Investigation into *Salmonella* Carriage and Antimicrobial Resistance in Australian Weaner Pigs

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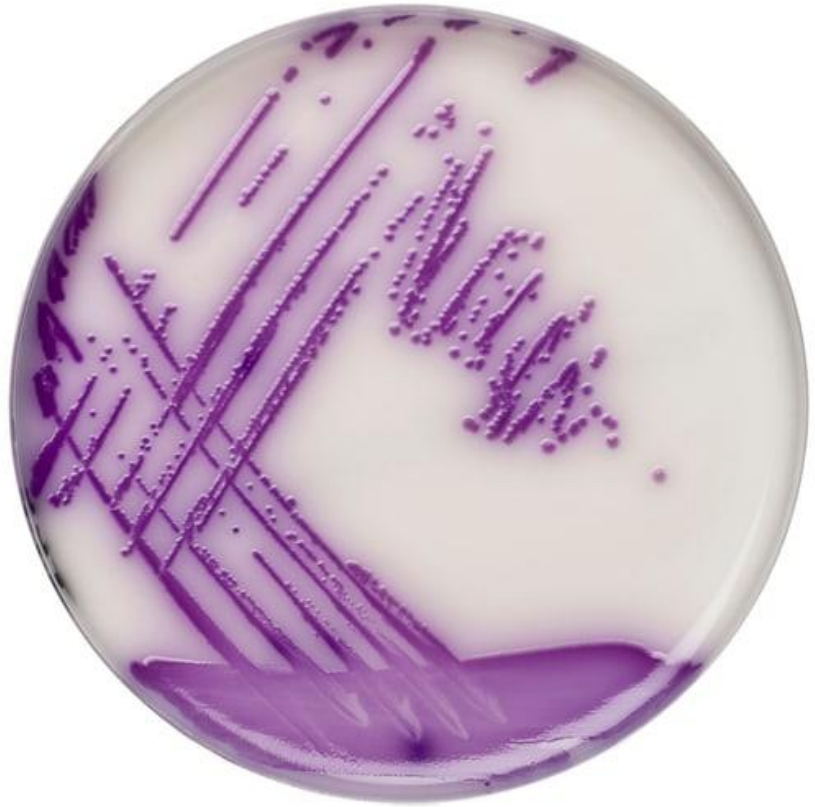
Overview

- Background
- Aims and Hypothesis
- Methods
- Results
- Limitation and future directions
- Conclusion

