

# Epidemiology of AMR in a rapidly urbanizing city

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## URBAN ZOO

## Disease emergence in Urban areas



# Introduction

- The emergence and transmission of resistant bacteria and their AMR determinants is not well understood
- Nairobi, capital of Kenya (pop: 4 million), represents rapid urbanization in Sub-Saharan Africa
- Drivers of antibiotic use –  
High burden of infectious diseases, increased antibiotic use with rising incomes, and ease of antibiotic purchase
- Urban agriculture and livestock keeping common (Household = interface)
- *Escherichia coli* is an ideal organism to study the spread of AMR in these complex interfaces



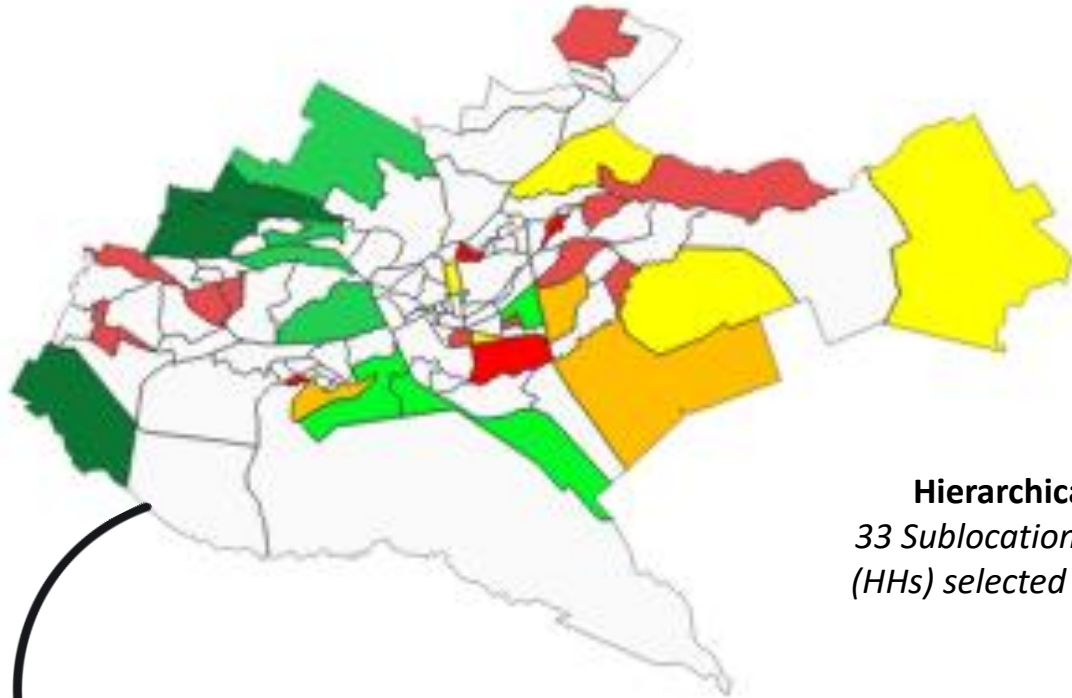
# Aims

Investigate carriage and diversity of AMR bacteria and their resistant genes in humans and animal populations

H<sub>0</sub>: ARGs have a cosmopolitan distribution

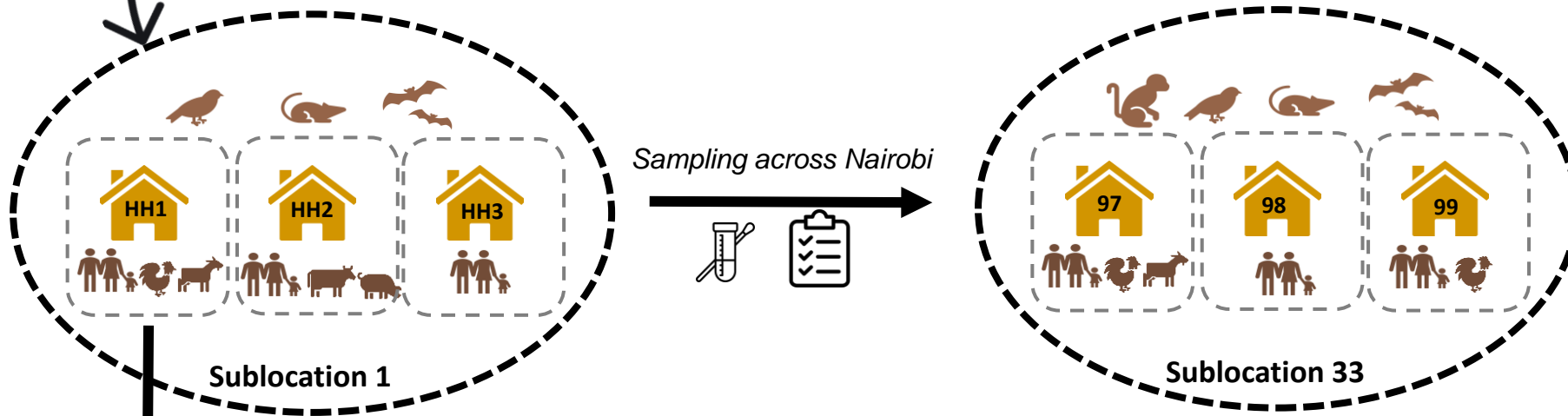
H<sub>0</sub>: Livestock keeping increases risk of human carriage of AMR genes



