

Foodborne Antimicrobial Resistance II:

Beyond drivers in Food Animal Production



Environment

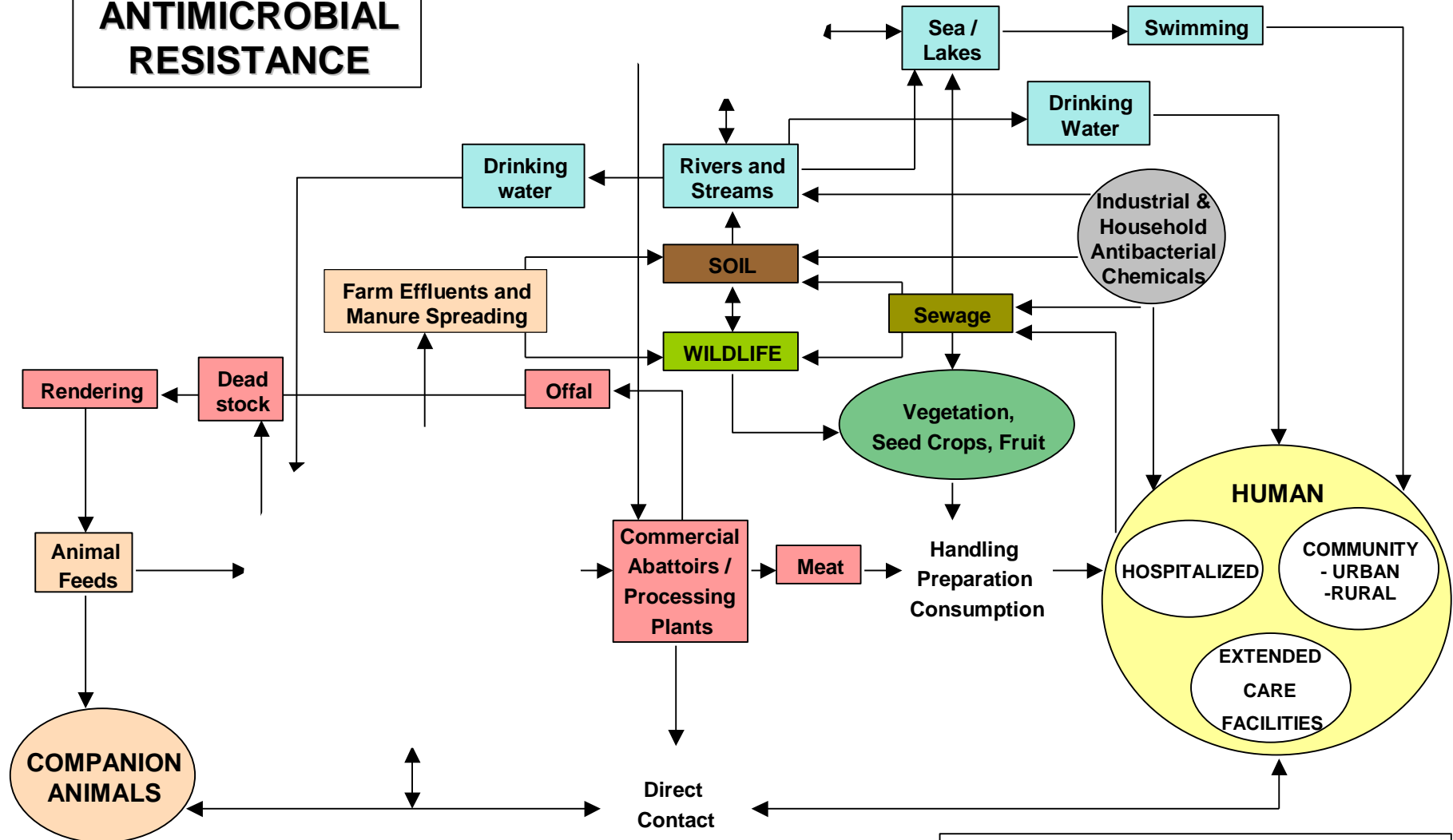


Biocides



Plant-based foods

EPIDEMIOLOGY OF ANTIMICROBIAL RESISTANCE



after Linton AH (1977), modified by Irwin RJ



Biocides and Disinfectants

Important for sanitation and hygiene

Shared Targets

Triclosan-Isoniazid

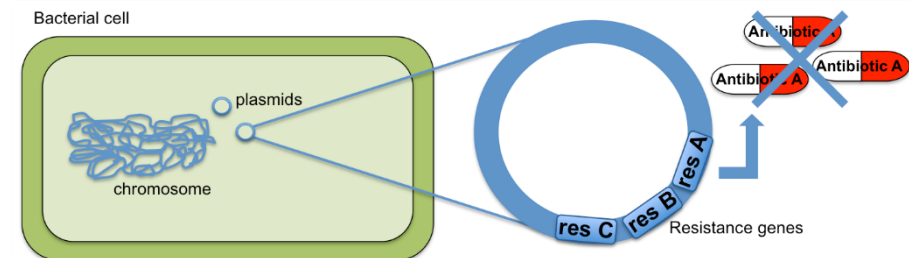
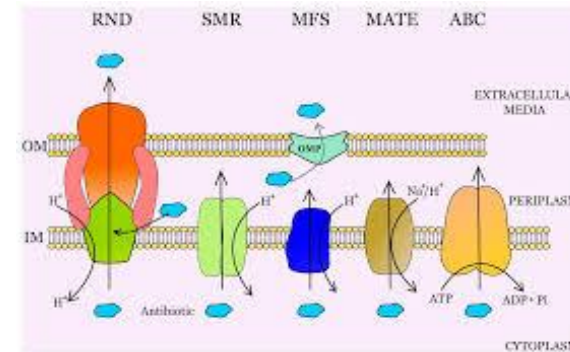
Cross-selection

