Drug Use on the Farm & Antibiotic Resistance in Raw, Stored, & Treated Manures

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Cornell | PRO-DAIRY | Dairy Environmental Systems

Dairy Practices Council
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Task Force 1

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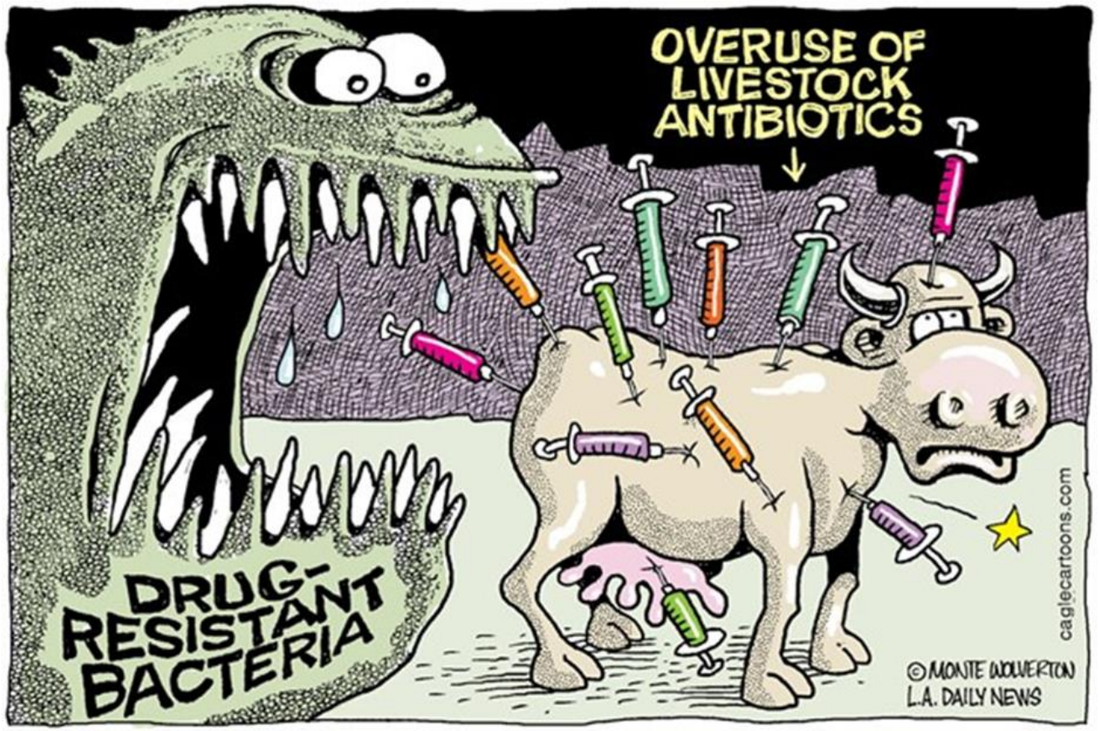
Outline

- What is Antibiotic Resistance?
- Antibiotic Use on Northeast Modern Dairy Farms
- Antibiotic Residues in Dairy Manure
- Antibiotic Resistance Genes in Dairy Manure