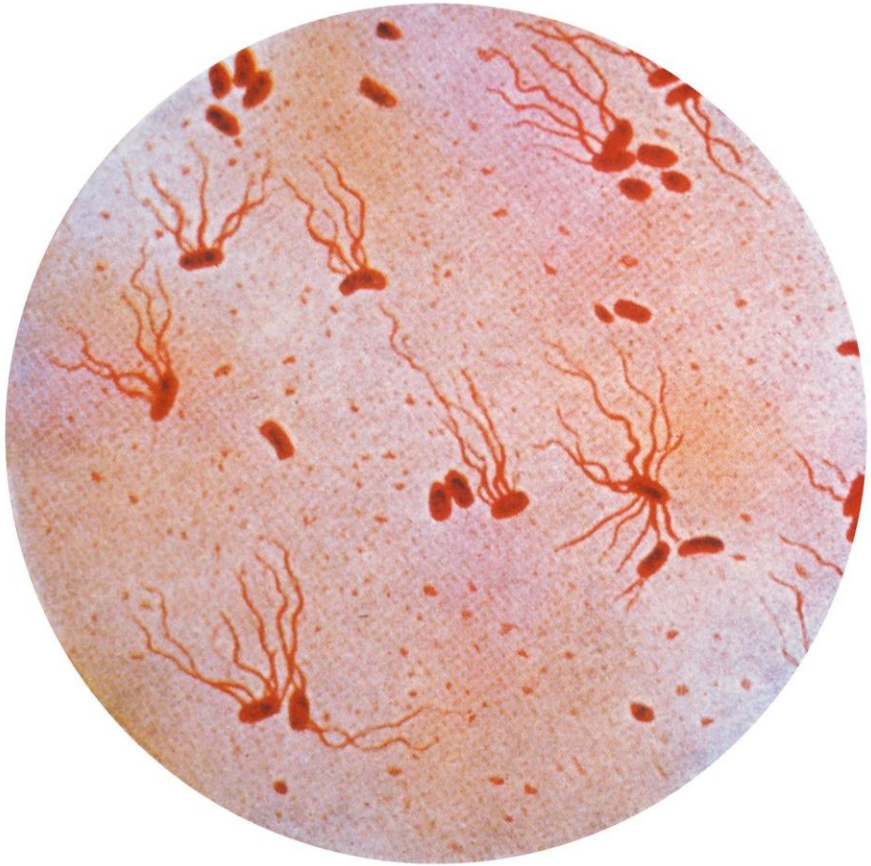
Salmonella enterica

- Gram Negative and zoonotic bacteria
- Salmonellosis – enteritis, diarrhea, septicaemia, death
- Non-typhoidal *Salmonella* - top foodborne pathogen worldwide that causes human disease
- Persistent pathogen (many serovars)



A Cause for Concern : Human and Animal Health

- Zoonosis means both animals and humans are affected
- Negative impact on livestock industry
- Young, old, immunocompromised – more susceptible
- May lead to decrease in production yield / premature death

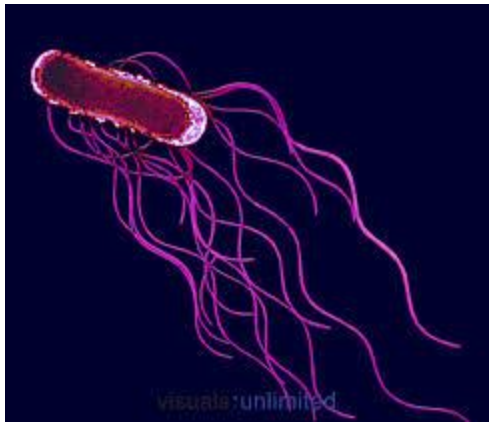


The Disease in Pigs

- Often asymptomatic
- If any manifestations: diarrhea, loss of appetite, gastroenteritis, sepsis
- Often prophylactically treated with antimicrobials in food and drinking water
- Gives rise to antimicrobial resistance

Previous Work in Pigs

- Disease often systemic
- Multidrug resistance detected in many countries such as Australia, Thailand and Croatia
- Monophasic Variant of *Salmonella enterica* serovar Typhimurium found in increasing numbers in Australia and around the world



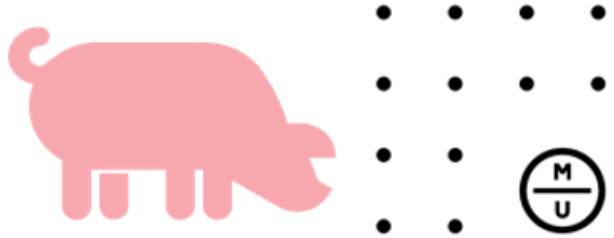
Weaver T. Monophasic Salmonella Typhimurium in Australian pigs. minerva-accessunimelbeduau [Internet]. 2017; Available from: https://minerva-access.unimelb.edu.au/items/9a0b2006-7cb7-53d0-b93b-8ba433846a63

Kidsley AK, Abraham S, Bell JM, O'Dea M, Laird TJ, Jordan D, et al. Antimicrobial Susceptibility of Escherichia coli and Salmonella spp. Isolates From Healthy Pigs in Australia: Results of a Pilot National Survey. Frontiers in Microbiology. 2018 Jul 9;9

The Study

- Investigate *Salmonella* carriage in young pigs in Australian piggeries
- Weaner pigs (4-6 weeks)
- *Salmonella* prevalence, Antimicrobial Resistance profiles and Serovar diversity

Hypothesis



- We expected to find *Salmonella* at moderate prevalence among weaner pigs in Australian Piggeries
- Expected to detect antimicrobial Resistance (AMR) against some broad-spectrum antimicrobials, but not against Critically Important Antimicrobials (CIAs) in human treatment
- Expected to find a wide range of serovars