Efflux

Membrane Permeability

Co-selection

Plasmids and Integrons



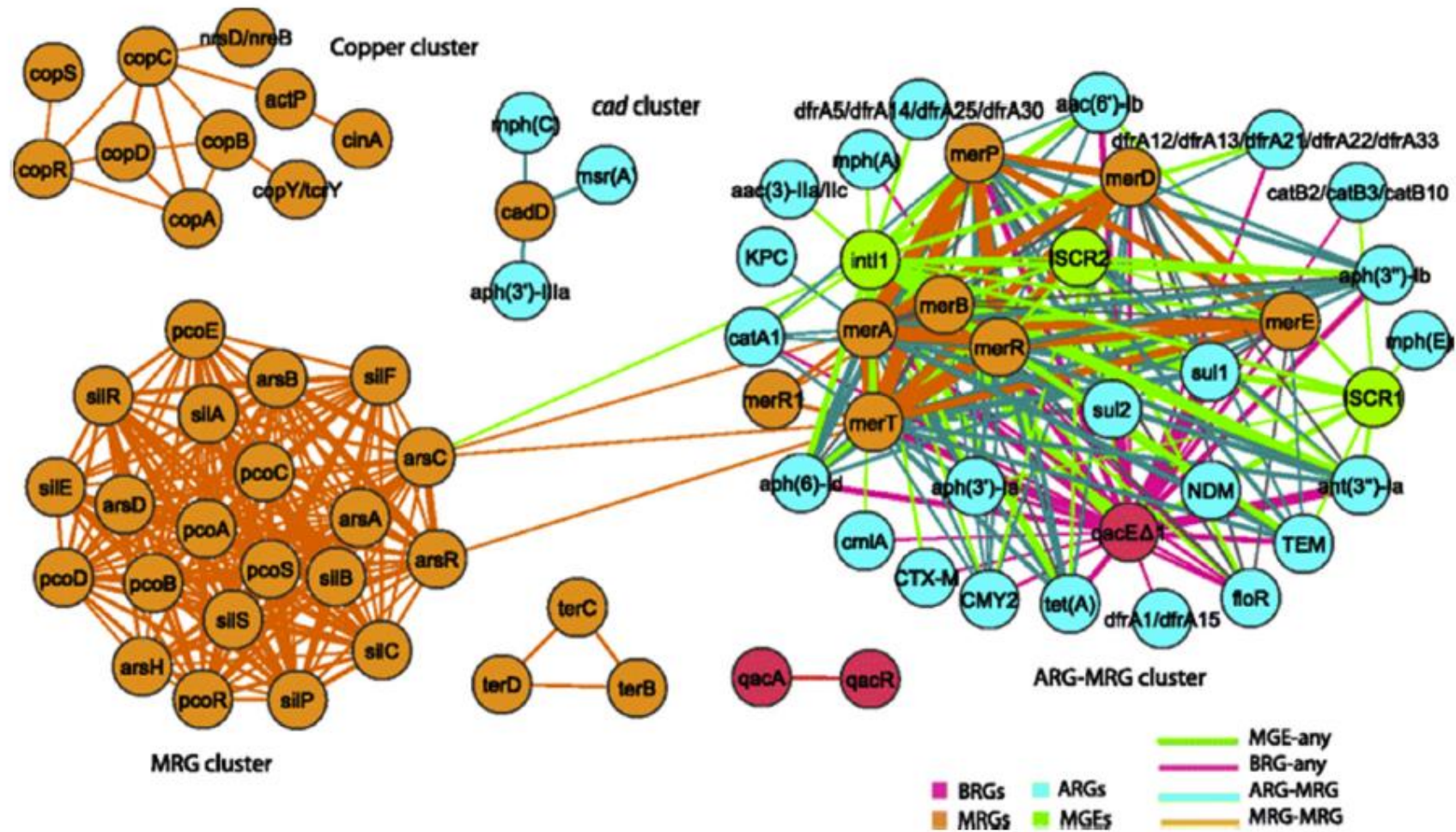


Fig. 3. Co-occurrence of antibiotic resistance genes (ARGs), metal resistance genes (MRGs) and biocide resistance genes (BRGs) based on 4582 plasmid sequences. The thickness of these lines relate to the frequency of such co-occurrences. [Adapted with permission from Pal et al. (2015)].

Knowledge Gaps

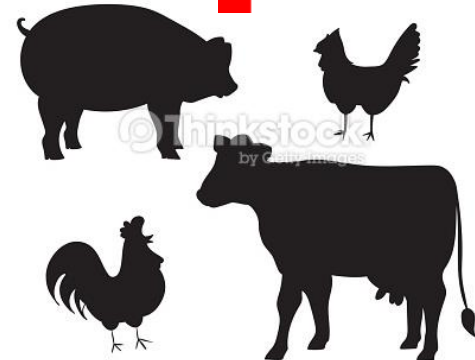
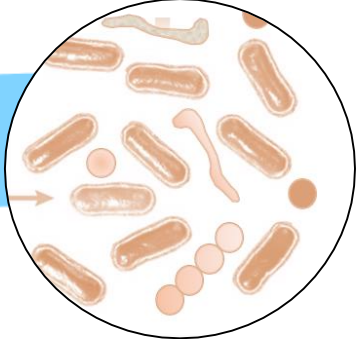
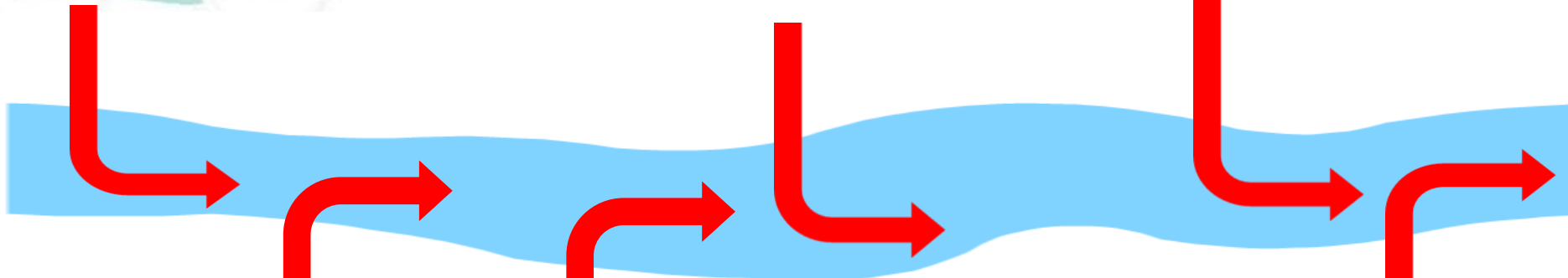
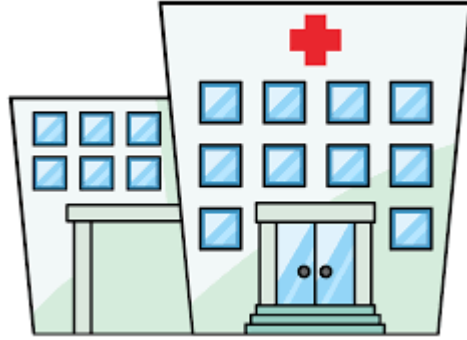
- Frequency of biocide resistance among contaminants and pathogens.
- Standardised protocols unavailable
- How often does food production use of biocides lead to AMR?
 - Exposure studies
- How often does AMR result in biocide resistance?



