Evaluating the impacts from on-farm antibiotic use – dose matters

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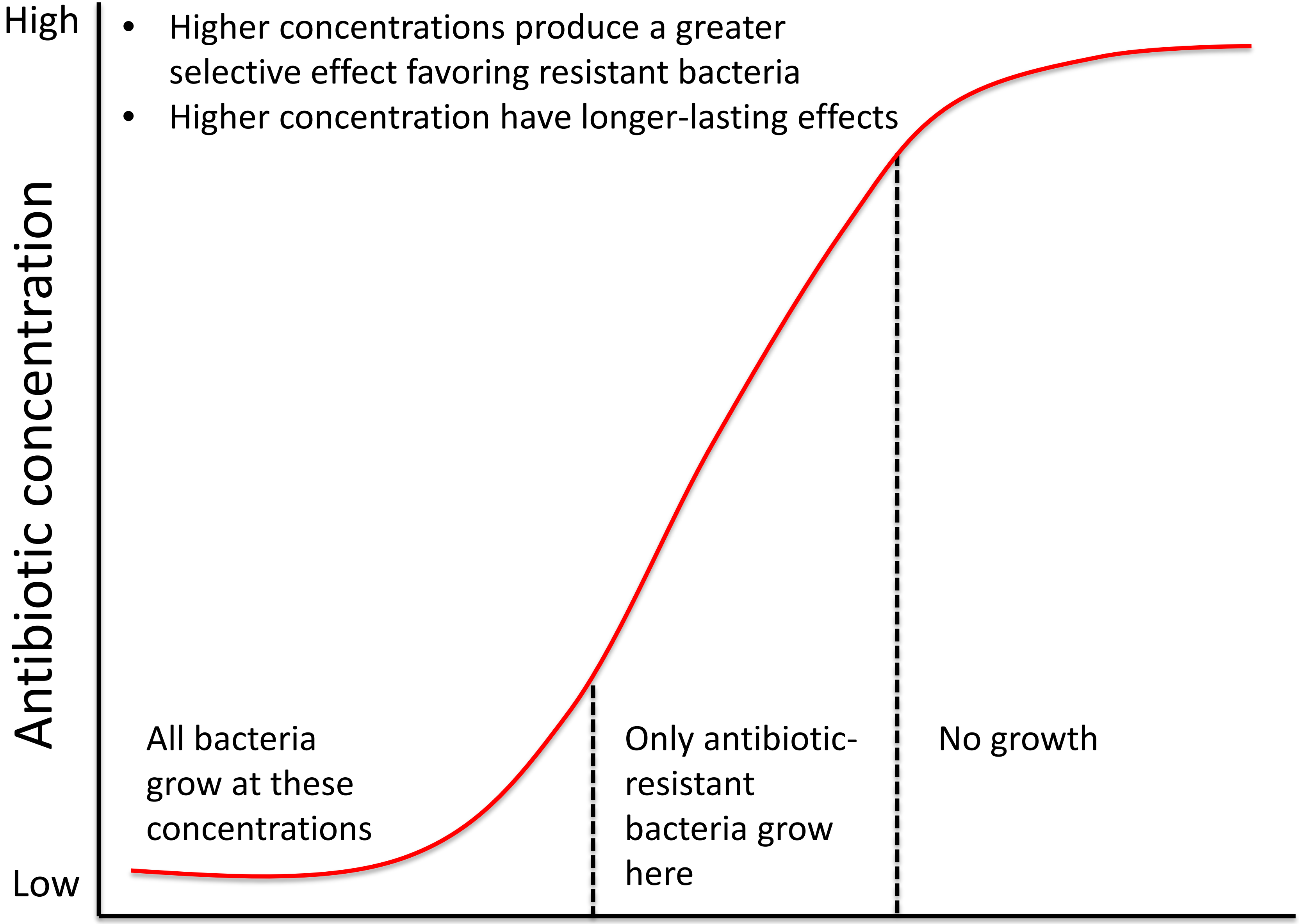
Concentration is important

- Higher concentrations produce a greater selective effect favoring resistant bacteria
- Higher concentration have longer-lasting effects



Spatially-explicit environments will always be accompanied by zones that are favorable to resistant bacteria