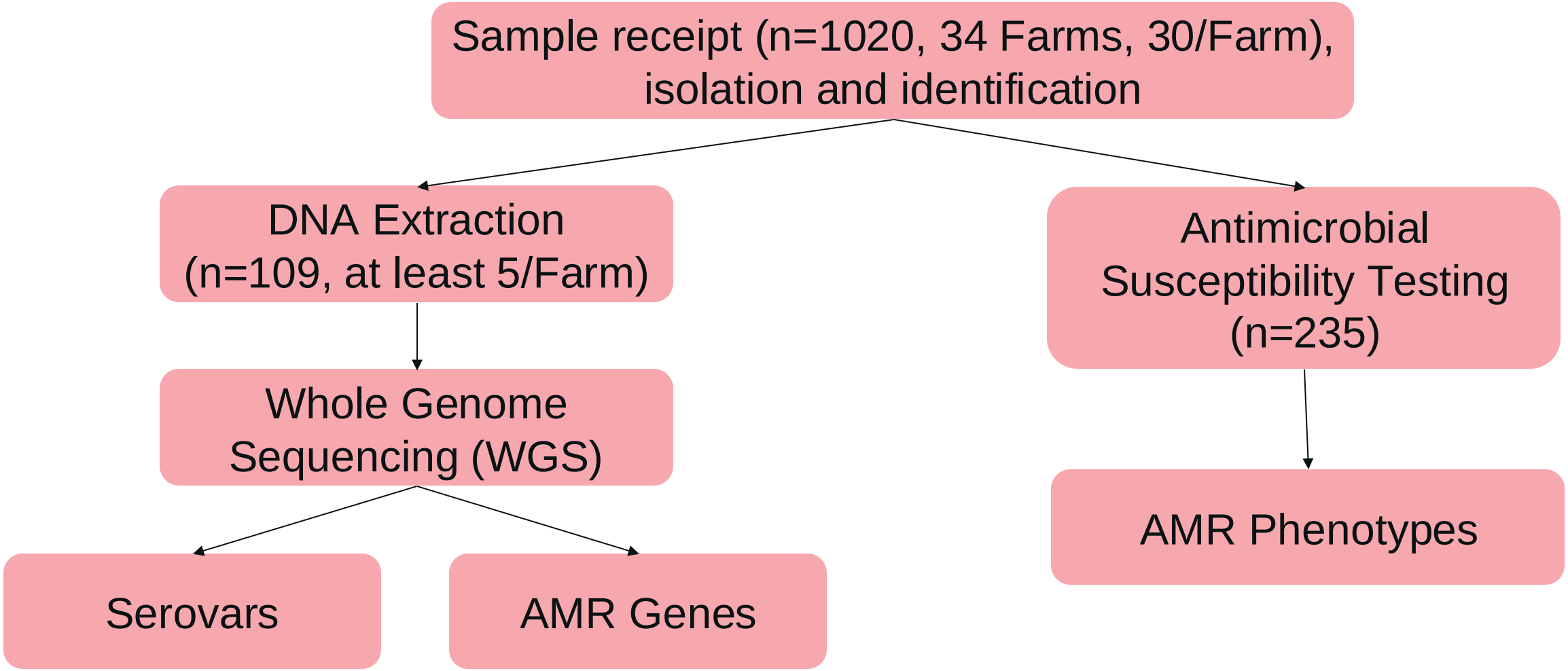
Methods and Materials - Overview

Sample collection, isolation and identification of presumptive colonies

Antimicrobial Susceptibility Testing (AST)