Environment

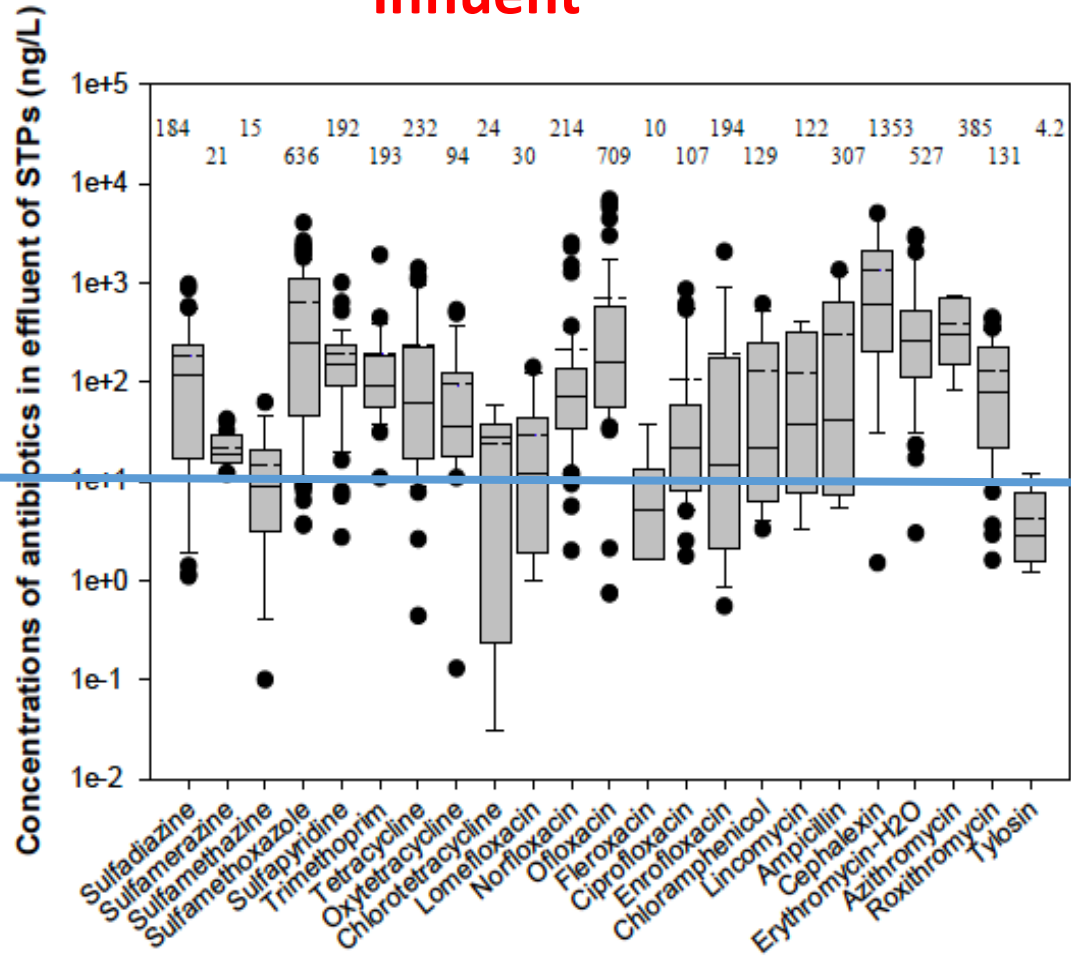
- Wastes (animal and human) contaminate the environment
- Animals and foods can be exposed to AM, AMR, and ARG via the environment