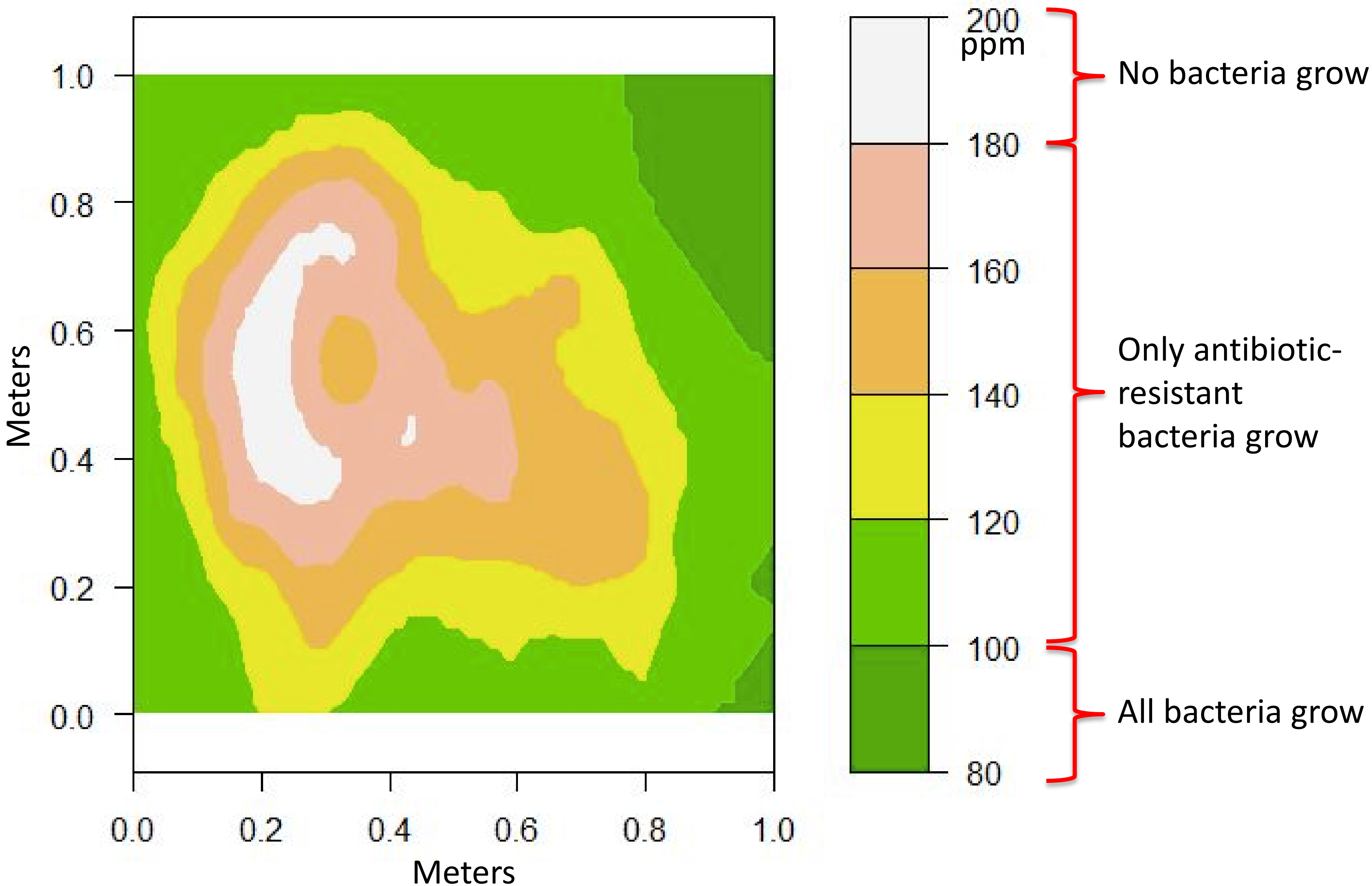
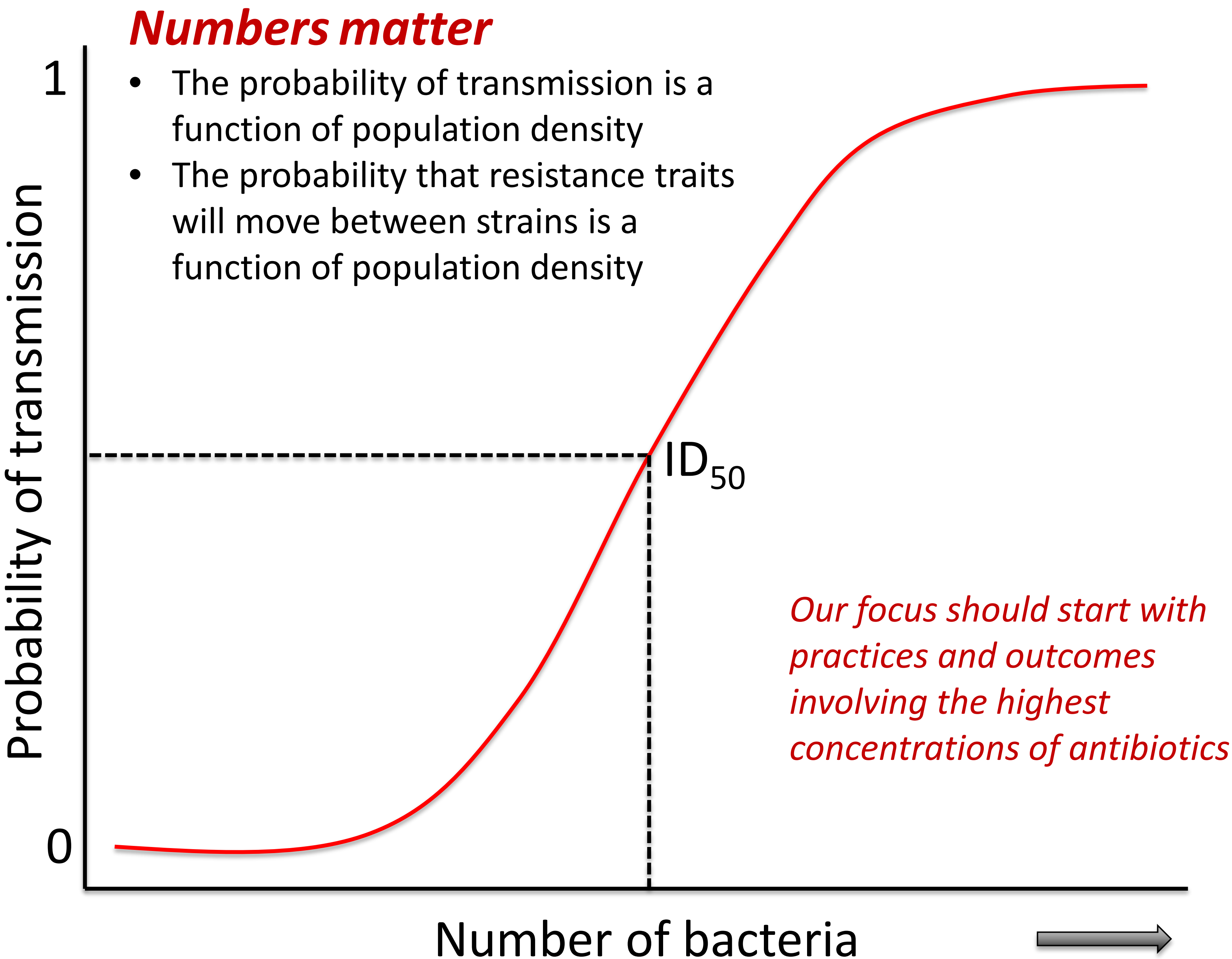