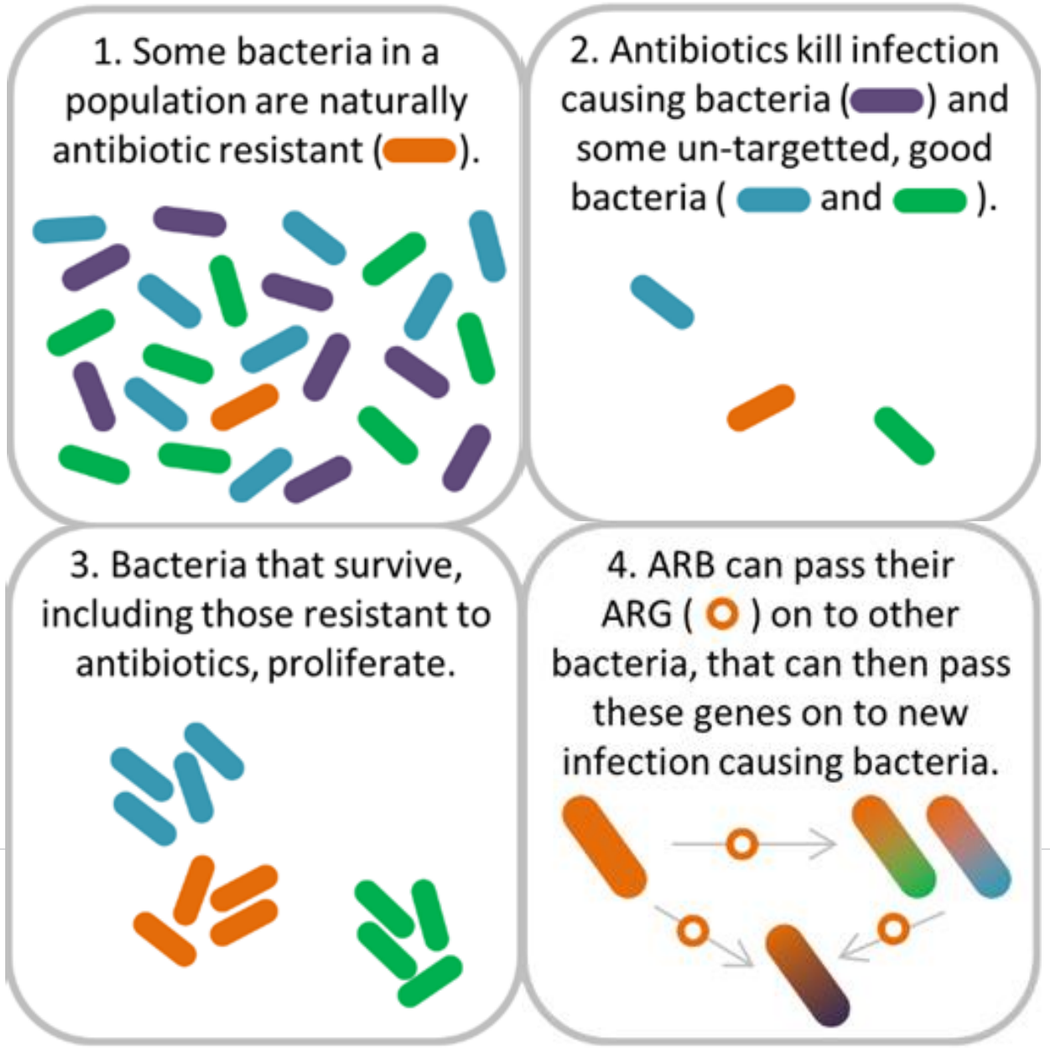
Antibiotic resistance (AR) is …

a natural process where previously susceptible bacteria develop the ability to resist the effects of an antibiotic.