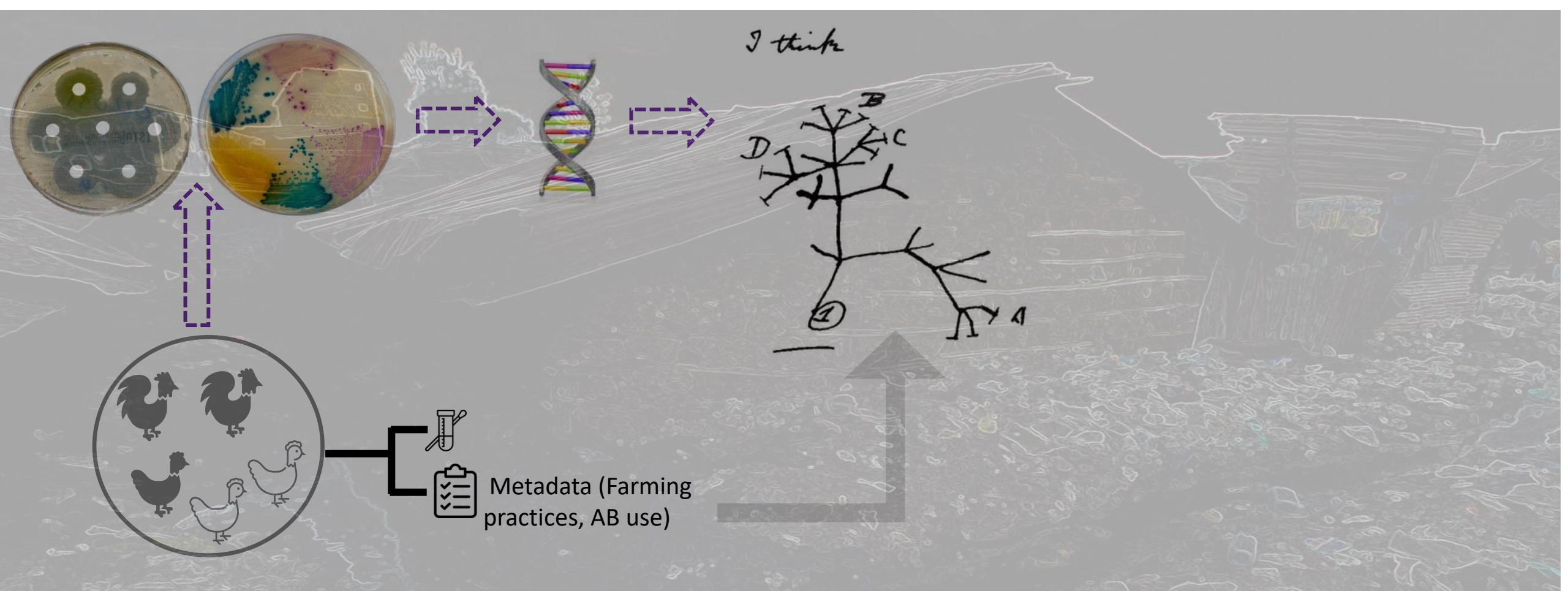


2015 to 2016  
(13 months)

**Hierarchical structured sampling design**  
*33 Sublocations were selected and 3 households (HHs) selected in each sublocation (total 99 HHs)*



- Biological material (Fecal swabs)
- Household metadata (socioeconomics, ecology, risk practices)



# Summary of source categories

Source	Number	%
Human	311	19
Livestock:	606	37
Poultry	324	20
Goat	109	7
Bovine	61	4
Pig	49	3
Rabbit	38	2
Wildlife:	421	26
Wild birds	245	15
Rodents	130	8
Primates	4	0.3
Carnivore	3	0.2

421



311



606

# AMR genes are common

- 56 ARGs + 13 points mutations detected = confer AMR to nine antibiotic classes
- Common ARGs - sul2 (41.3%), strA (36.8%), strB (37.2%), tetA (35.6%), and blaTEM-1B (23%)
- 365 (27%) isolates had at least one of the seventeen different ESBLs
- 8/69 genes commonly found in humans