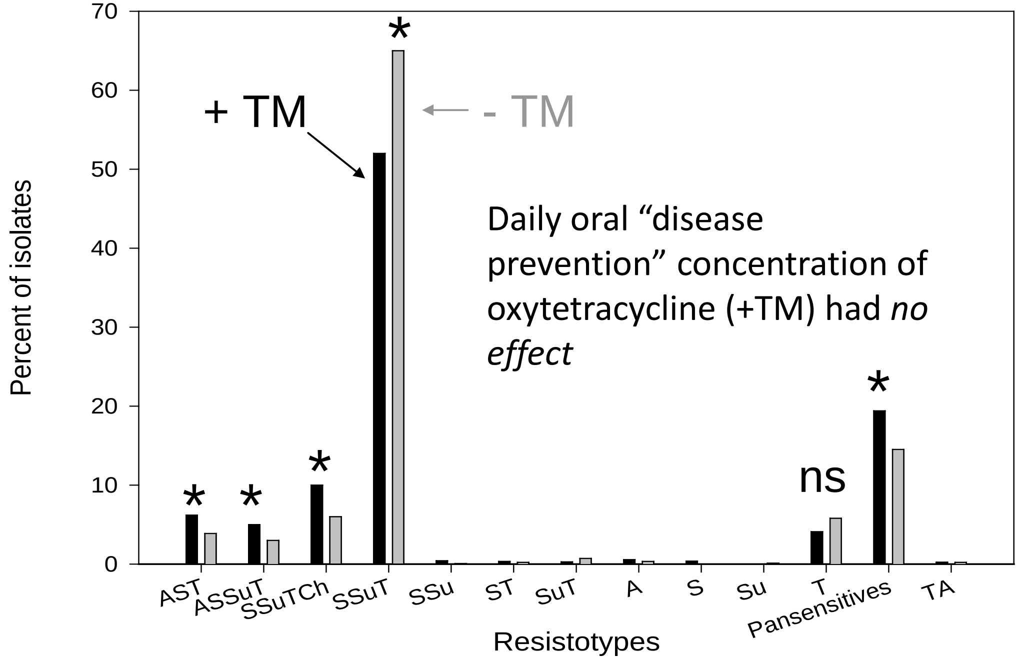