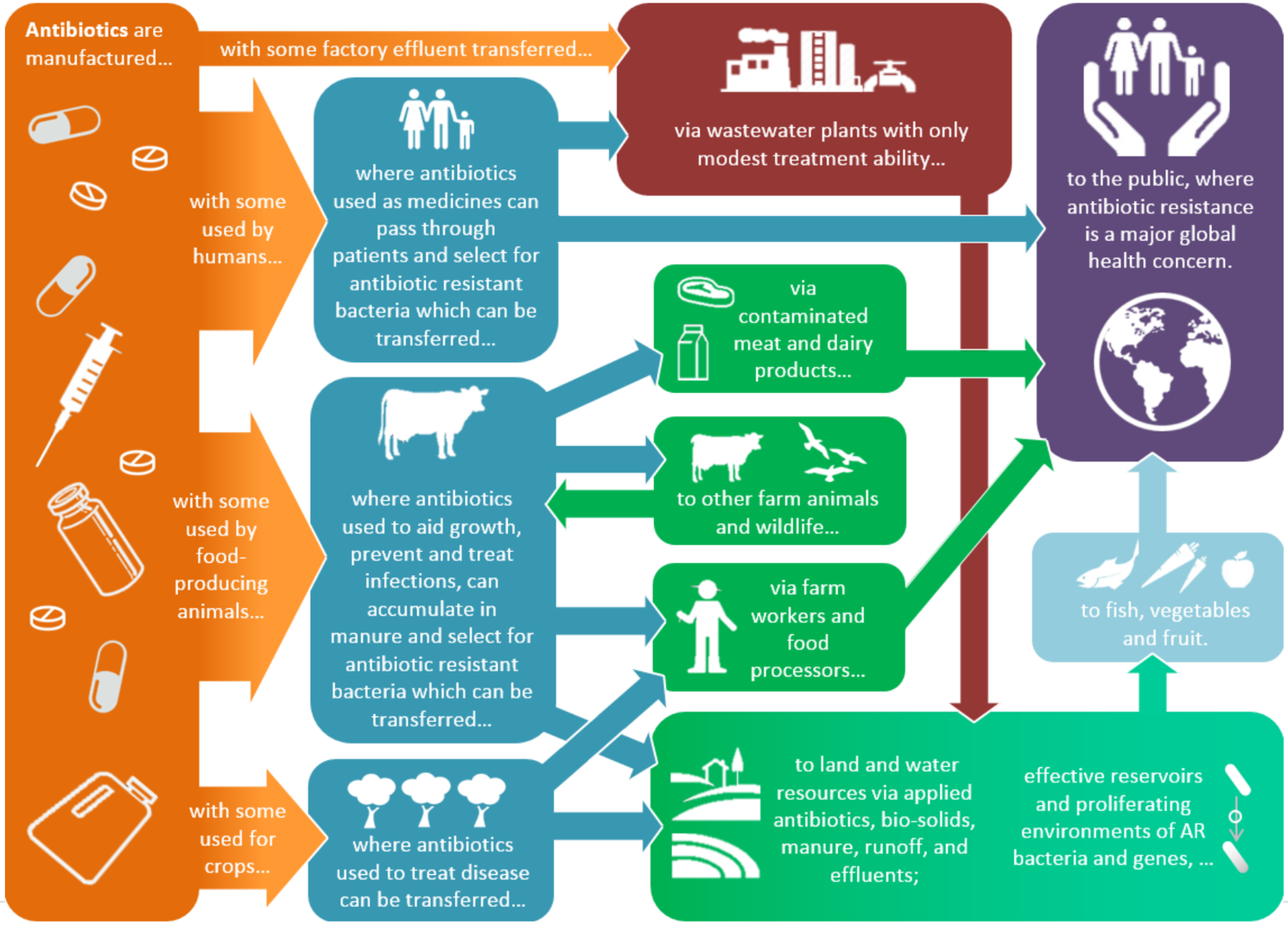
Antibiotic: chemical that kills or halts growth of bacteria

ARB: Antibiotic resistant bacteria. AR is not gained by the host (cow or human)!

ARG: Antibiotic resistance genes. Selected for by antibiotic, and horizontally spread!