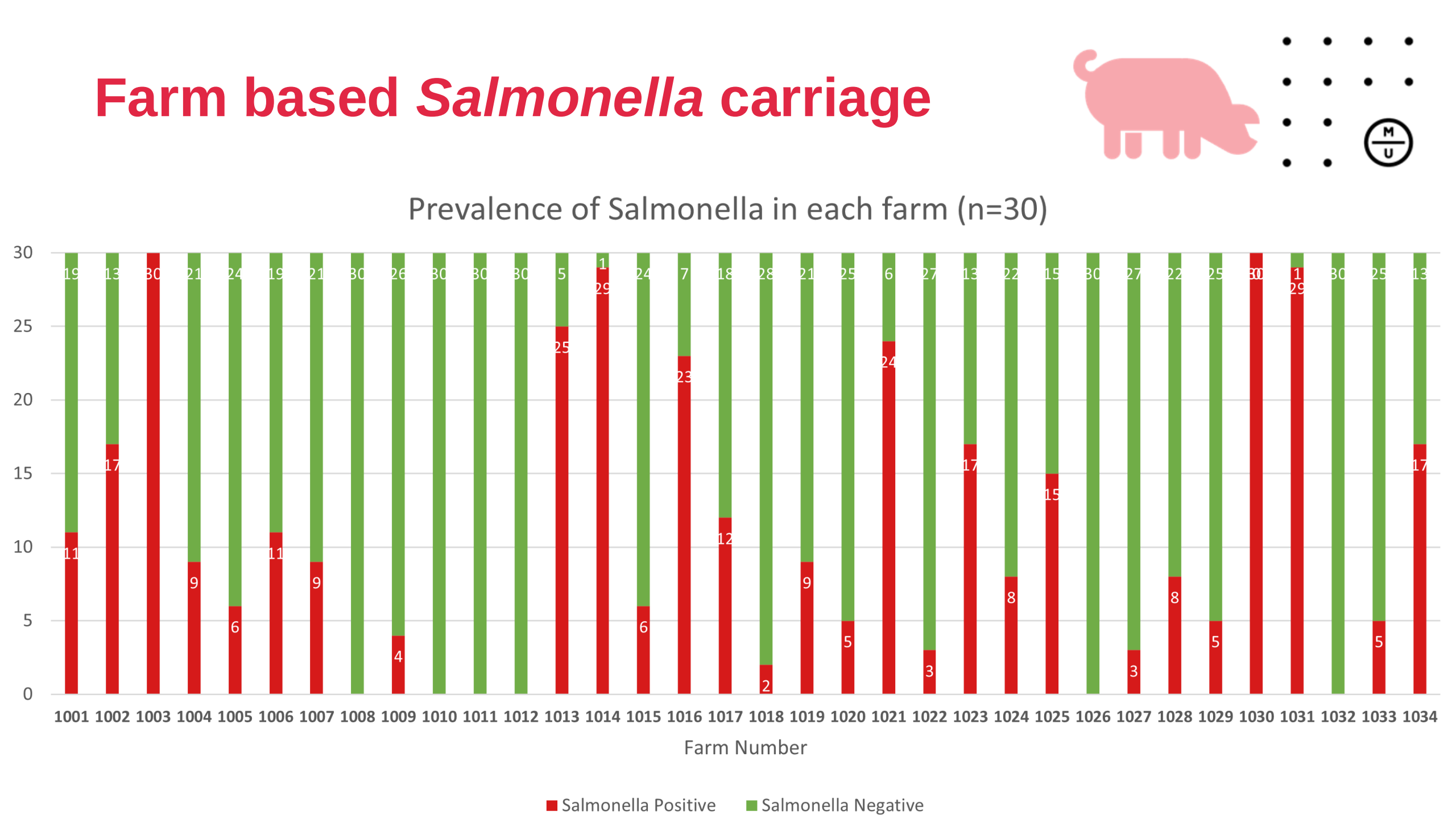
Whole Genome Sequencing (WGS)