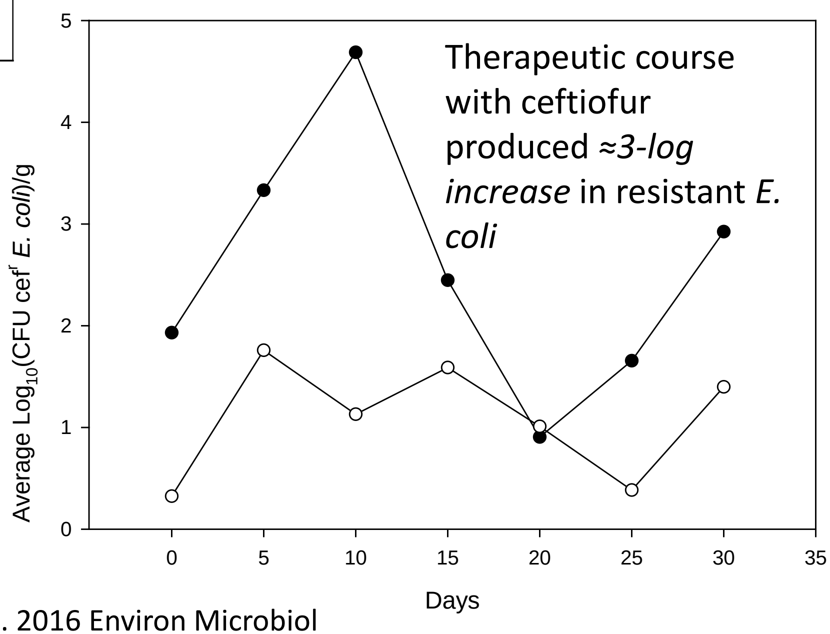
Figure adapted, URL available



Numbers matter
• The probability of transmission is a function of population density
• The probability that resistance traits will move between strains is a function of population density
1
0
Probability of transmission
ID50
Our focus should start with practices and outcomes involving the highest concentrations of antibiotics
Number of bacteria

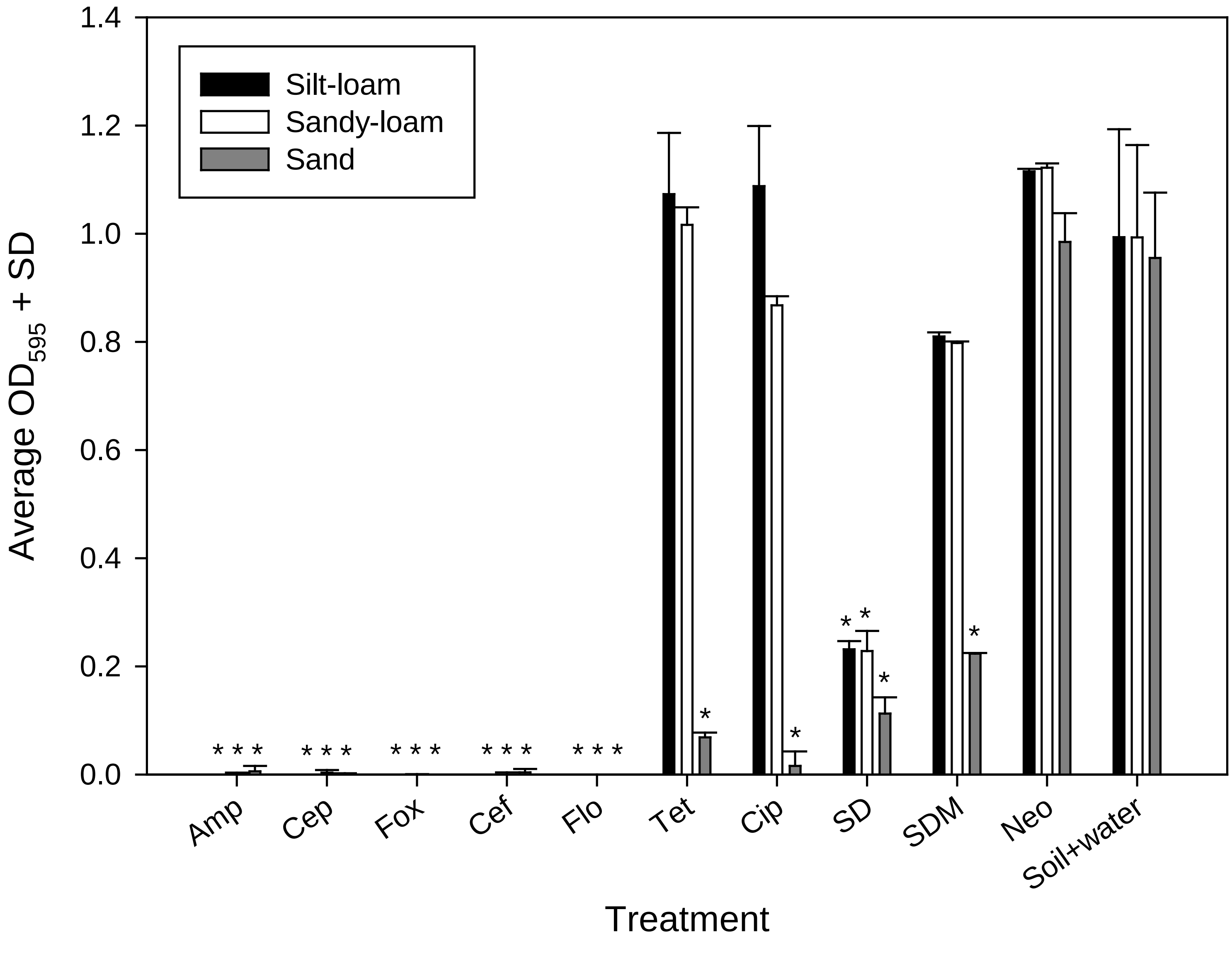
Therapeutic applications have a far greater selective impact compared to lower doses