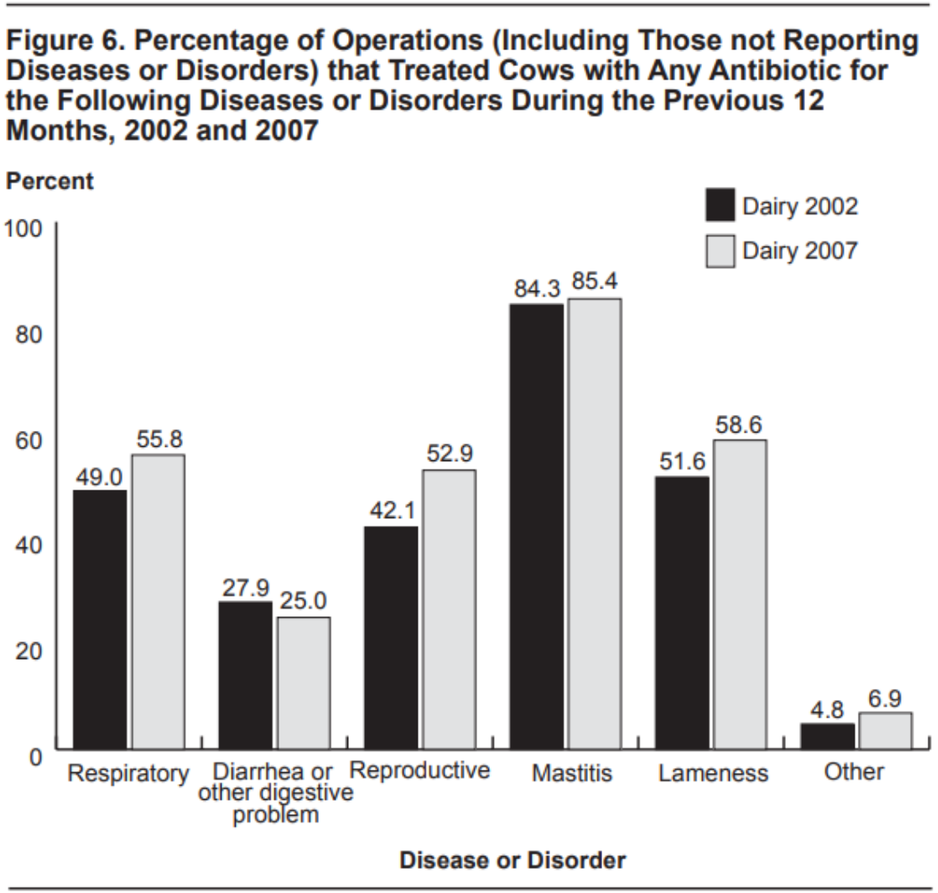


There are many influences on the spread of AR



Antibiotic use by modern dairies

- Therapeutic (Treat)
  - ~60% preweaned heifers
  - ~50% weaned heifers
  - ~85% cows for mastitis
- Prophylactic (Prevent)
  - ~60% medicated milk replacer
  - ~90% dry-off treatments
- Production
  - ~45% ionophores in feed
  - ~20% antibiotics in feed



☐ APHIS. 2008. Antibiotic Use on U.S. Dairy Operations, 2002 and 2007

Antibiotic use for cows at six NYS dairy farms

Drug Class	Antibiotic	Trade Name	Usage																		
			Mastitis				Reproductive			Foot/Lame/Injury				Enteric			Other				
			Dry	Mast.	Syst. mast.	Toxic	RP	Met.	Birth/ C-sect.	Foot rot	Feet	Lame	Injury/ Trauma	DA	Indig.	Diarhea	Resp./ Pneu.	Fever	Pink eye	Metaphyl	Other
Aminocoumarin	Novobiocin	AlbaDry Plus	2																		
Aminoglycosidases	Dihydrostreptomycin Sulfate	Quartermaster	3																		
	Neomycin	Neomycin																	1		
Amphenicol	Florfenicol *	Nuflor										1	1				3				1
	Florfenicol *	Resflor															3				1
Cephalosphorins	Ceftiofur Sodium *	Naxcel		1			2	1						1	1		3				
	Ceftiofur Hydrochloride *	Spectramast LC		5																	
	Ceftiofur Hydrochloride *	Spectramast DC	4																		
	Ceftiofur Hydrochloride *	Excenel		1	1	1	3	5	1	3				4	1		4	3			2
	Ceftiofur Crystalline Free Acid *	Excede		1			3	5	1	2		1		1	1	1	4	2		1	1
	Cephapirin Sodium	ToDay		2																	
Lincosamides	Pirlimycin Hydrochloride	Pirsue		5																	
Macrolides	Erythromycin	Erythromycin																			
	Tildipirosin *	Zuprevo																		1	
	Tulathromycin *	Draxxin															4				1
	Tylosin *	Tylosin								1											
Penicillins	Amoxicillin Trihydrate	AmoxiMast	1	4	1						1										
	Ampicillin	Polyflex		2	1		4	4	2	2	2		1	4	1		5	1	1		1
	Ampicillin	Hetacin		1																	
	Cloxacillin Benzathine	Dryclox	2																		
	Cloxacillin Benzathine	Orbenin	2																		
	Hetacillin Potassium	Polymast		1																	
	Penicillin G	Penicillin		1			2	2	1	1	1		3				1	2			2
	Penicillin G	AlbaDry Plus	2																		
	Penicillin G	Quartermaster	3																		
Sulfonamides	Sulfadimethoxine	Albon								1										1	
Tetracyclines	Oxytetracycline	LA 200		1	1		2	2	1	1	2	1	1		1		2	1	1		1
	Oxytetracycline	TETROXY® 343									1	1									
	Oxytetracycline	Biomycin 200					2	3	2	1	2	1	1				2	1	1	1	2
	Oxytetracycline	Oxytet 100									1										
	Tetracycline	SP 324 POWDER								1	1										
Quinolones	Enrofloxacillin *	Baytril															1				