## Fluoroquinolones

## Tetracyclines

## Sulphonamides

## Macrolides

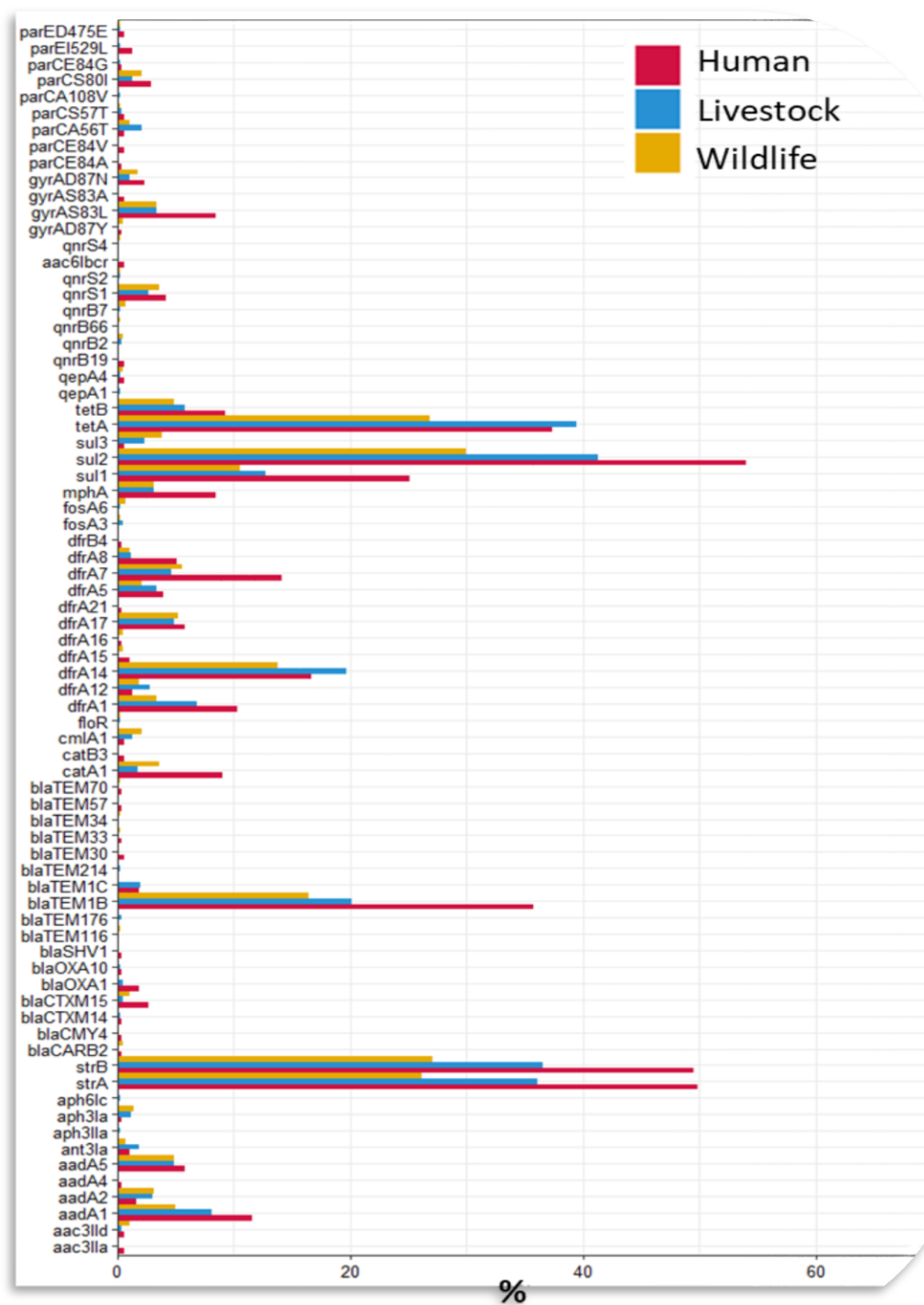
## Fosfomycin

## Trimethoprim

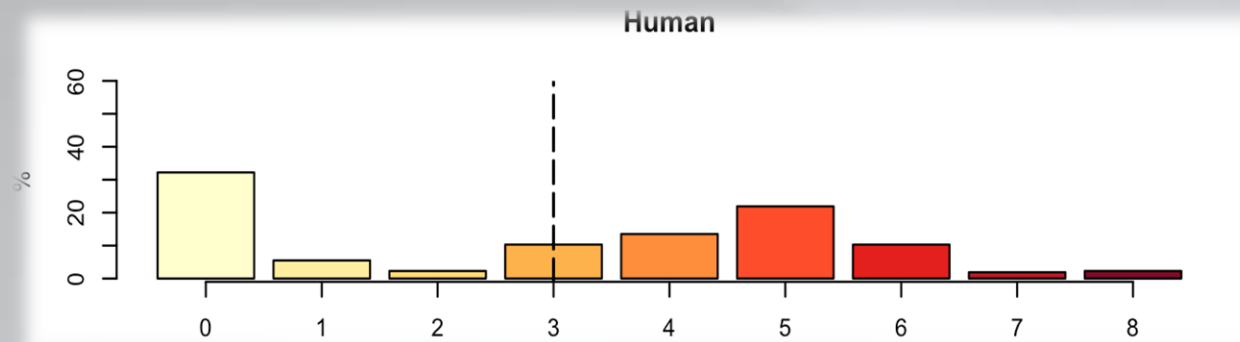
## Phenicols

## Beta lactams

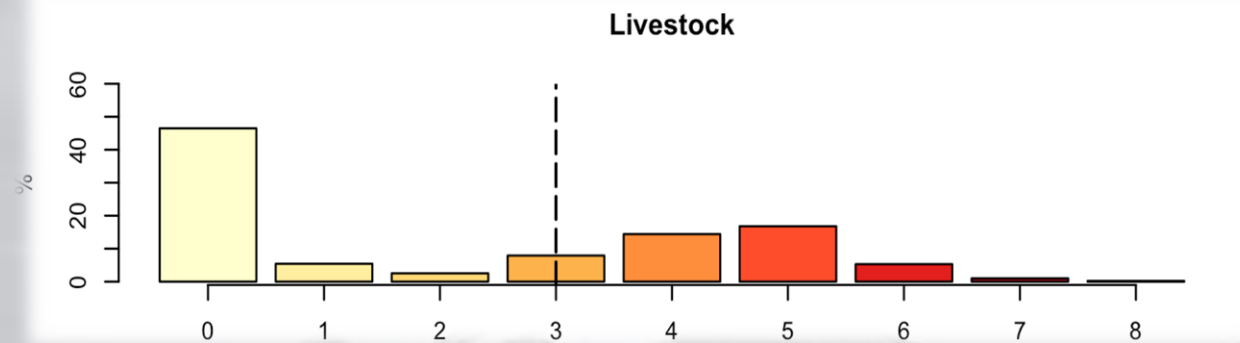
## Aminoglycosides



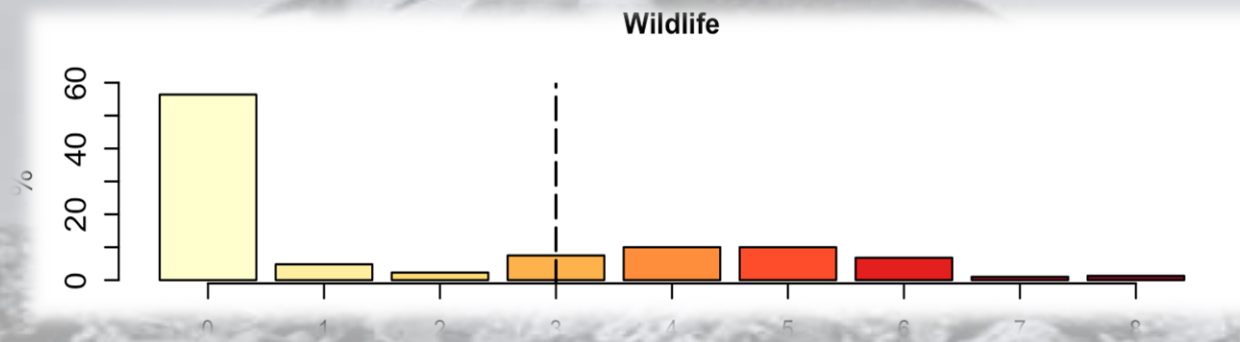
a



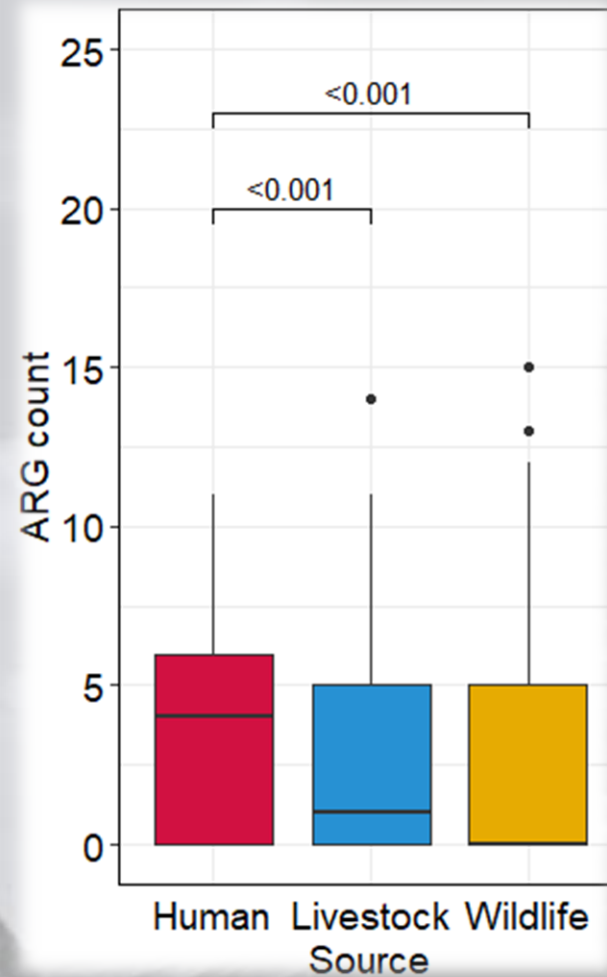
b



c



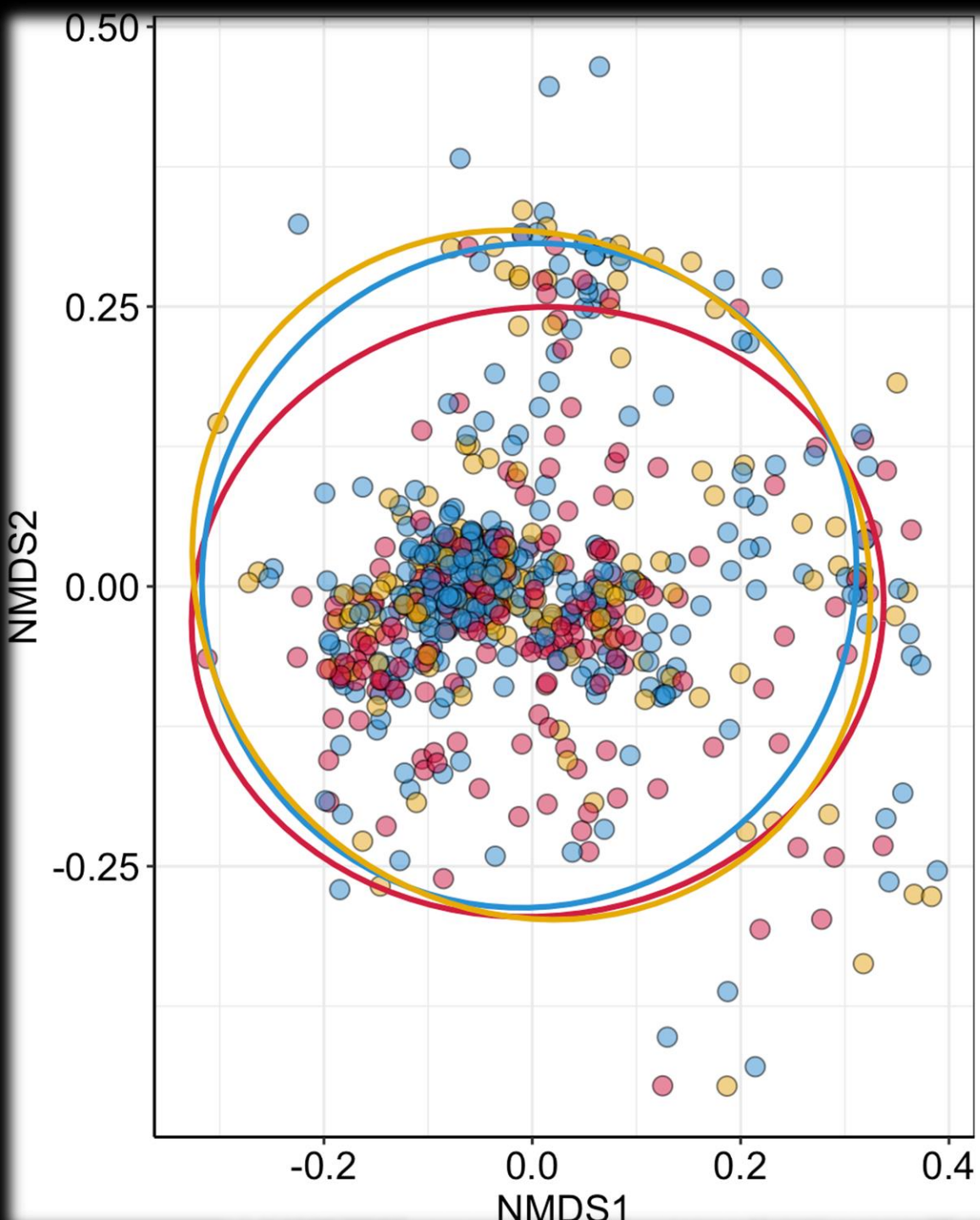
Number of antibiotic classes