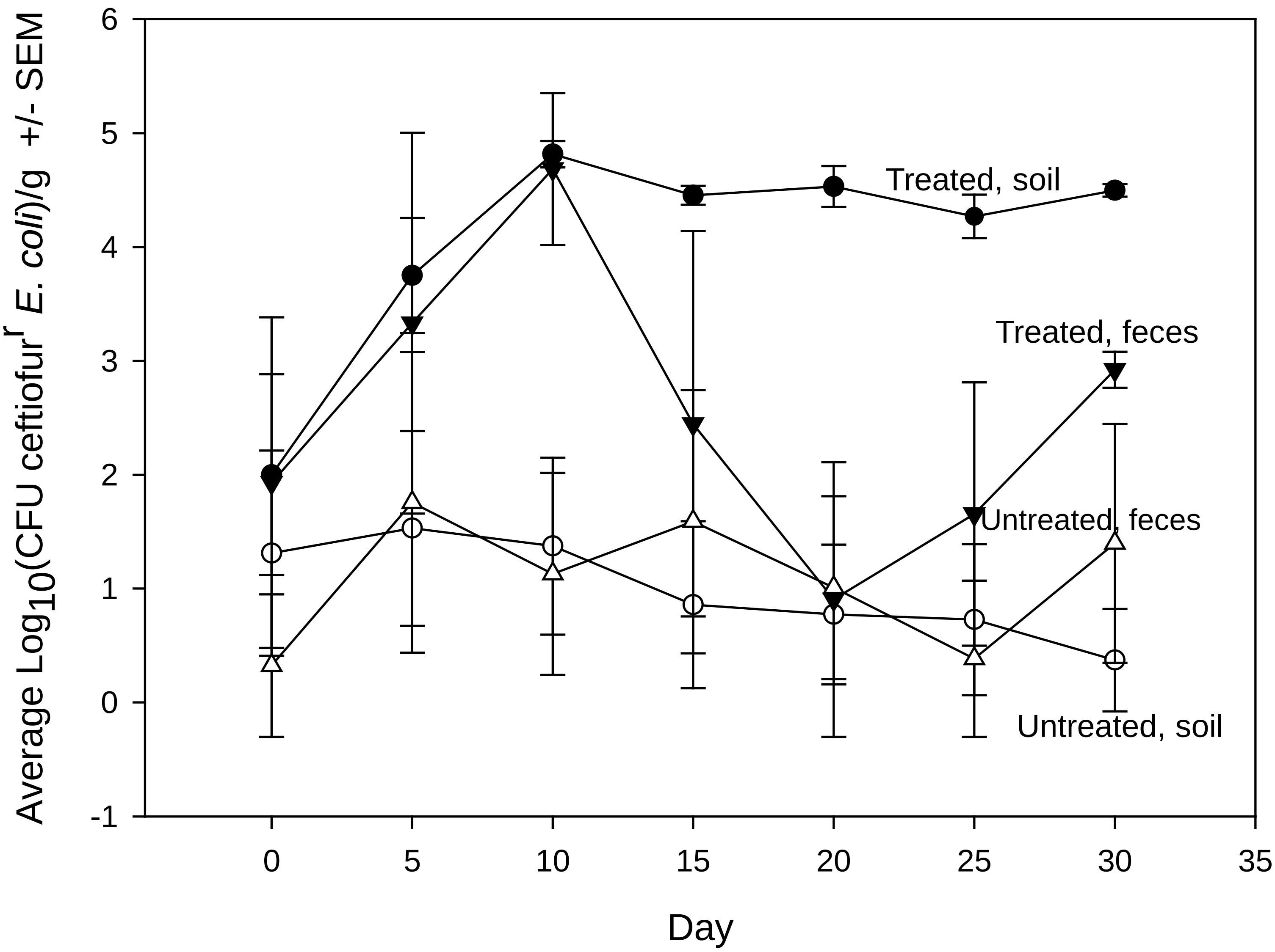
Khachatryan et al. 2004 Appl Environ Microbiol; Subbiah et al. 2015 JEQ, Liu et al. 2016 Environ Microbiol