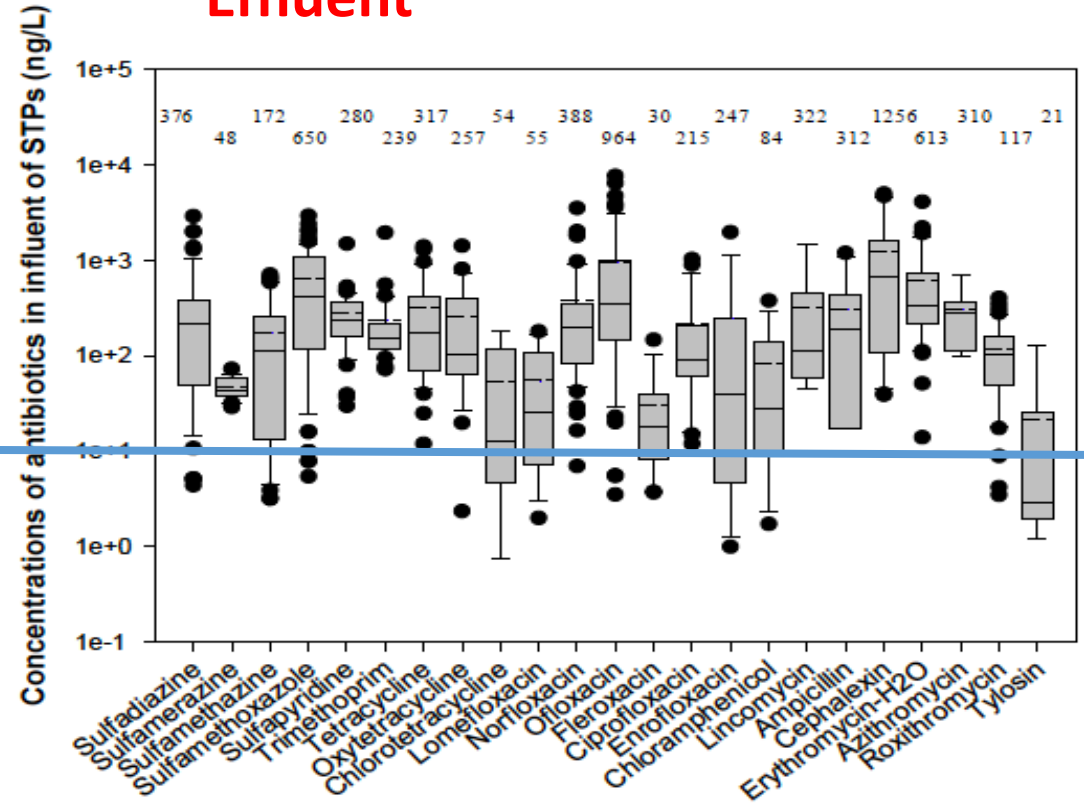


Waste Water Treatment

Influent



Effluent



Source Qiao et al. (In Press) Environment International

Antibiotic Concentrations in Animal Manures

Metabolism

Animal Species

Drug

Dose

Degradation

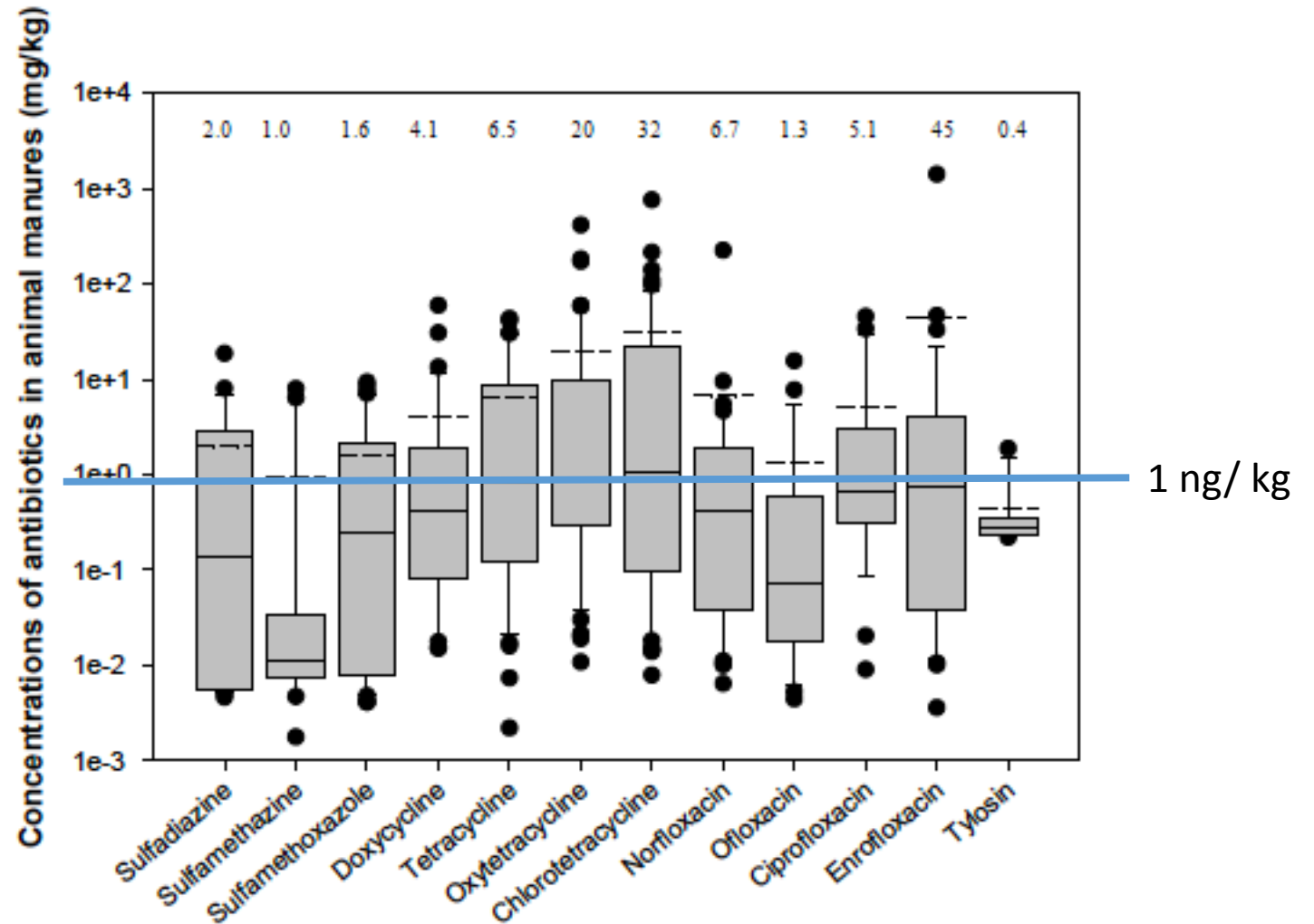
Drug

Concentration

Matrix,

Adsorption

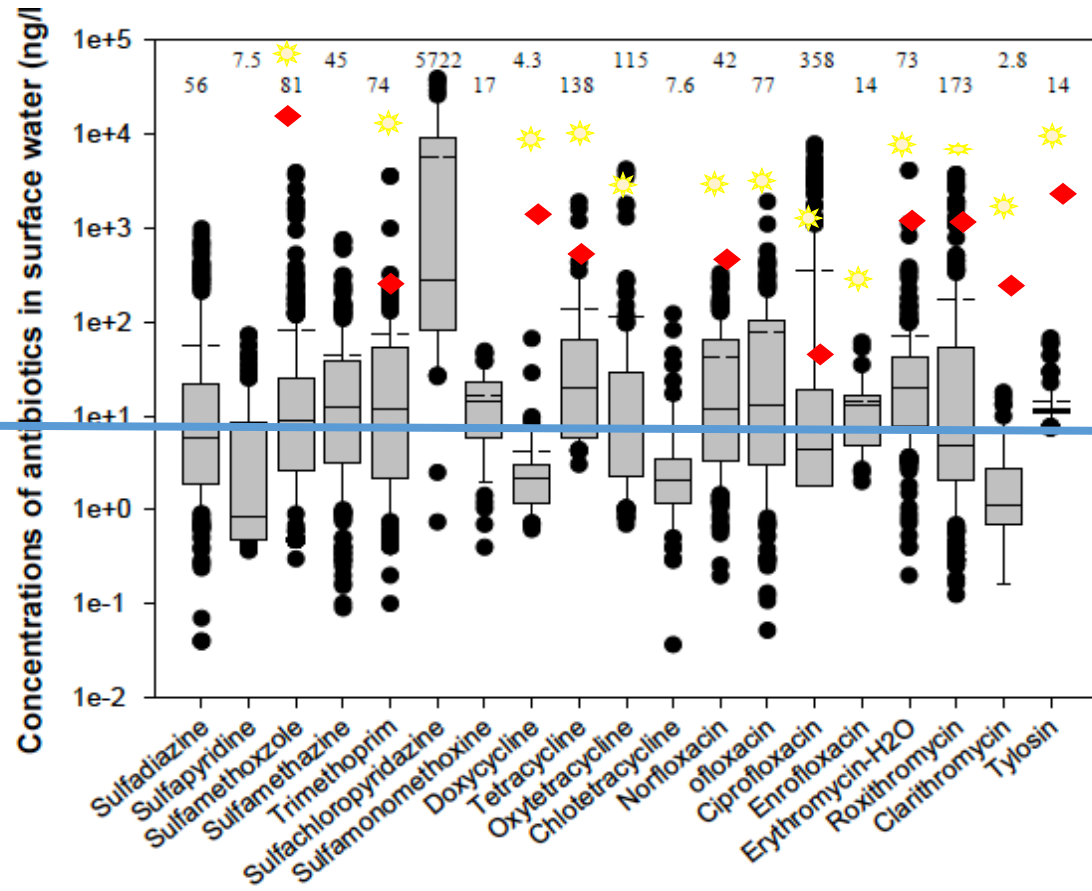
Temp, pH, H₂O



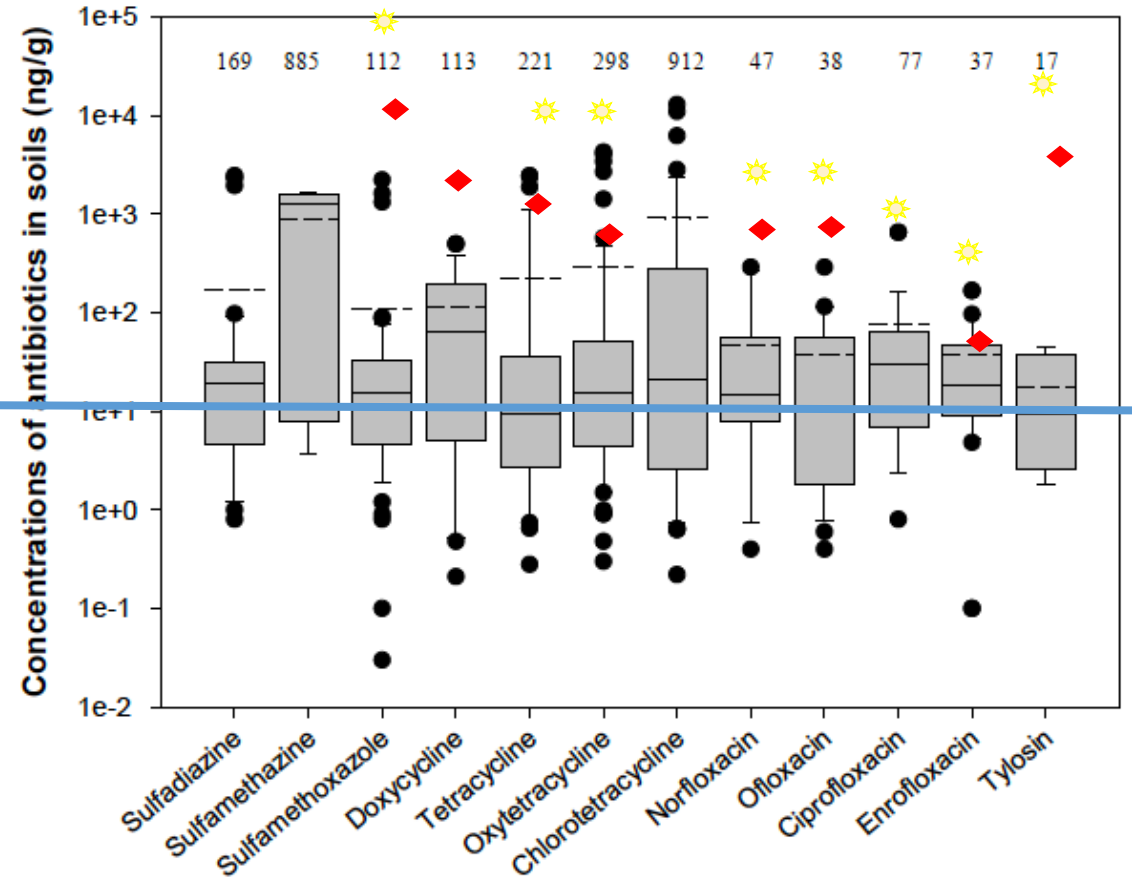
Source Qiao et al. (In Press) Environment International