Human isolates had more acquired AMR genes than livestock and wildlife isolates

MDR carriage was common - Human 60.1%, Livestock 45.5% and wildlife 36.6





source  
— human  
— livestock  
— wildlife

## AMR gene communities are not structured by host

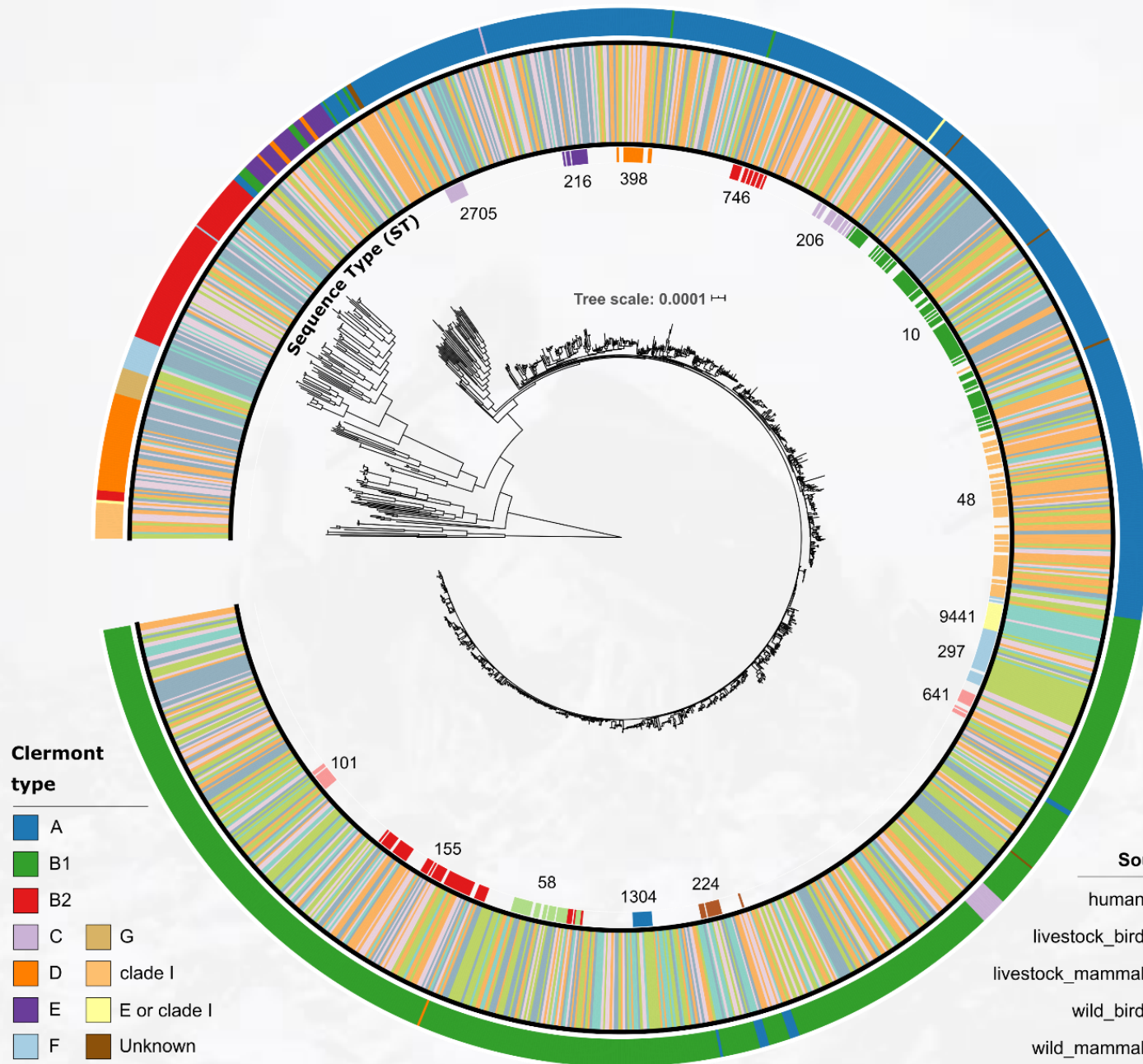
- **Non-metric multi-dimensional scaling (NMDS) of a Bray-Curtis distance matrix**
- **AMR gene assemblages in both human and animal were not statistically different**