Not all antibiotics remain bioavailable in soil



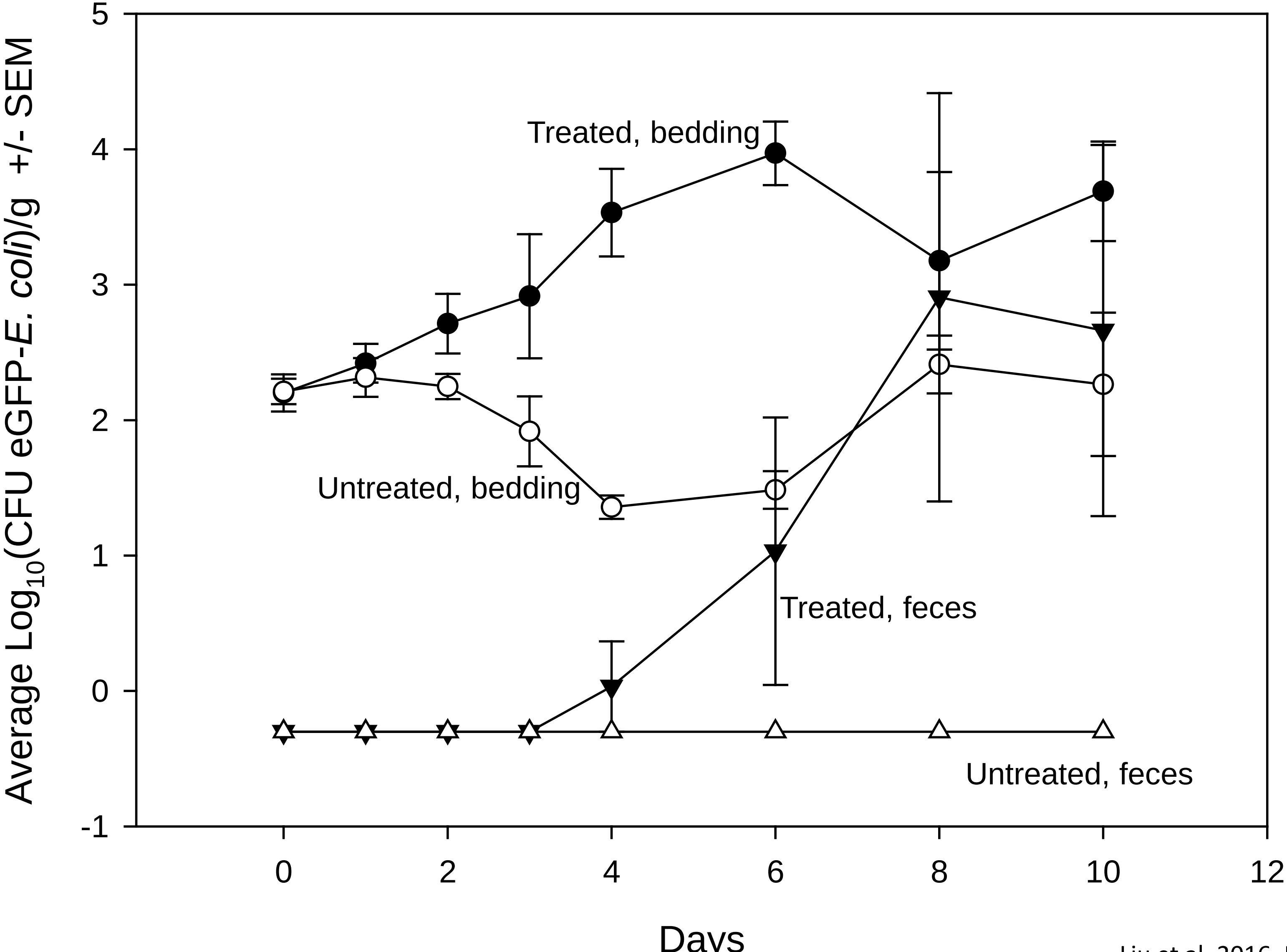
Subbiah et al. 2012a Appl Environ Microbiol