Methods and Materials

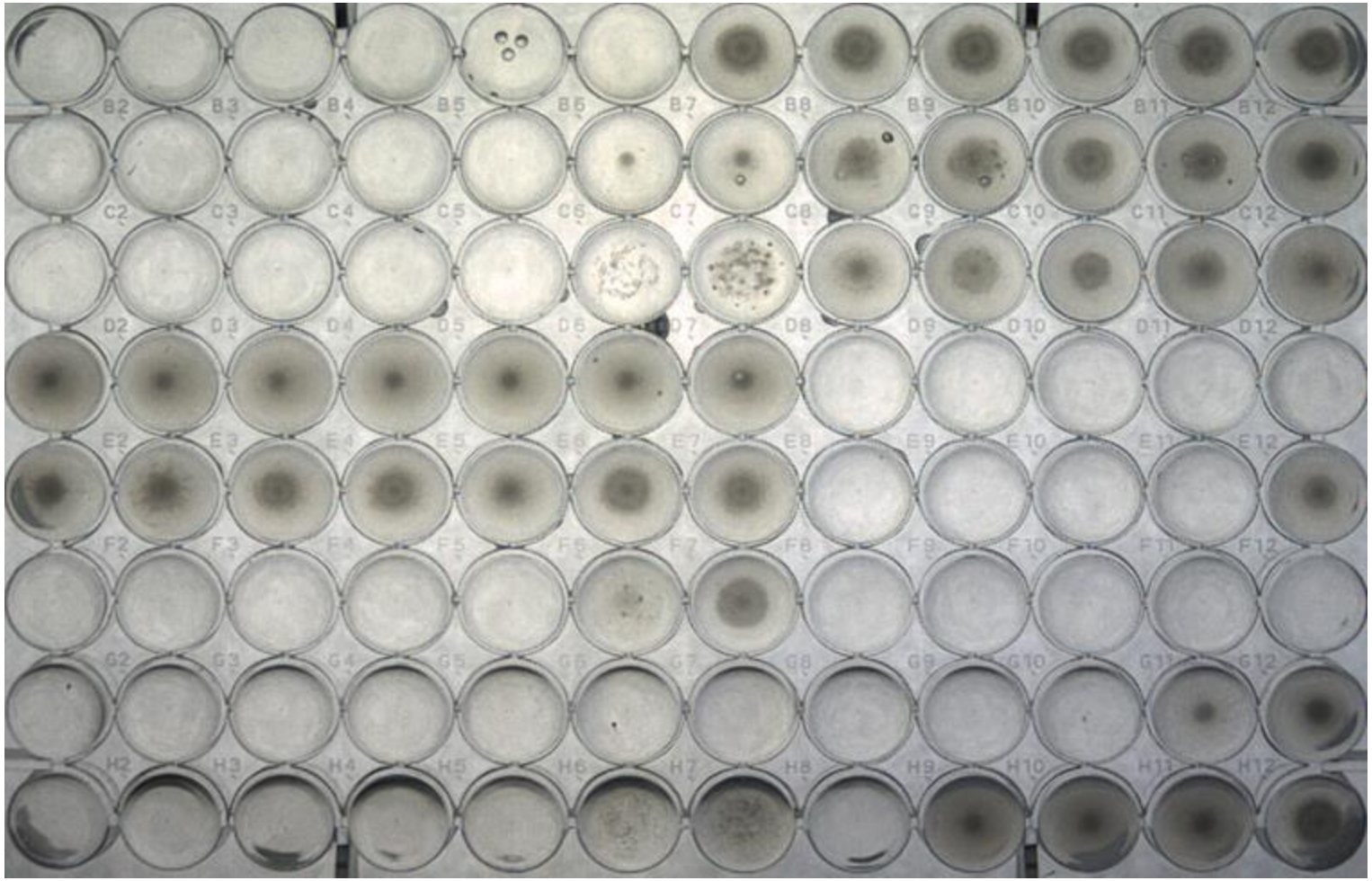


Results

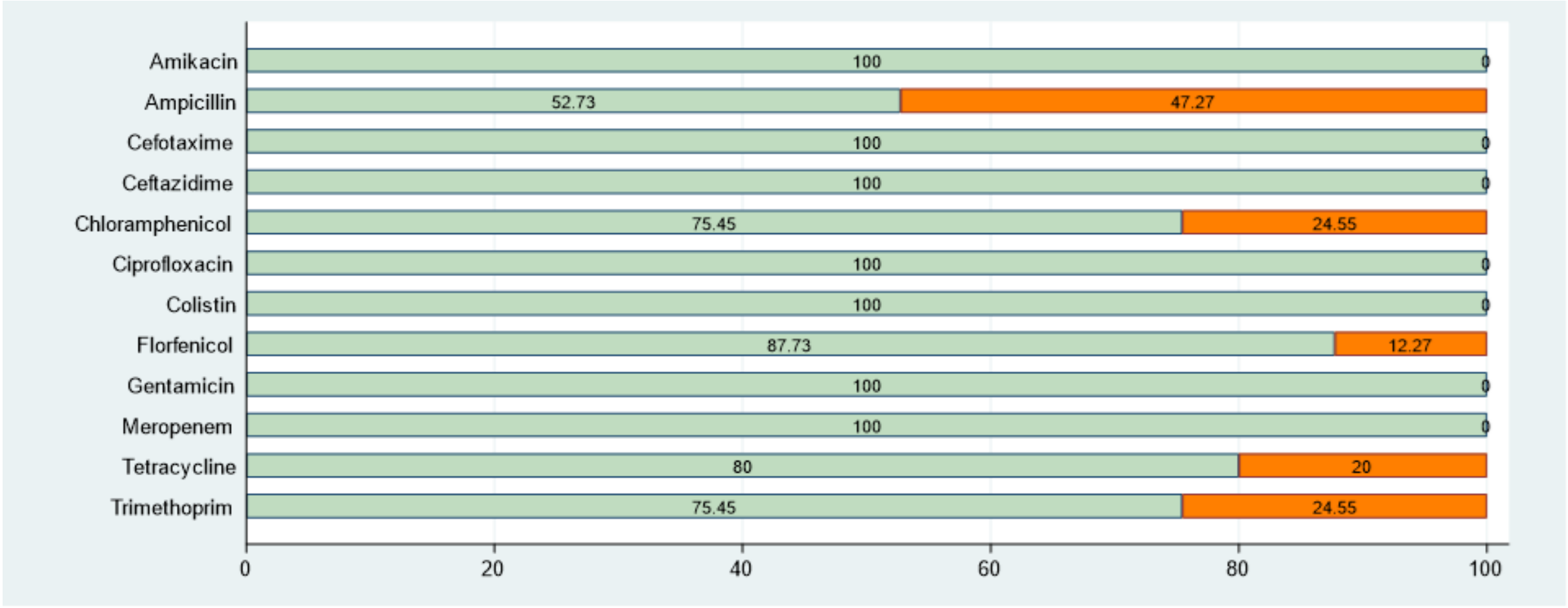
Farm based *Salmonella* carriage



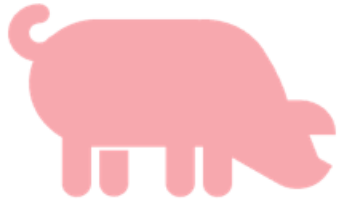
Antimicrobial Susceptibility Testing



AMR – *Salmonella enterica* (n=235)



