that involves both crop and livestock farming. CirFSafe is the model framework developed for this prediction based on compound transfer mechanism.

Circular food production & design of CirFSafe models

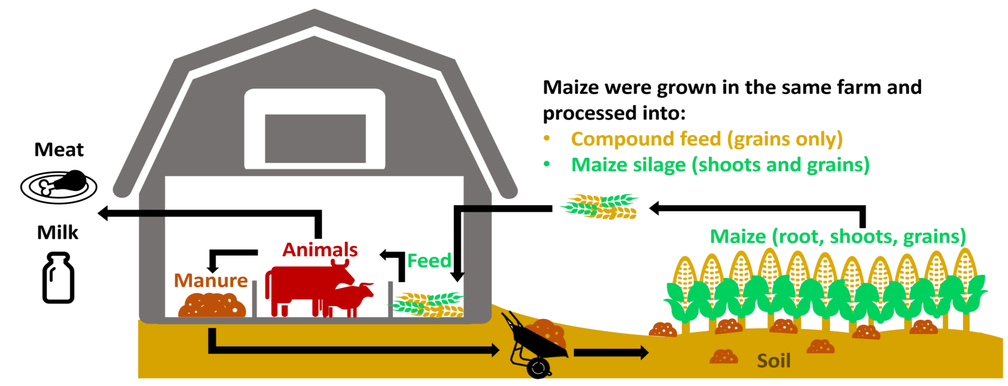

Figure 1. Illustration of the circular food production and relevant farming compartments

Two circular food production systems, each involving a single animal species, were simulated under two exposure scenarios:

Table 1. Designs of antimicrobial exposure scenarios and animal-diet combination

Exposure scenario	Animals-diet combination
Annual constant exposure via treatment and feed intake	Dairy cows: fed with the combined diet (CC diet: silage + compound feed) and silage-only diet (CS diet)
A one-off exposure (in the first year of circularity) via manure application	Veal calves: fed with the combined diet (VC diet).

Three existing models were adjusted and interlinked to predict the fate of AMs in each circular cycle.

Predicted AM residues in soil, maize grains, and shoots of the previous cycle is used as the input of the next cycle.

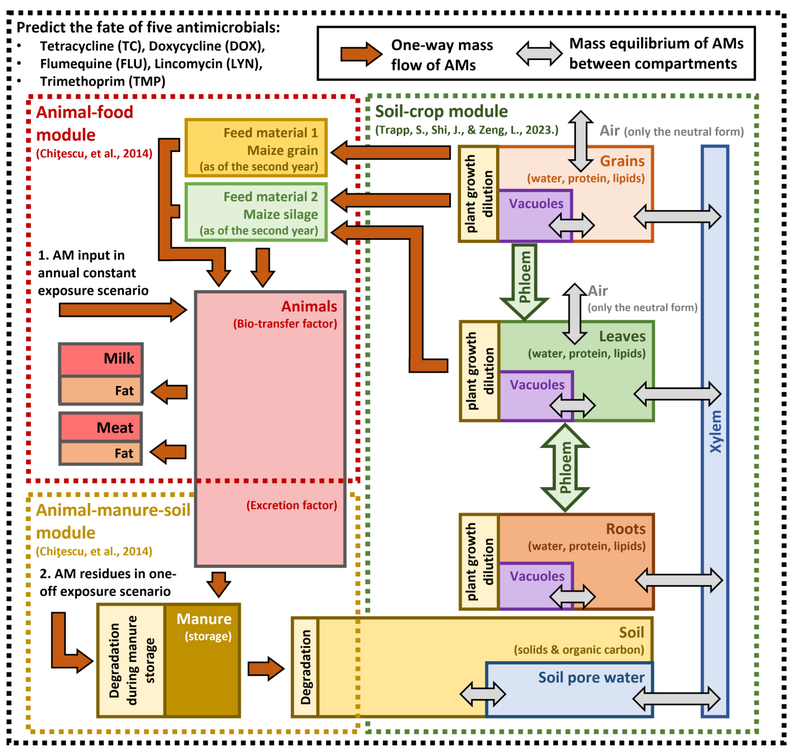

Figure 2. Schematic concept of the model framework simulating antimicrobial fate in the circular food system