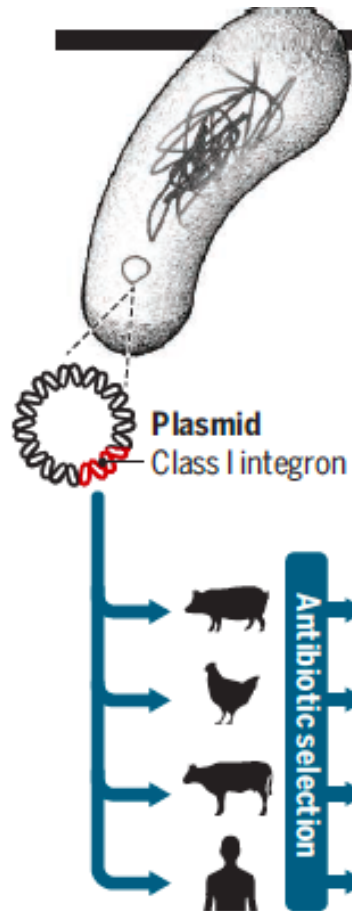
Antibiotic Concentrations in the Environment

River Water



Soils

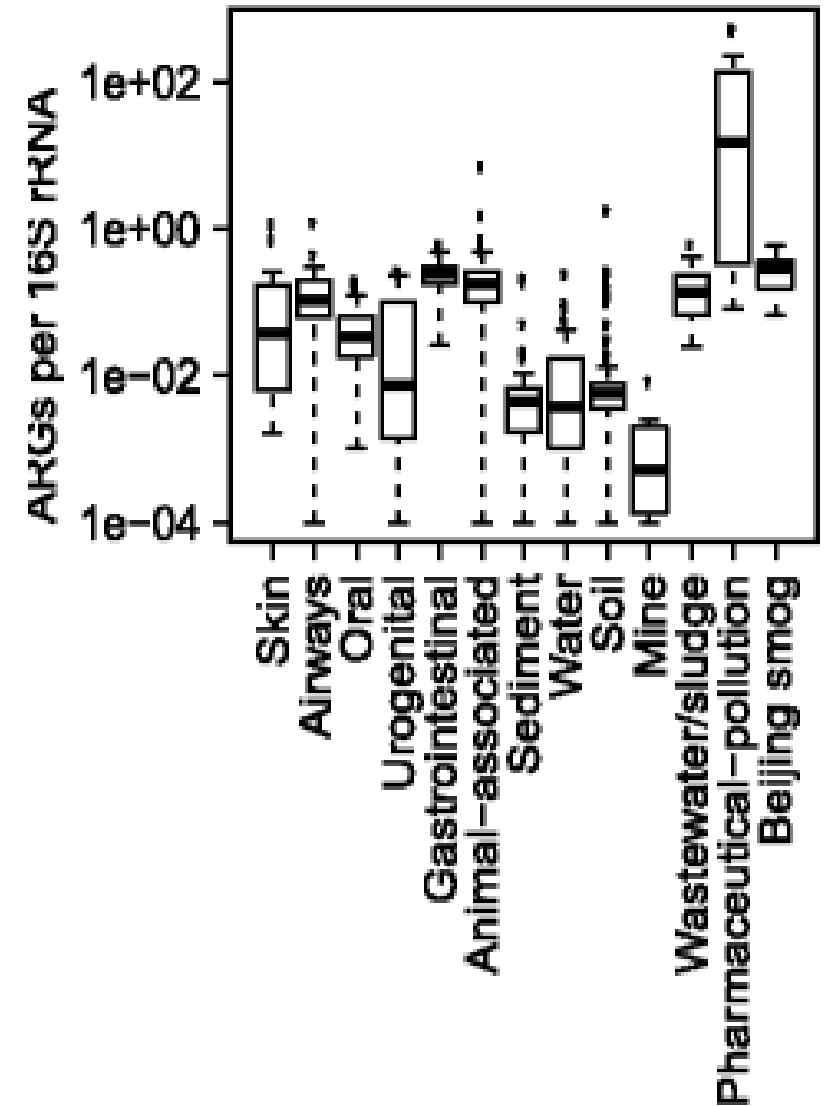




Global change for microbes

The clinical class 1 integron illustrates how human activities affect the abundance and distribution of genes and microorganisms. Driven by antibiotic selection, it has colonized different bacteria, vertebrate hosts, and continents. Its spectacular rise in abundance has been driven by antibiotic selection. Large numbers of integron copies are now being shed back into the environment, driving the spread of antibiotic resistance. See supplementary materials for data sources.

COPIES PER GRAM FECES	GRAMS OF FECES PER DAY	SIZE OF POPULATION	TOTAL COPIES RELEASED PER DAY
$10^8 - 10^{11}$	570	1×10^9	$10^{19} - 10^{23}$
$10^8 - 10^{10}$	20	1×10^{10}	$10^{19} - 10^{21}$
$10^6 - 10^7$	3000	1.4×10^9	$10^{19} - 10^{20}$
$10^6 - 10^7$	160	7.6×10^9	$10^{18} - 10^{19}$



Knowledge Gaps

- Relative contribution of Agriculture
- Significance of ARGs in water, soil
- Low dose selection
- Cost-benefit analysis of effective mitigation strategies



Reducing Environmental Loading

- Reduced Usage
 - Denmark-pigs
 - Norway Fish
- Protection of direct contamination of waterways
- Treatment of waste
- Novel technologies
 - Biochar?