**BUT .....**

High inter-host ARG similarity BUT minimal strain sharing

$H_0$ : plasmids are responsible for ARG intra/inter-transmission

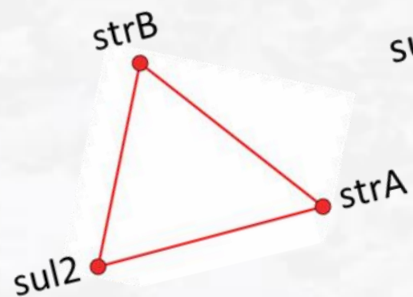
Muloi *et al*, under review



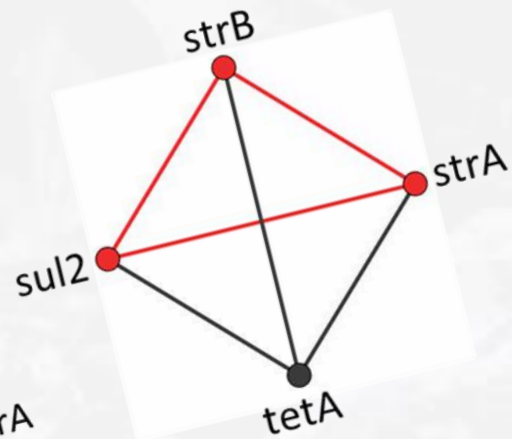
# High inter-host ARG similarity BUT minimal strain sharing

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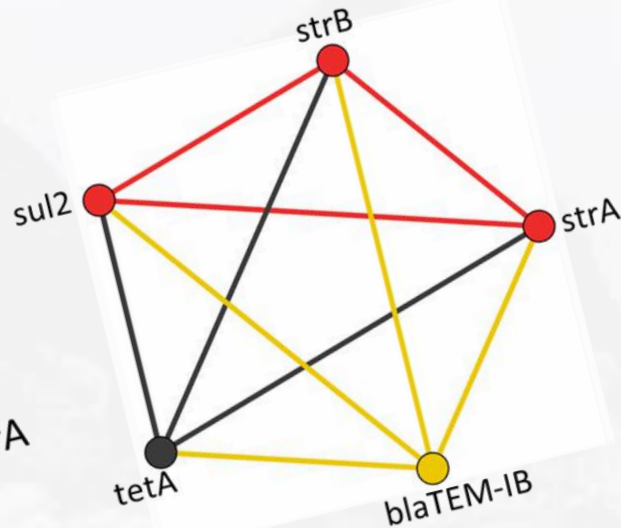
366 isolates