Critically important
Highly important
according to WHO

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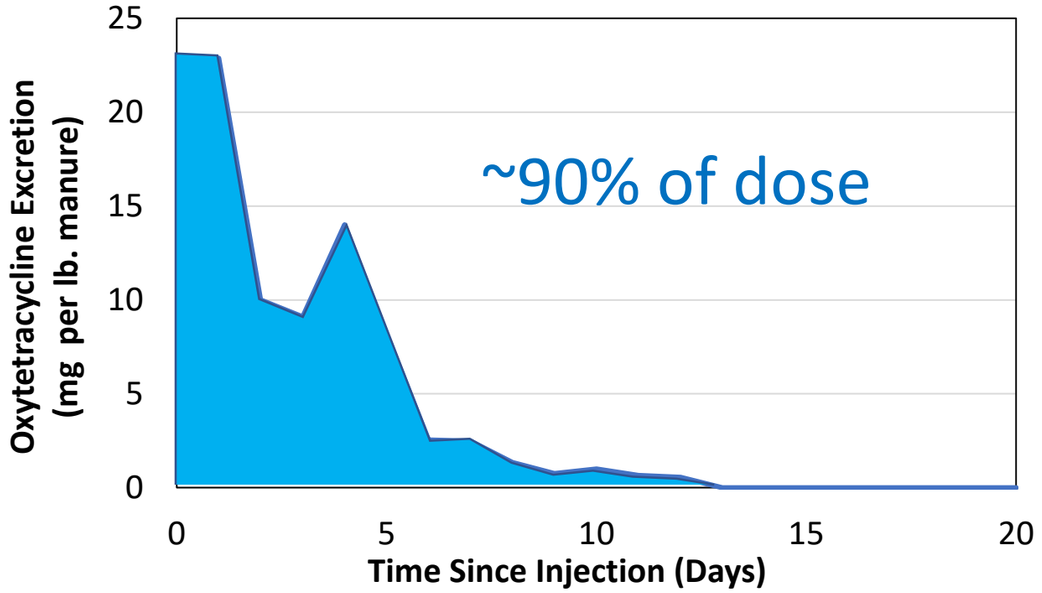
Fate of administered antibiotics



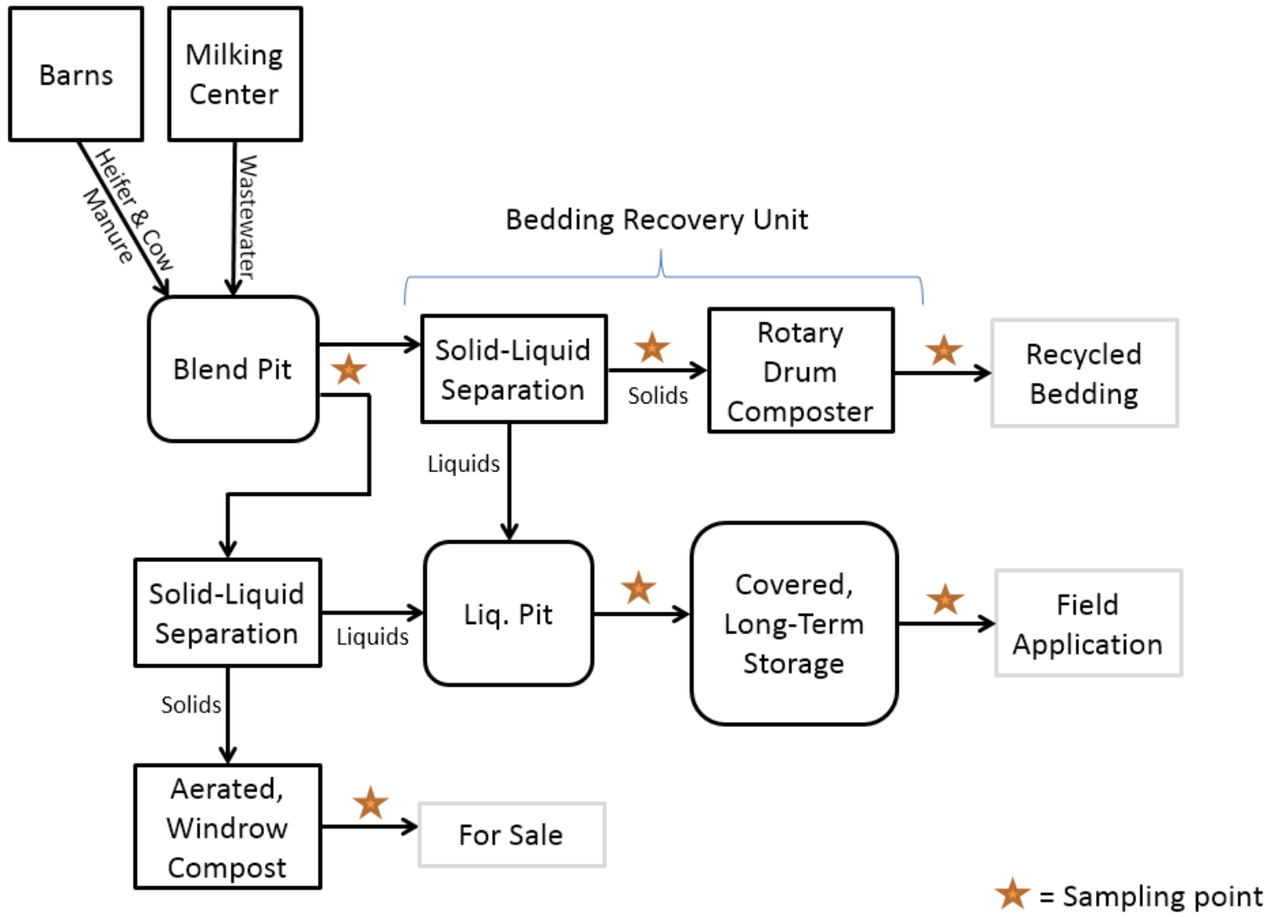
Excretion of oxytetracycline (OTC) in feces of a 3.5 year old, 970 pound Holstein cow following 8,800 mg injection.