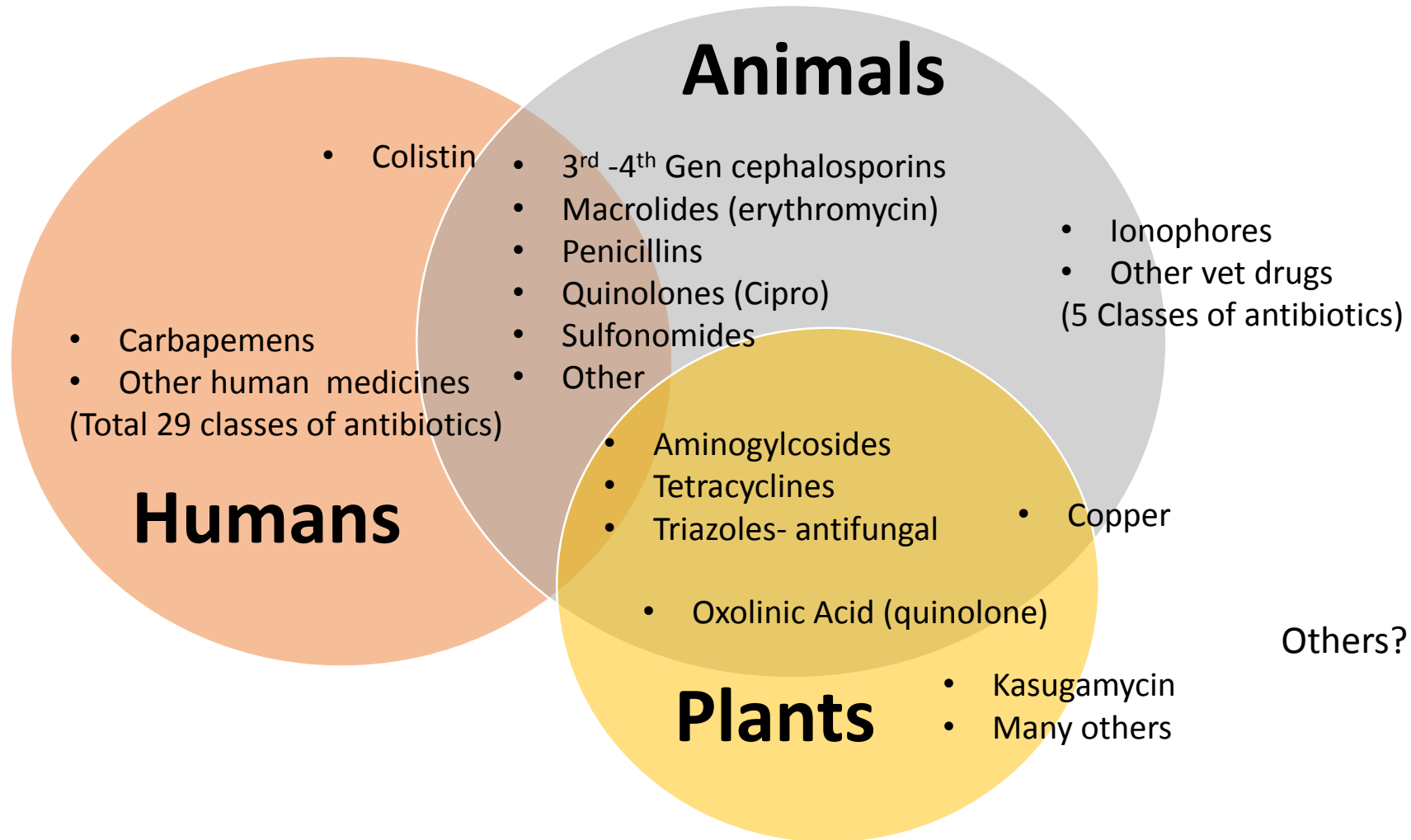
Plant-based foods

- Soil
- Irrigation
- Soil Amendments of Animal Origin
- Wildlife Intrusion
- Workers



- Workers
- Processing
- Handling
- Storage
- Retail

Antimicrobials Used in Medicine and Agriculture

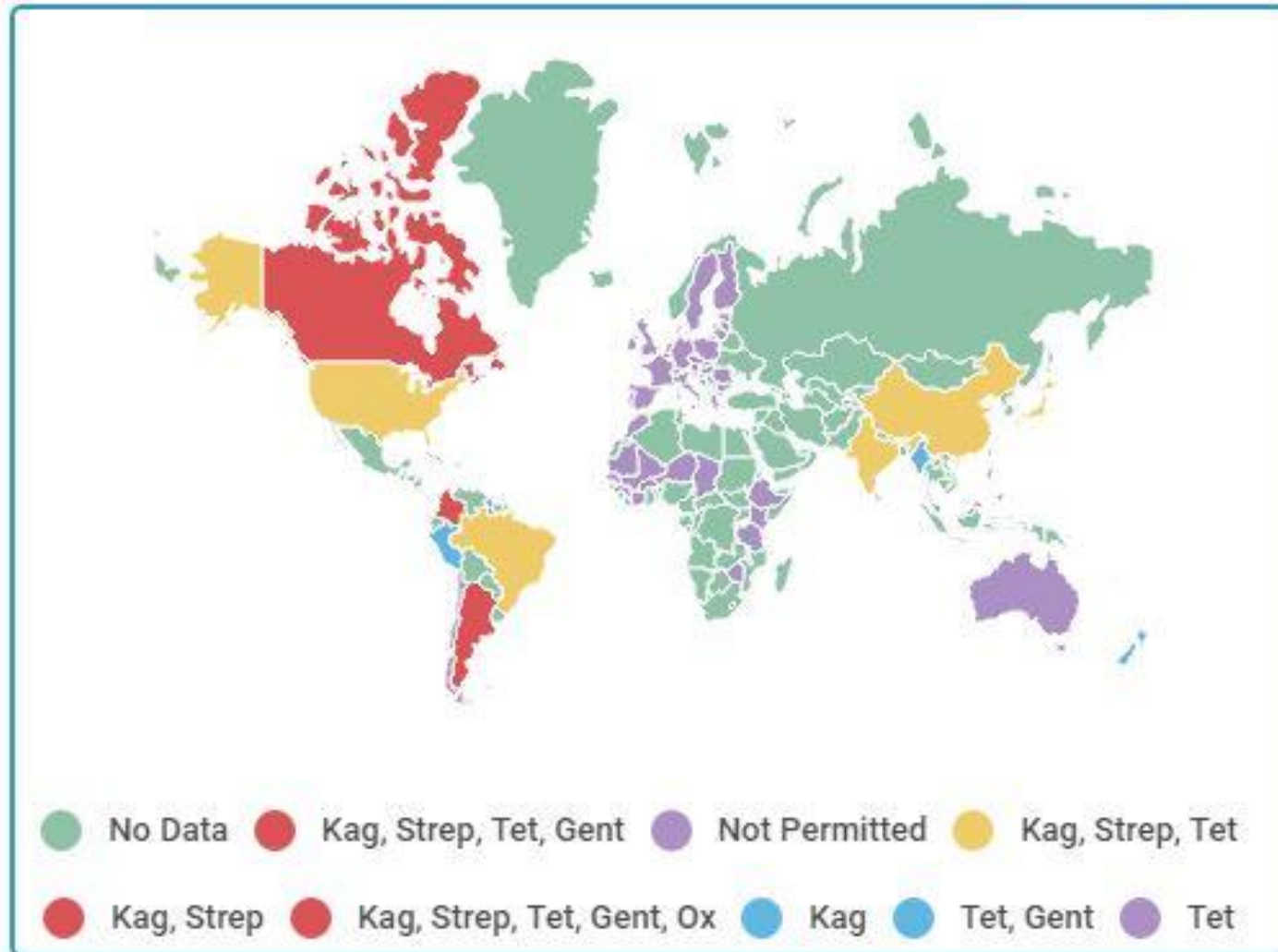


Antibiotics for plants

- Important for Plant Health
 - rice blast
 - cucumber angular leaf spot
 - cabbage black rot
 - apple and pear blight
- Uptake by plants