Third-generation cephalosporin example



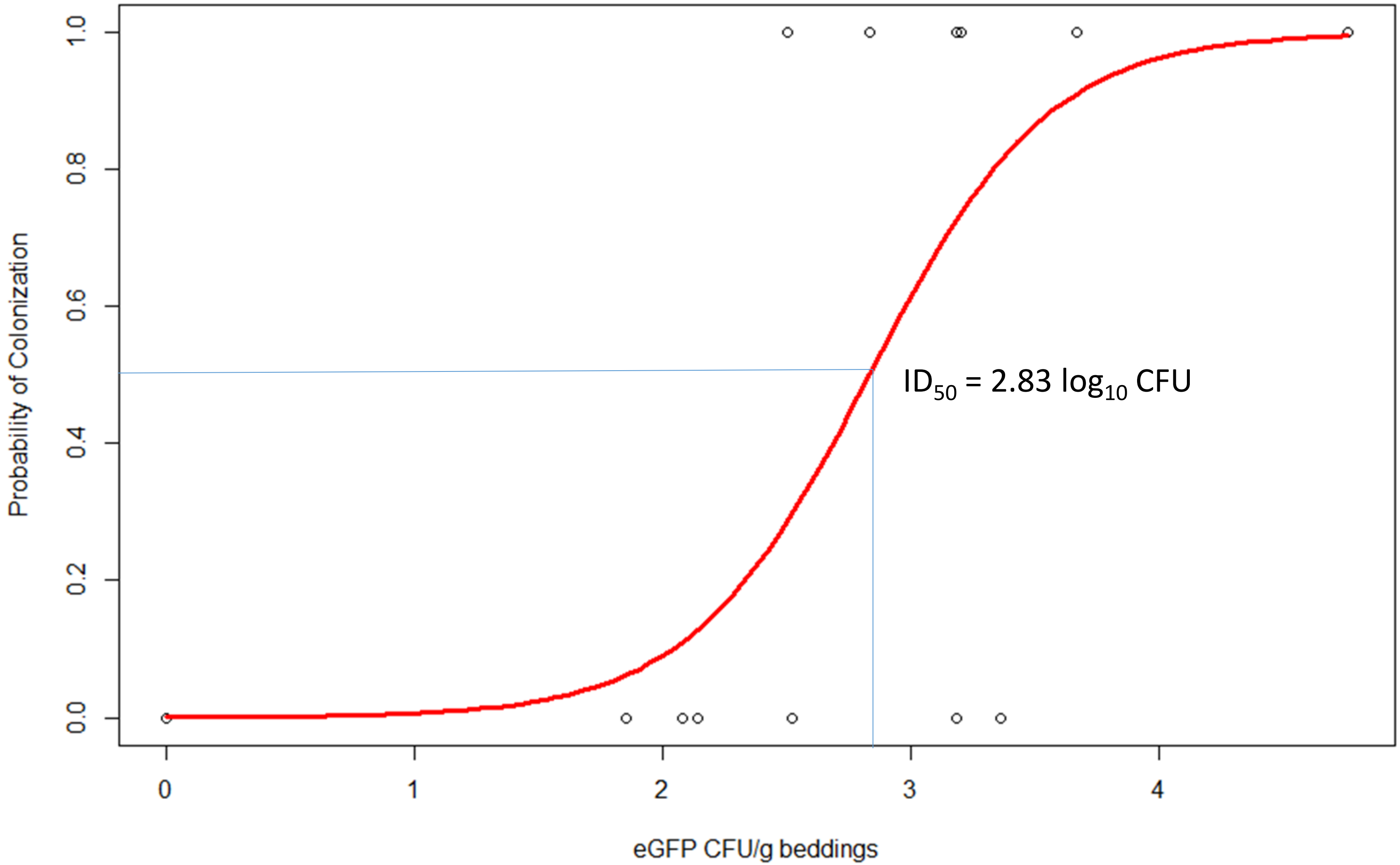
Liu et al. 2016. Environ Microbiol

Ceftiofur residues in urine selectively favor resistant *E. coli*



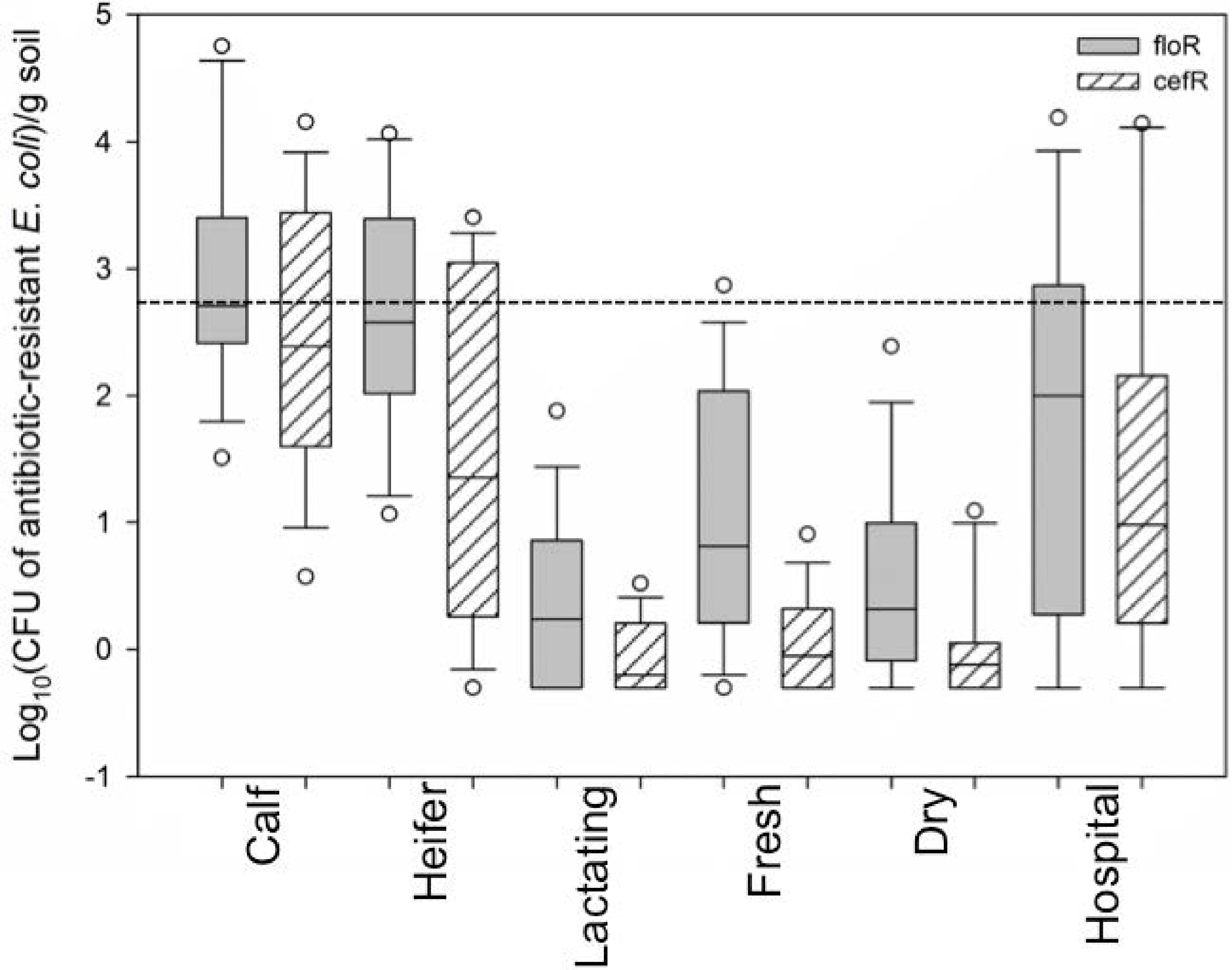
Liu et al. 2016. Environ Microbiol

More *E. coli* in soil equals greater probability of transmission



Liu et al. 2016. Environ Microbiol

Working farms have a robust and predictable distribution of antibiotic-resistant *E. coli* – with some averages equivalent to the estimated ID_{50}



Conclusions

1. Not all antibiotics or administration practices confer the same risk of selecting for antibiotic resistance, meaning that we can be "smarter" about how we employ antibiotics.
2. Robust soil-borne reservoirs of antibiotic-resistant *E. coli* arise after exposure to excreted antibiotics from therapeutic applications.
3. The density of resistant bacteria often exceeds the estimated ID_{50}, meaning that they could play an important role in persistence of resistant bacteria on farms.
4. Reservoirs of resistant bacteria can be found in predictable locations, meaning that they can be targeted for mitigation.