(OTC has 96 hr. milk & 28 d meat withholds)

☐ Ince et al. 2013. *Bioprocess & Biosystems Engineering* 36:541–546

- B-lactams (Pen. & Ceph.): very susceptible to degradation
- Macrolides: persistent, recalcitrant
- Tetracyclines: persistent, mobile
- Sulfonamides: soluble

Sampling manure for antibiotic residues



- 6 NY, 2 PA, 3 MD dairies
- Sample pre- and post-manure treatments every ~6 weeks for 1 year
- Tested for:

  penicillins (none detected)
  cephalosporins (none detected)
  tetracyclines (≤ 2,000 ng/g TS)
  sulfonamides (≤ 400 ng/g TS)
  macrolides (≤ 2000 ng/g TS)

Targetting ARGs

Gene	Description
mefA	Macrolide Lincosamide Streptogramin_b
ermB	Macrolide Lincosamide Streptogramin_b
ereB	Erythromycin resistance
tetA	Tetracycline efflux pump
OXA-2 Group	Class D beta-lactamase
CTX-M-1-Group	Class A beta-lactamase
VEB	Class A beta-lactamase
aadA1	Aminoglycoside-resistance
AAC(6)-Ib	Aminoglycoside resistance

Sul1	Sulfonamide resistance
TetO	Tetracycline resistance
OXA-1	Class D beta-lactamase
Int1	Integrase 1

Several other ongoing efforts

- Anaerobic digester trials
  - Bench-scale spike experiments
  - Pilot-scale test system