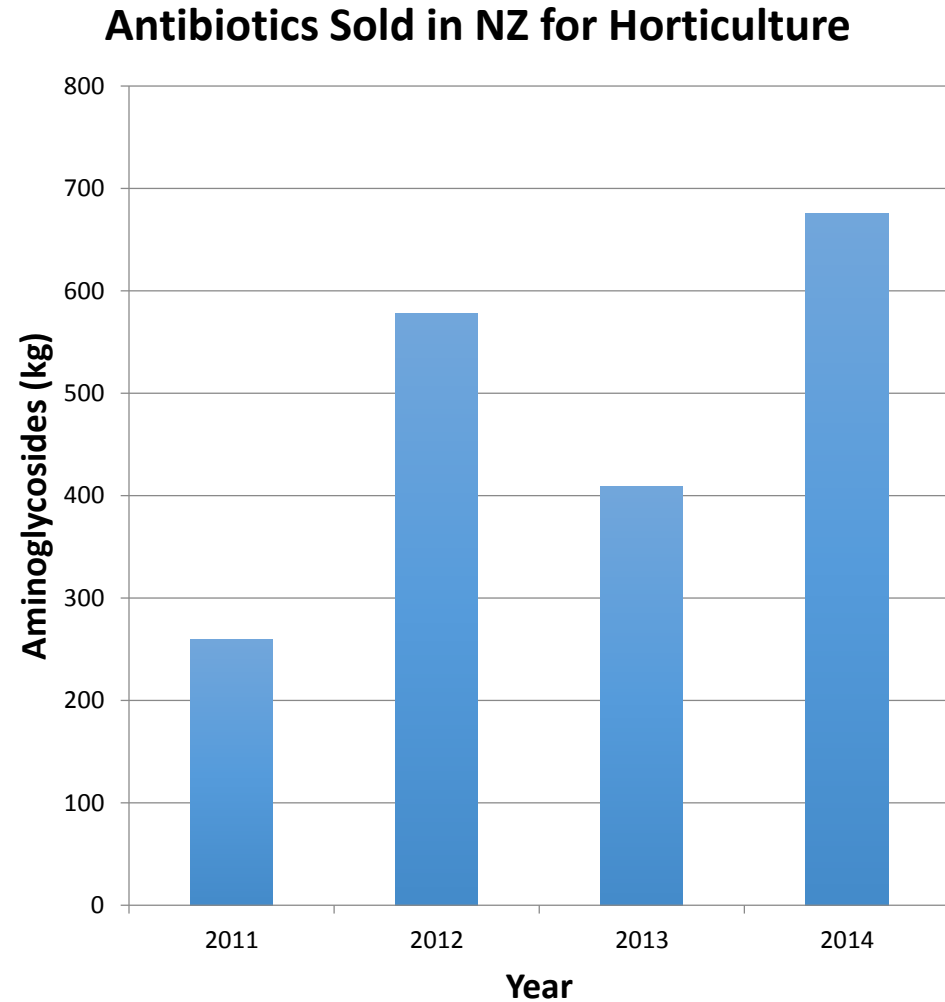


Antimicrobial use Approval



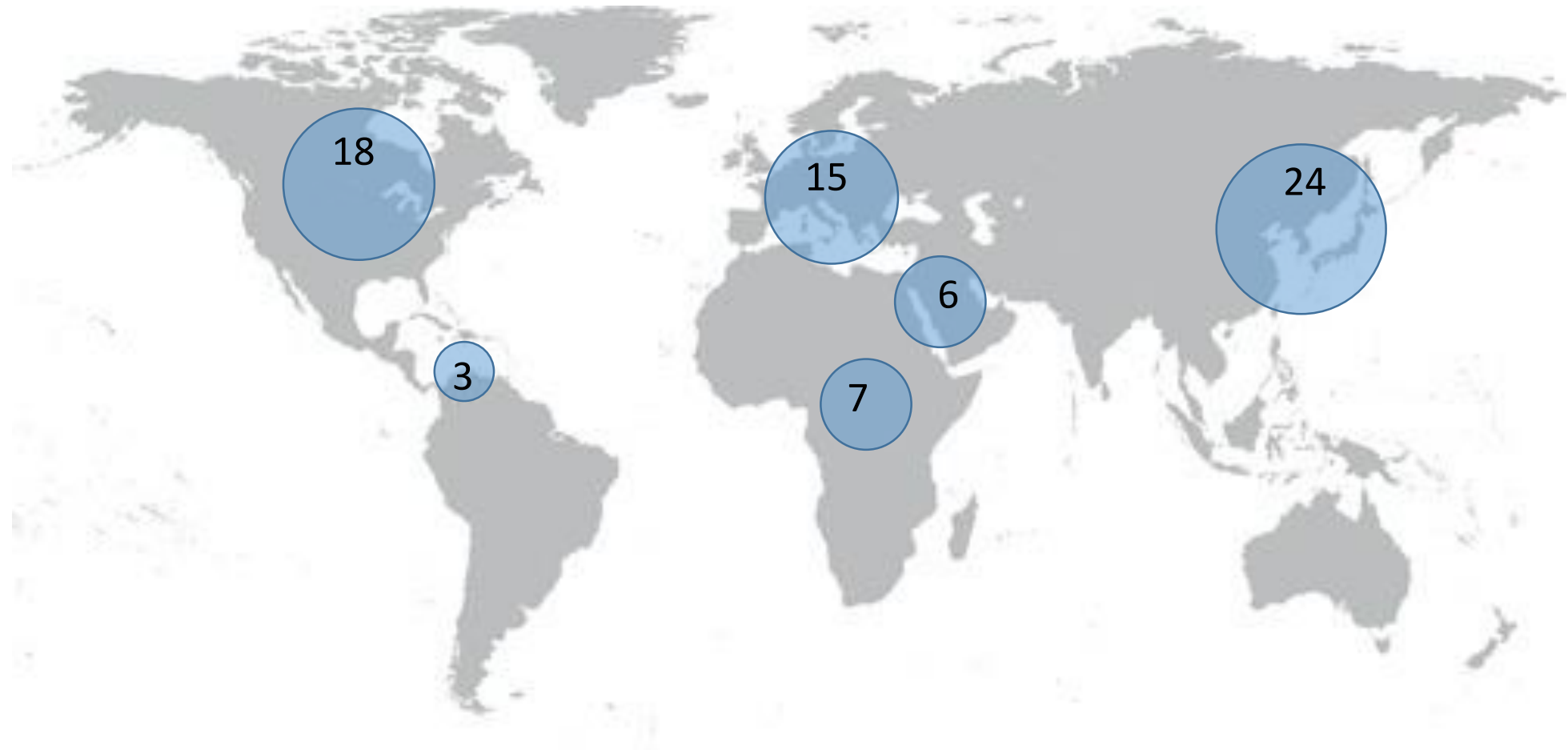
Amounts Used

- USA
 - 2011
 - 36 tonnes (0.26%)
 - (13,542 tonnes used in food animal)
- NZ
 - 0.9-1.5% of all AB sales