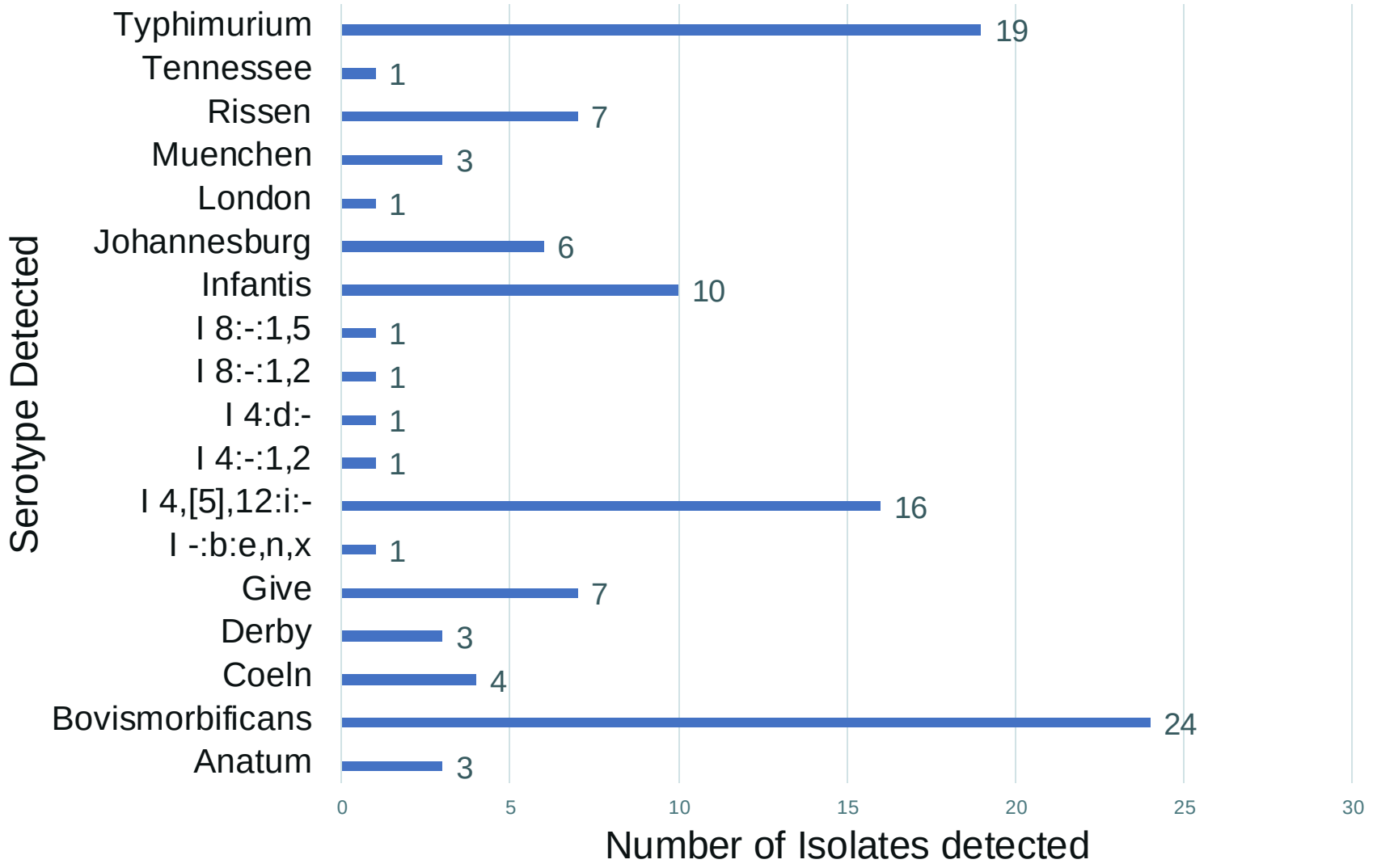
Resistance Phenotypes



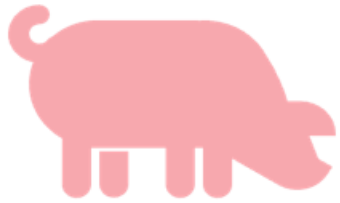
Phenotype	*Salmonella* n=235	
	n	%
nil	116	52.73
bla	33	15.00
bla_tet	17	7.73
bla_fpi_phe	27	12.27
bla_fpi_phe_tet	27	12.27