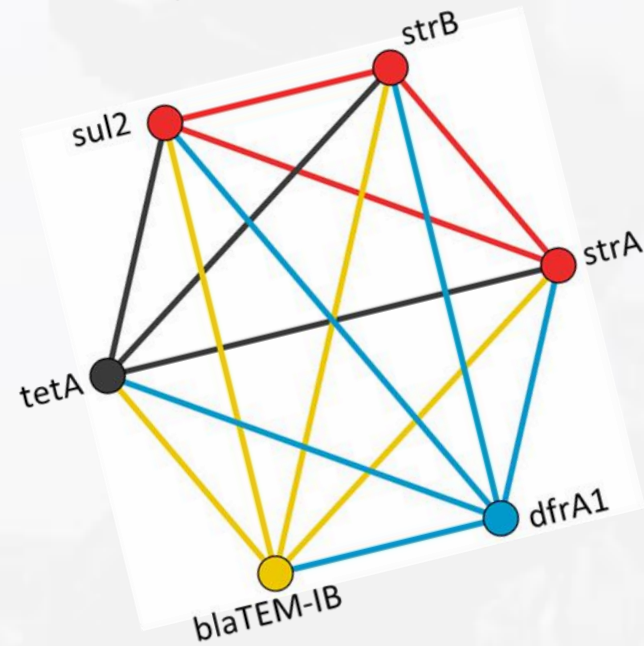
255 isolates



144 isolates



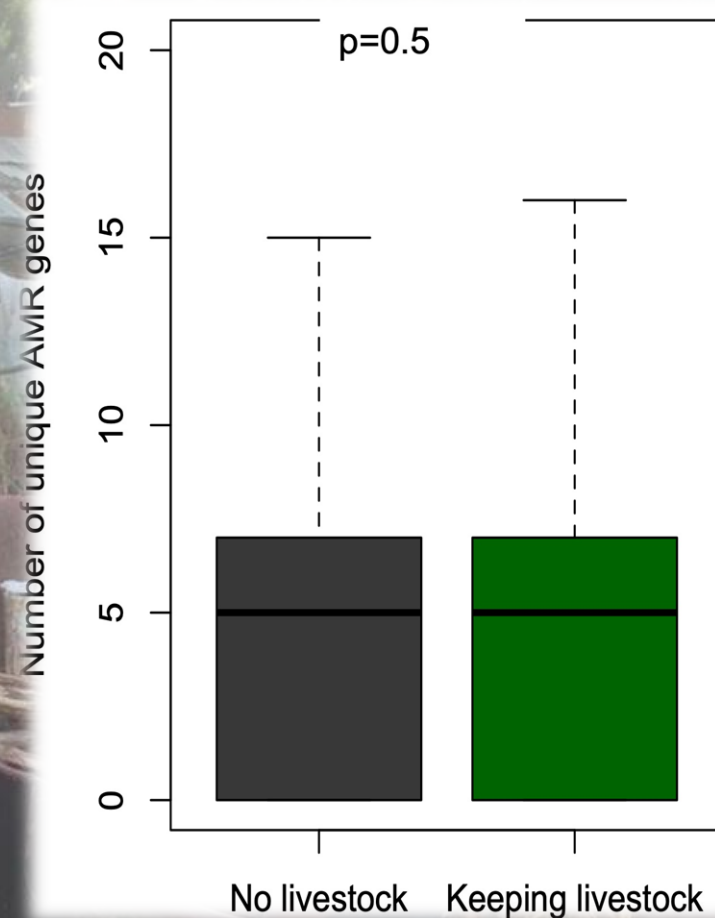
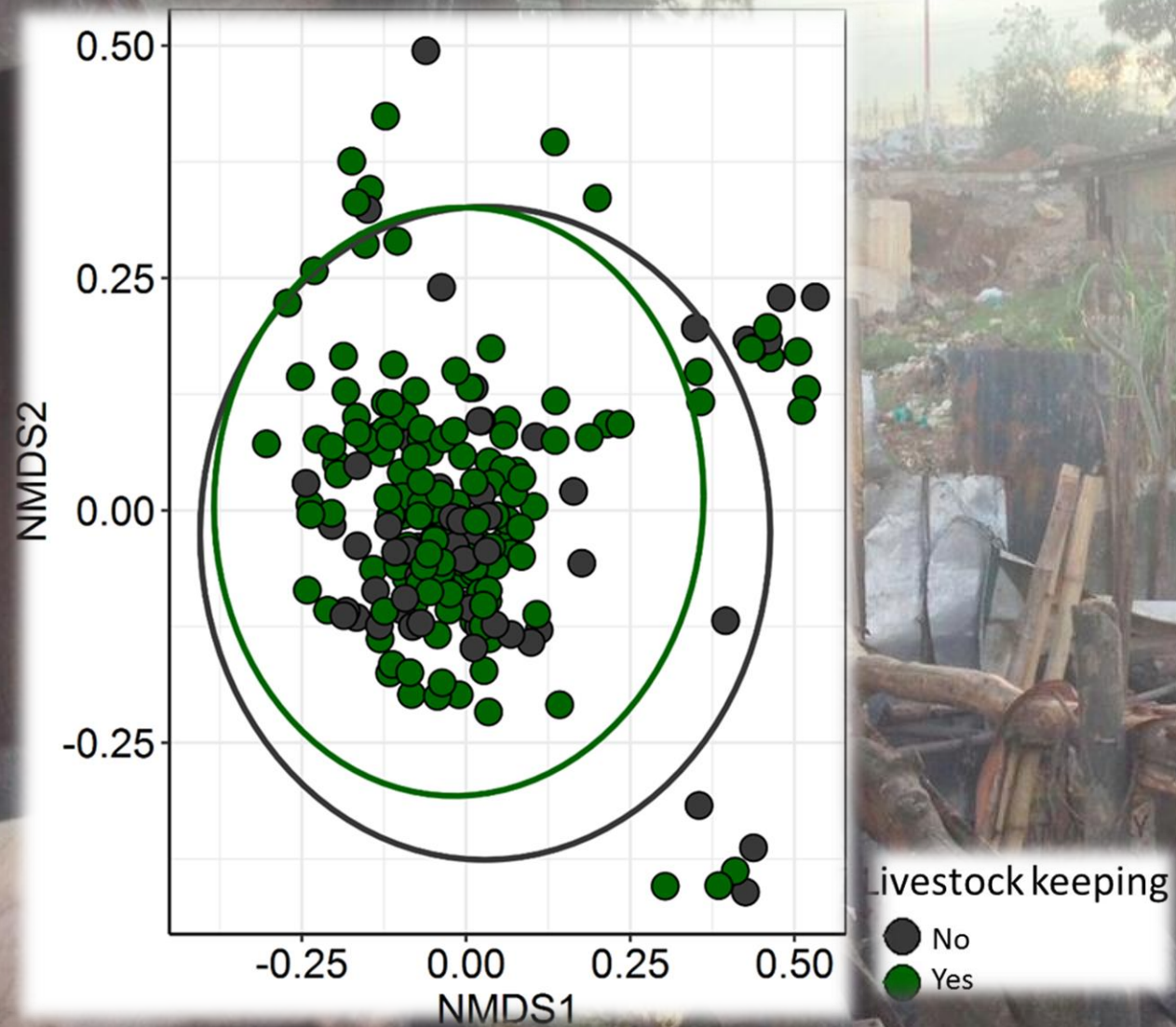
72 isolates