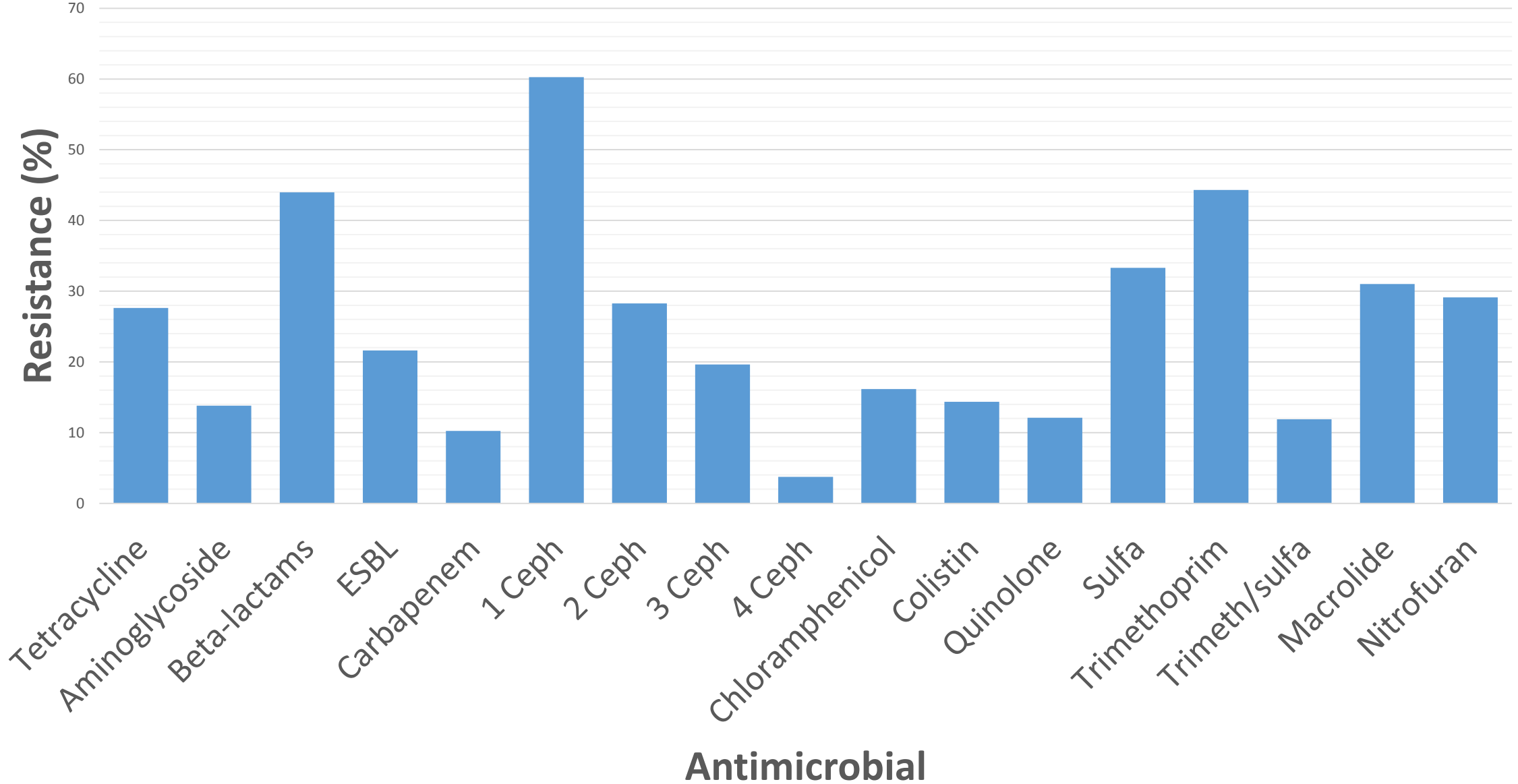


Extracted from NZ MPI

Studies on AMR in Vegetables



AMR among Gram-negative isolates from Vegetables





Knowledge Gaps

- Linkages between AMU in horticulture and AMR on foods of plant origin
- Role dietary ARGs on human health
- AMR populations in Vegetarians and non vegetarians

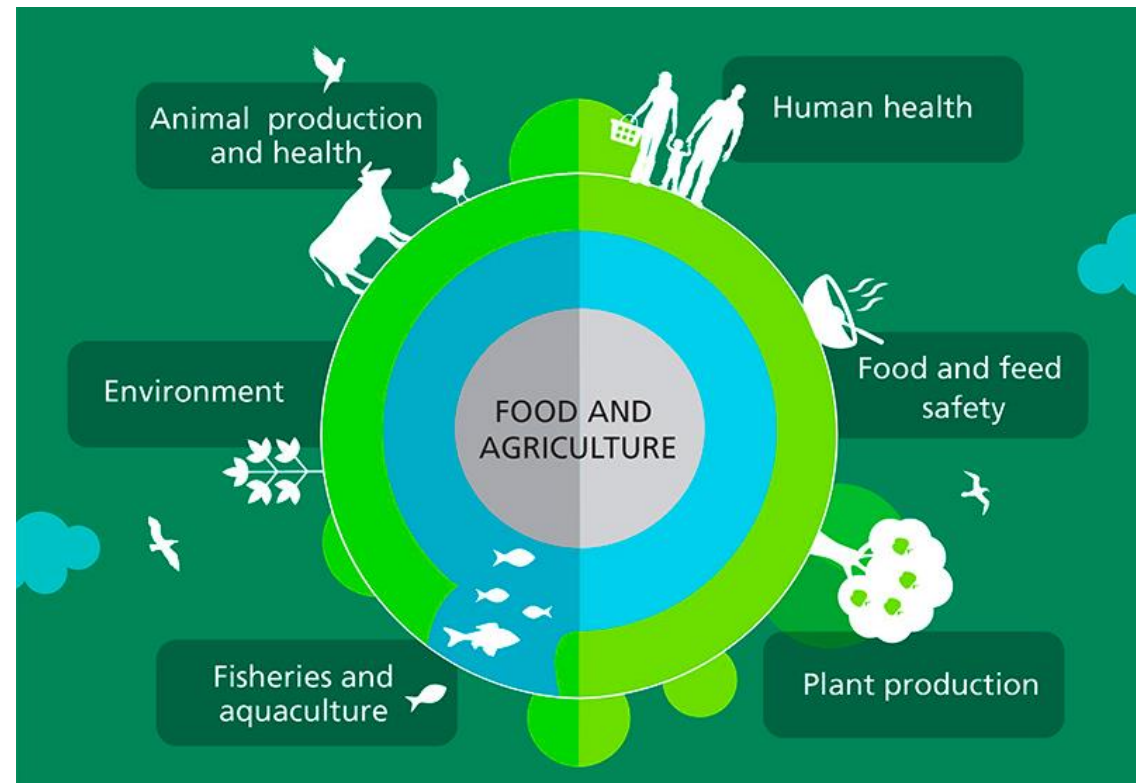
Prevention of AM/AMR/ARG on plants

- Plant Health
- Integrated Pest Management (IPM)
- Treated Organic fertilizers
- Water Quality
- Prudent use



FAO Activities

- One Health
 - Tripartite
 - UNEP
- Expert / Stakeholder Consultation, Evidence Mapping
 - Horticulture
 - Environment
 - Biocides
- Call for data



Summary

- Multiple drivers for AMR in foods
- Biocides and antimicrobials important for food security and safety
- Use antimicrobials only when necessary
- Considerable Research Gaps
 - Agriculture contribution to environmental contamination relative to other sources
 - Impact of horticultural antibiotic use
 - Extent of biocide selection for AMR