AMR profiles based on phenotypic analysis : bla – beta-lactams, tet – tetracyclines, fpi – folate pathway inhibitors, phe – phenicols

Serovar Diversity (n=109)



Serovar Distribution Per Farm



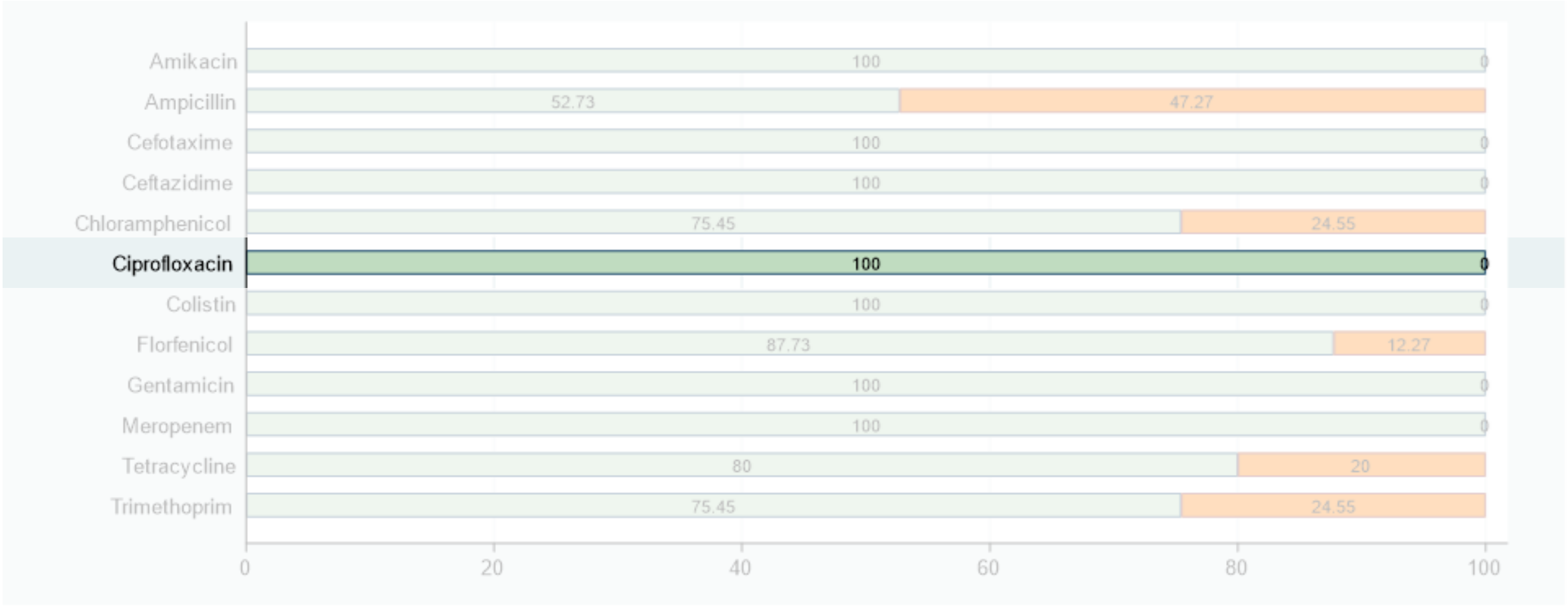
- Up to 4 different serovars in a single farm