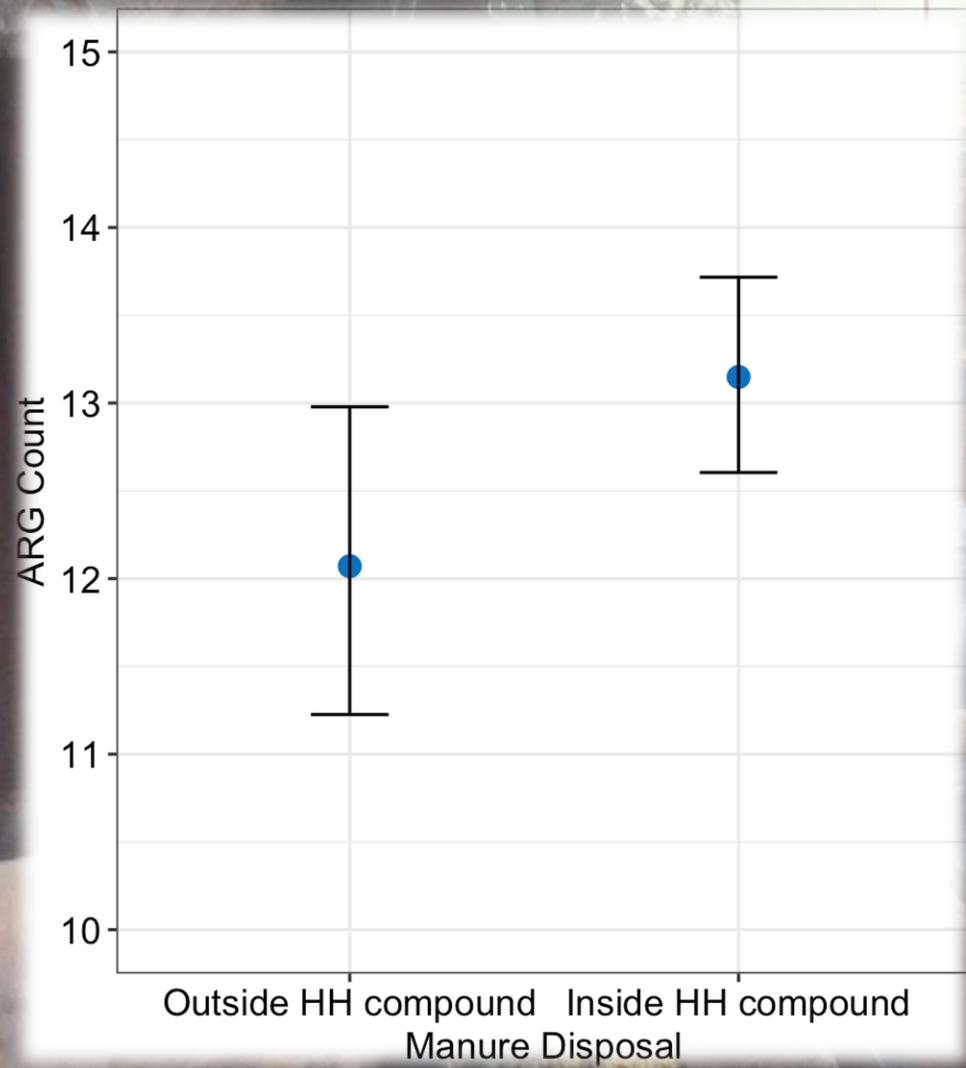
*Nanopore sequencing analysis ongoing*

Does livestock keeping  
influence AMR carriage  
in humans?