Prediction of annual constant AM exposure scenario

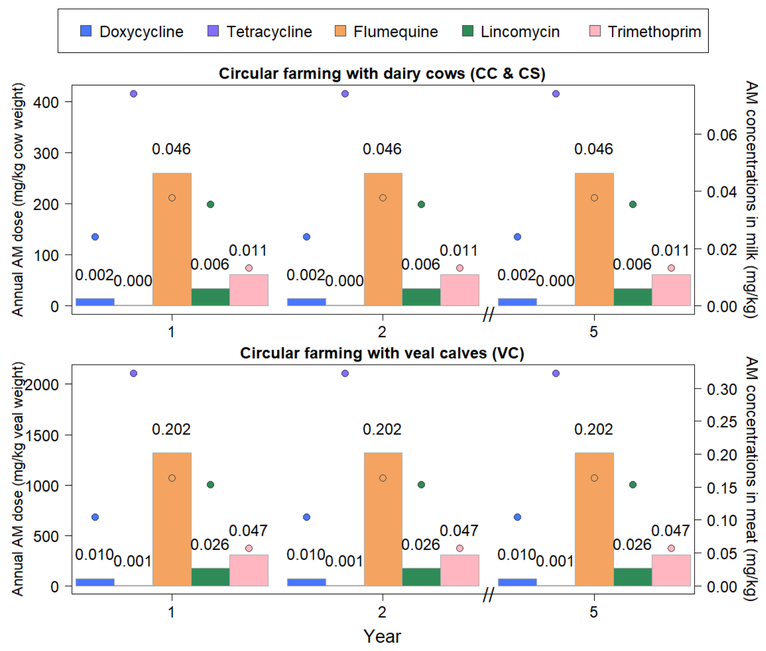

Figure 3. Predicted annual AM residual concentrations in food products under the constant exposure scenario

- Negligible contribution from contaminated animal feed to AM residues in food products, compared to the routine annual AM treatment.
- FLU & TMP tend to accumulate in milk and meat despite their lower exposure levels.

Prediction of one-off AM exposure scenario (FLU)

- Under one-off high-level exposure from contaminated manure, most FLU were found in soil and maize shoots.
- Residual concentration of FLU is negligible within three circular farming years.
- FLU residues do NOT exceed EU Maximum residual levels (MRLs).

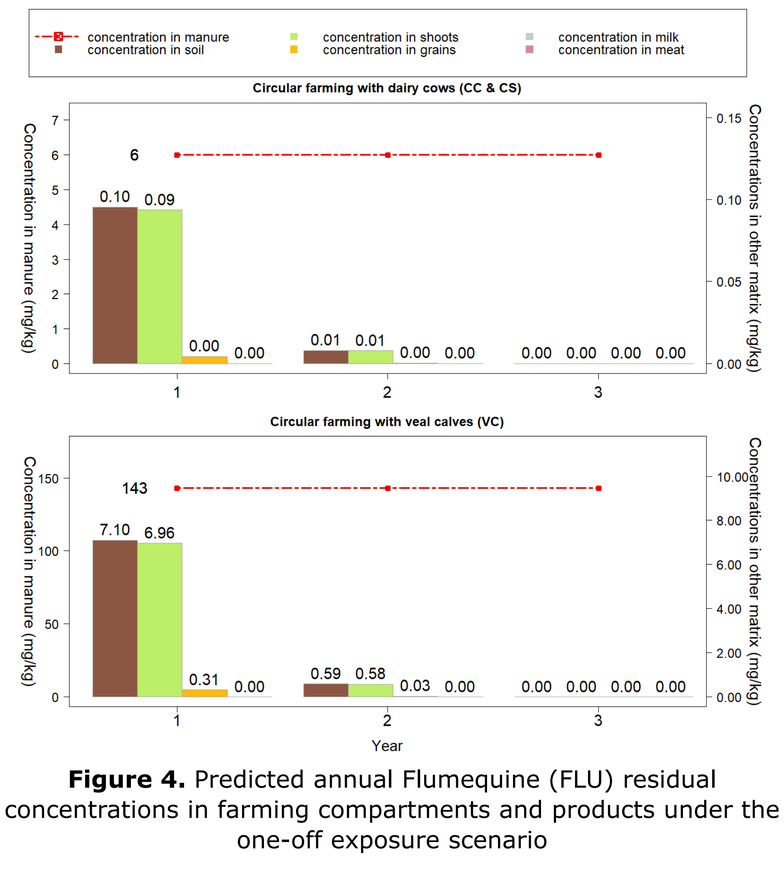

Figure 4. Predicted annual Flumequine (FLU) residual concentrations in farming compartments and products under the one-off exposure scenario

Conclusions

- ❑ First comprehensive quantification of AM fate over multiple years in a circular food system involving both crop & livestock farming.
- ❑ Recycling animal manure and feeding animals with contaminated feed may not result in AM residues exceeding EU MRLs.
- ❑ FLU & TMP were found to tend to accumulate in milk and meat.

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