Crop uptake

Growth chamber w/ manure amendments

- Outreach/Extension

Cornell University

Dairy Environmental Systems Program

www.manuremanagement.cornell.edu

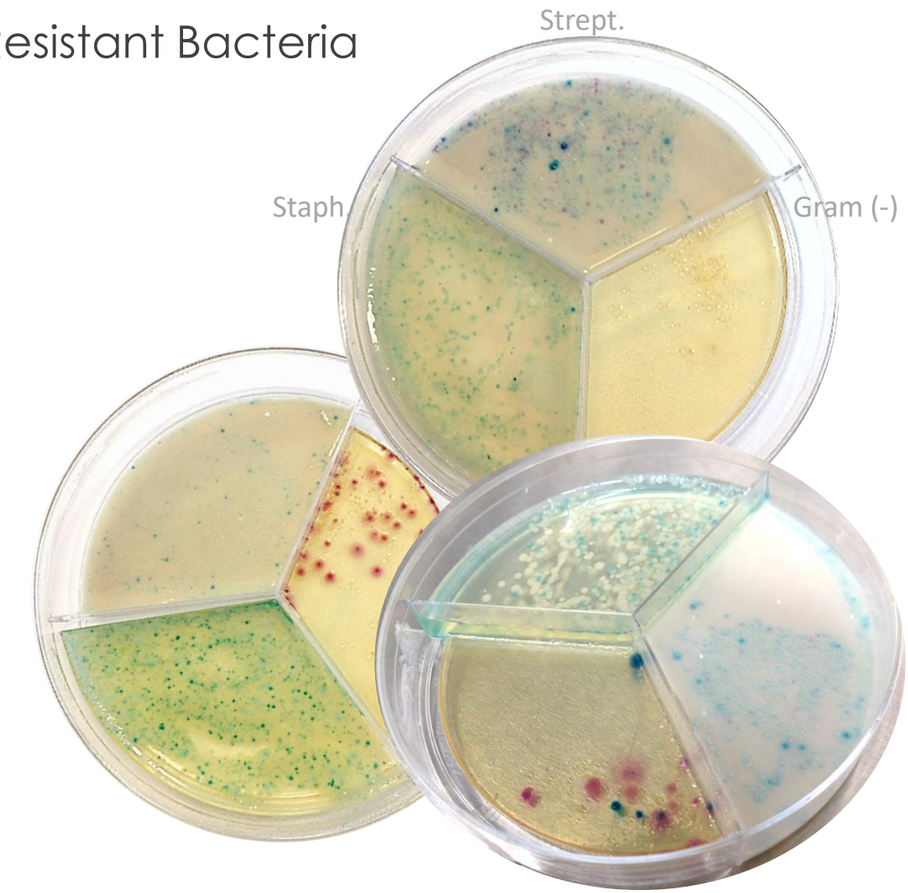
ANTIBIOTIC RESISTANCE AND DAIRY PRODUCTION

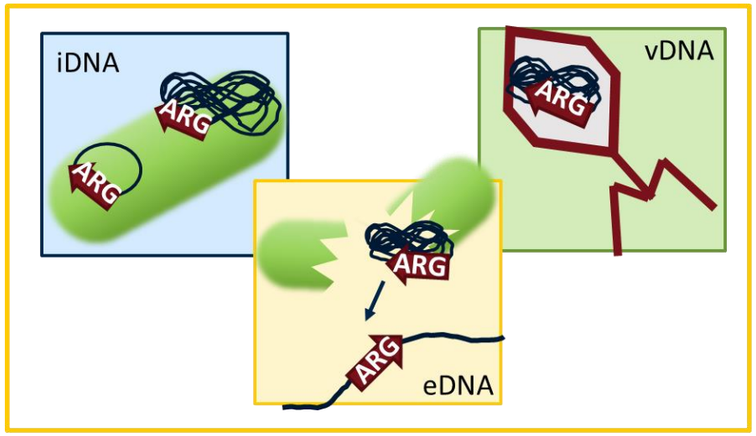
- FACT SHEET* -

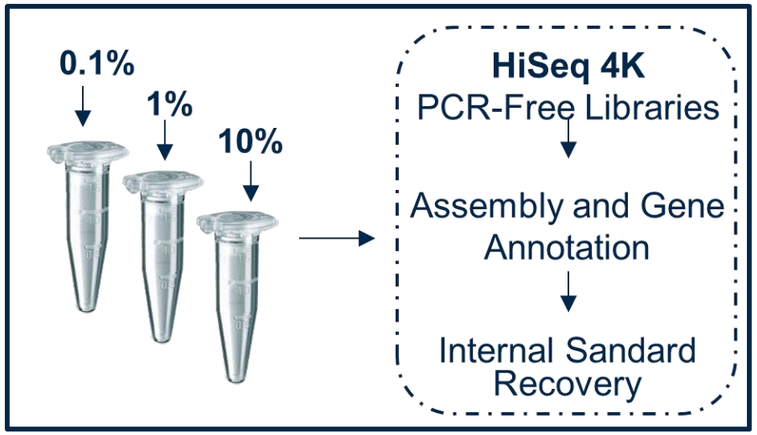
PRO-DAIRY

- Modeling the fate of antibiotics

- Antibiotic Resistant Bacteria







1. ARGs on Mobile Genetic Elements

Process: Compare ARGs in isolated fractions of DNA with qPCR to understand dynamics of ARGs in different DNA fractions.
Outcomes: Recommendations for treatment strategies to target persistent gene forms.

2. Quantitative Metagenomics

Process: Screen for ARGs of interest in manure samples using a quantitative metagenomic approach.

Outcomes: Quantity and identity of ARGs in manure.

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