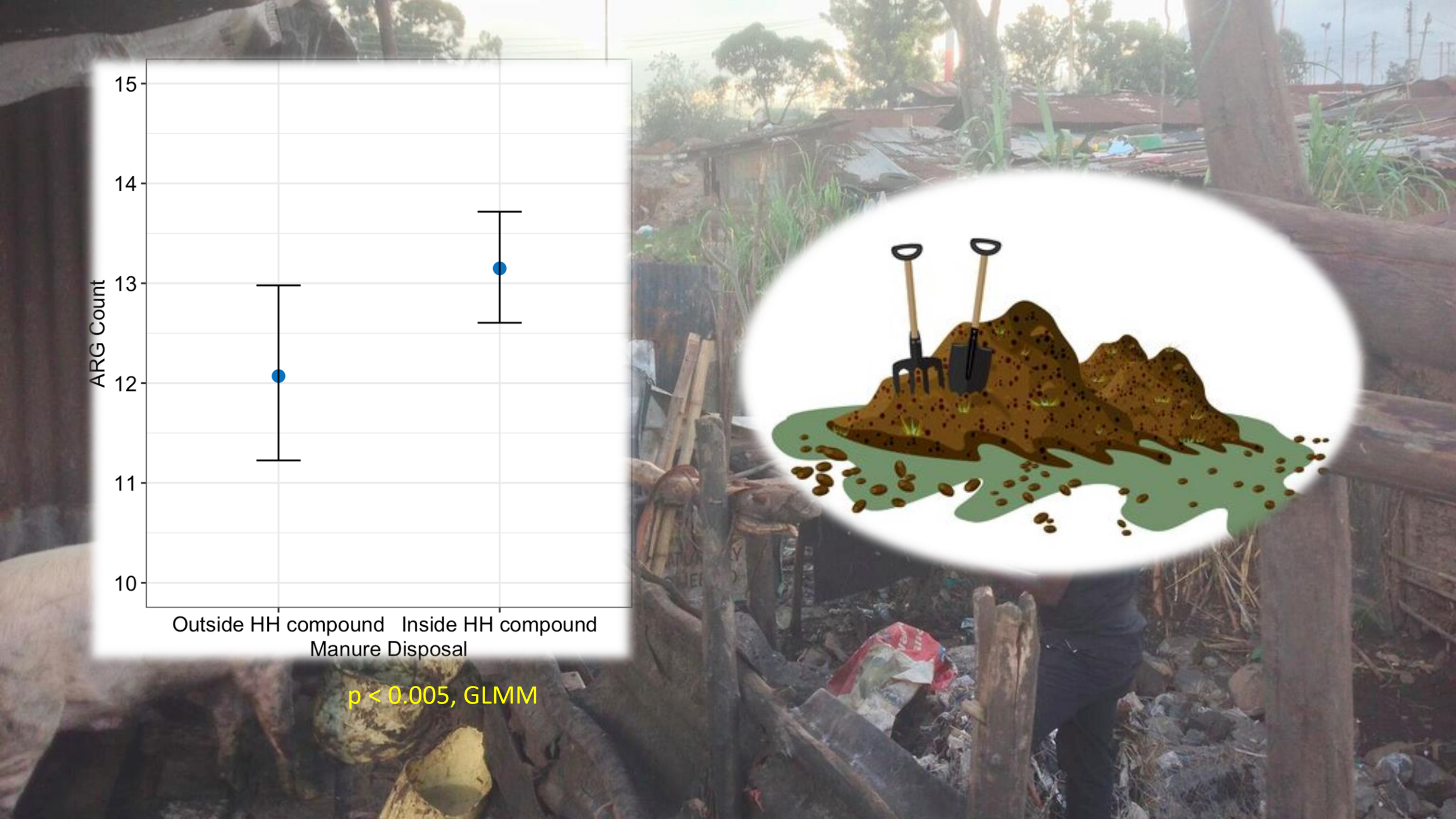


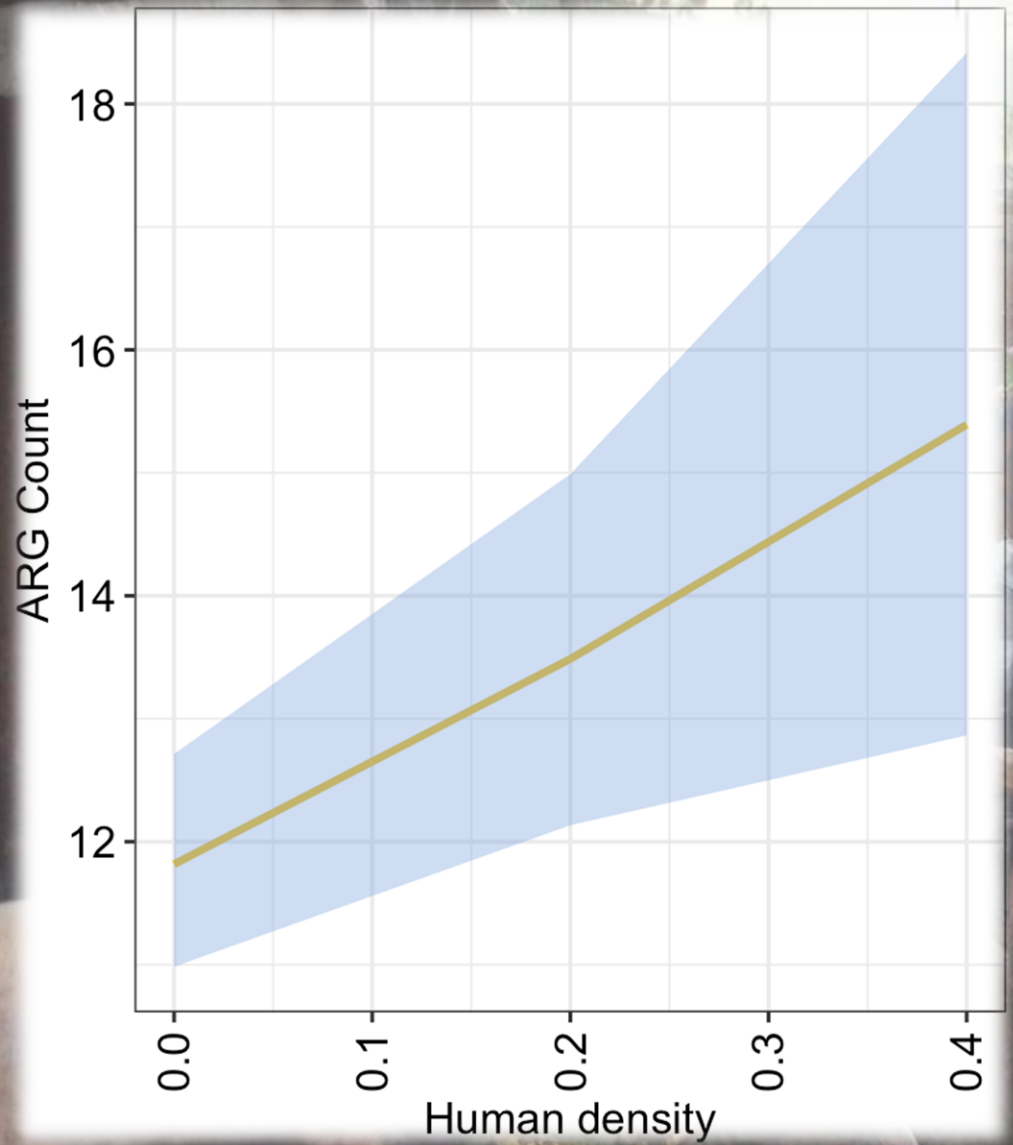


**Summary: Livestock keeping has little effect (if any) on carriage of different kind of AMR genes or number of AMR genes**



$p < 0.005$ , GLMM






# CONCLUSIONS

Widespread AMR genes – common in both human and livestock

Higher carriage (abundance and diversity) of AMR genes in humans vs livestock







Similarities in the resistome of the isolates did not match the patterns of shared genomes – perhaps reflective of usage patterns or HGT mechanisms

Livestock keeping has NO role on human AMR carriage but manure management and human density does!

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Disease emergence  
in urban areas



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Judy Bettridge  
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## Human – livestock pairs (n=10)

Pair	Isolate ID	cgMLST	Source	ST	HHID	Wealth group	AMR	Livestock keeping	Liv_exposure	Edu	M/F	Occupation	Age
1	TMP022790	1	chickens	10	NGN080	5		yes	moving handling housing manure milking eggs slaughter	1	M	domestic	37
	INT008356				GTN074	6							
2	PLQ2189	1	geese	538	KTS088	1		yes	moving handling housing manure eggs slaughter	2	M	farmhand	36
	PLQ2296				KTS088	1							
3	ALQ020141	3	chickens	23	UTH030	6	aph(3'')-Ib, aph(6)-Id, blaTEM-1B, dfrA8, mph(A), sul2	no	N/A	N/A	N/A	N/A	N/A
	ALQ020449				UTH029	6	aph(3'')-Ib, aph(6)-Id, blaTEM-1B, dfrA8, mph(A), sul2						
4	INT004723	3	bovine	6178	KRR037	2		yes	handling milking eggs	6	M	public_sector	60
	INT004696				KRR037	2							
5	INT007533	3	ducks	58	MWK056	6		yes	moving handling housing manure	3	M	domestic	36
	INT007394				MWK056	6	aph(3'')-Ib, aph(6)-Id, sul2, tet(A)						
6	ALQ023299	4	rabbit	9454	SPV064	2		yes	moving handling housing manure milking eggs slaughter	2	M	farmhand	31
	INT006051				SPV064	2							
7	ALQ023299	4	turkeys	9454	SPV064	2		yes	moving handling housing manure milking eggs slaughter	2	M	farmhand	31
	INT006147				SPV064	2							
8	TMP021689	4	chickens	206	KHW049	6	ant(3'')-Ia, aph(3'')-Ib, aph(3')-Ia, aph(6)-Id, dfrA14, mph(A), sul2, tet(A)	yes	N/A	N/A	N/A	N/A	N/A
	TMP021678				KHW049	6	ant(3'')-Ia, aph(3'')-Ib, aph(3')-Ia, aph(6)-Id, dfrA14, mph(A), sul2, tet(A)						
9	INT007648	8	turkeys	1237	KOR058	7		yes	N/A	N/A	N/A	N/A	N/A
	INT005176				EAS044	5							
10	TMP024272	10	chickens	48	LOR099	1	blaTEM-1C,	no	none	6	M	manager	57
	TMP024453				LOR097	1	blaTEM-1C, tet(A)						