Farm Number	Serotypes detected	Number
1001	Bovismorbificans	2
	I 4,[5],12:i:-	4
1002	Bovismorbificans	3
	Give	1
	Muenchen	1
	Tennessee	1
1003	Bovismorbificans	6
	Give	2
1004	I 4,[5],12:i:-	1
	Rissen	4
1005	Bovismorbificans	1
	Give	3
	I 4:d:-	1
1006	Coeln	1
	Infantis	5
	Typhimurium	3
1007	Give	1
	I 4,[5],12:i:-	1
	Infantis	4
1009	I 4,[5],12:i:-	4
1013	Bovismorbificans	10
	I 8:-:1,5	1
1014	Bovismorbificans	2
	Coeln	2
	I 4:-:1,2	1
	Typhimurium	4
1015	I 8:-:1,2	1
	Muenchen	2
	Rissen	2
1016	Coeln	1
	Typhimurium	11
1017	I 4,[5],12:i:-	1
	Rissen	1
1018	Derby	1
	Infantis	1
1019	I 4,[5],12:i:-	3
	Johannesburg	2
1020	Give	2
	I 4,[5],12:i:-	2
	London	2
1021	I -:b:e,n,x	1
	Johannesburg	4
1022	Anatum	3

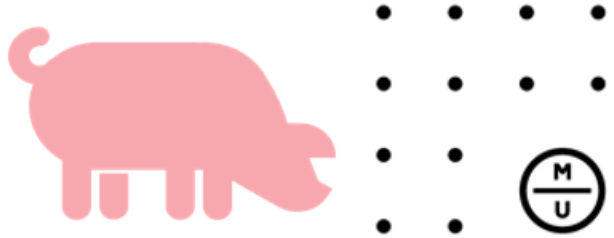
Results and Discussion – AMR Genes

Antimicrobial Class	*Salmonella* n=109	
	AMR genes	Frequency (%)
AMINOGLYCOSIDE	*aadA1*	18.35
	aadA2	15.60
	aph(3'')-Ib	11.93
	aph(6)-Id	11.93
BETA-LACTAM	*blaTEM-1*	31.19
EFFLUX	*mdsA*	79.82
	mdsB	79.82
FOSFOMYCIN	*fosA7.3*	1.83
PHENICOL	*cmlA1*	15.60
	floR	7.34
SULFONAMIDE	*sul2*	19.27
	sul3	17.43
TETRACYCLINE	*tet(A)*	8.26
	tet(B)	8.26
	tet(M)	2.75
TRIMETHOPRIM	*dfrA12*	15.60
QUINOLONE	*qnrS1*	8.26

AMR - *Salmonella enterica* (n=235)



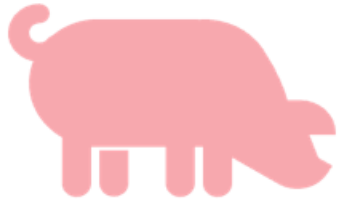
Conclusions



- High levels of *Salmonella* carriage in weaner pigs
- Low levels of antimicrobial resistance (no AMR detected in more than 50% of samples)
- No CIA resistance detected – positive outcome
- Resistance results are consistent with other Salmonella work in cattle and horses
- Wide variety of serovars detected

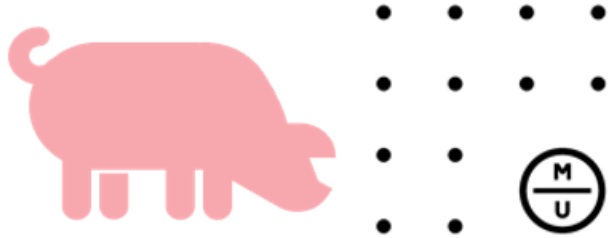
Abraham R, Sahibzada S, Jordan D, O'Dea M, Hampson DJ, McMillan K, et al. Antimicrobial resistance and genomic relationships of Salmonella enterica from Australian cattle. International Journal of Food Microbiology. 2022 Jun;371:109672.

Limitations and Future Direction



- Enrichment steps may have generated bias for certain serovars
- Single colony testing eliminated any potential for multiple strains to be found in any single fecal sample
- Only 5-15 isolates were selected for WGS per farm
- Not all districts across Australia were sampled – potentially not an accurate representation of *Salmonella* in weaners across the country

- Include as many as possible in all stages of testing (Prevalence, AST, WGS)



Thank you

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