Existing AMR surveillance programme in livestock in India and suggestions for future framework

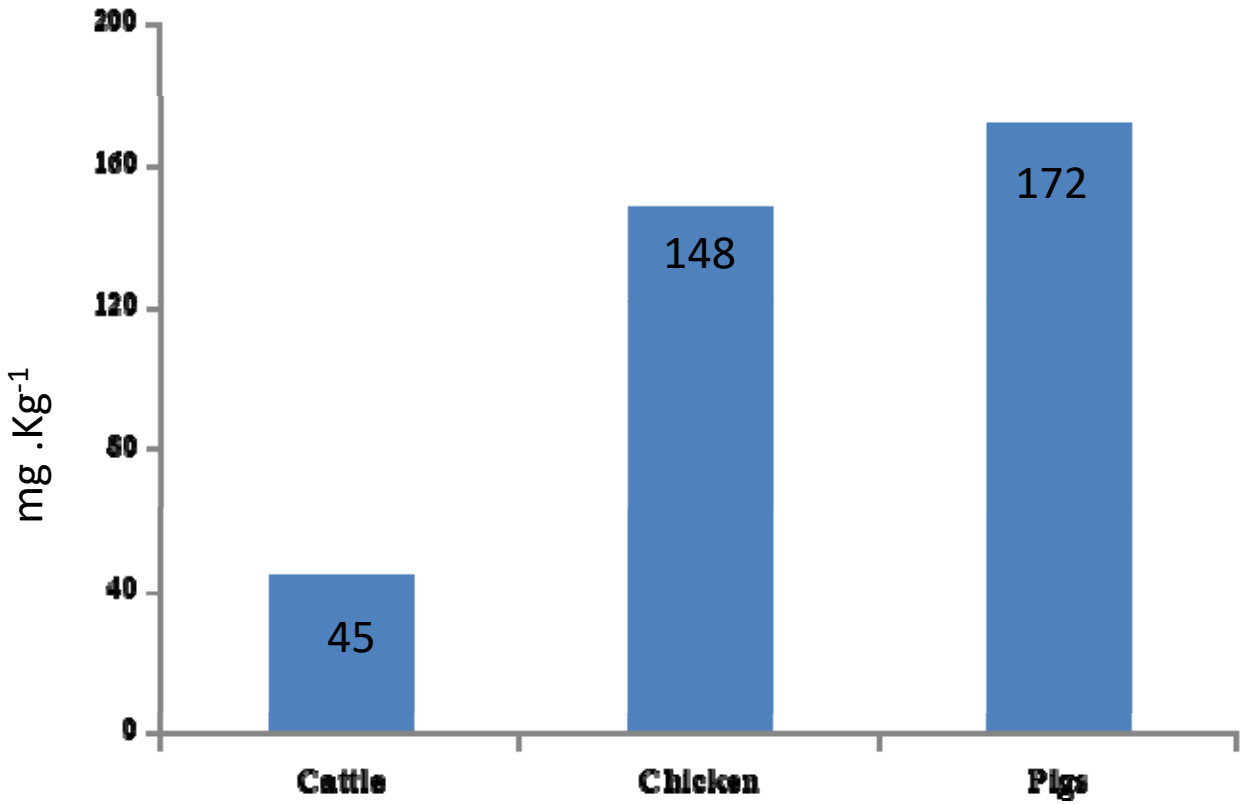
Samiran Bandyopadhyay
ICAR-Indian Veterinary Research Institute
samiranvet@gmail.com

Existing AMR surveillance

Use of antibiotics in animals

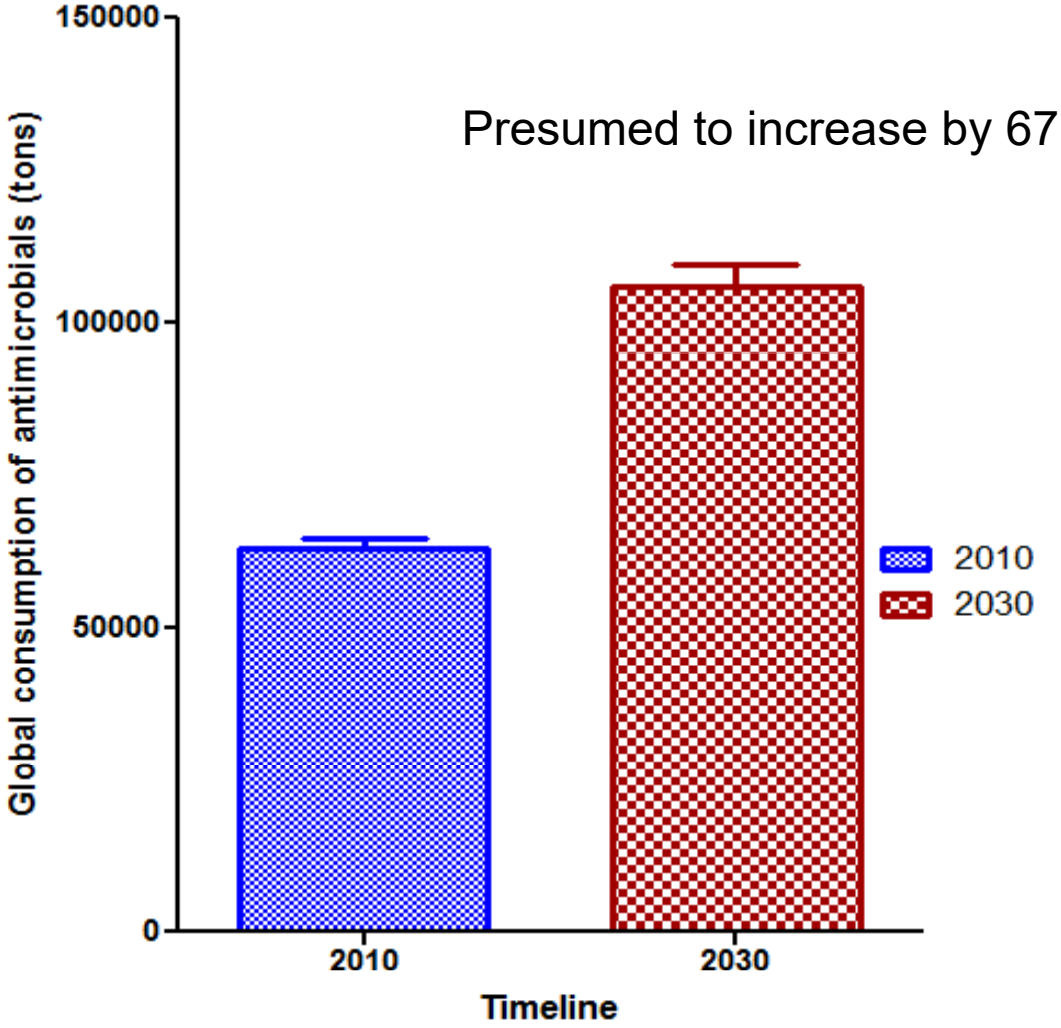
- Both in food and pet animals antibiotics are used.
- Concern regarding use of antibiotics specially in poultry feed.
- Reserve antibiotics are reportedly used in poultry rearing.
- By 2030 there is an estimated increase of antibiotic consumption by 99% in BRICS countries.
- **In many cases owners and farmers can not afford antibiotics** although, India accounted for 3% (4th largest) of global consumption of antibiotics in food animals behind China(23%), USA (13%) and Brazil (9%), in comparison to India with largest population of diverse livestock species.

Global average annual consumption of antimicrobials per kilogram of animal produced



Boeckel et al., 2015, PNAS 112(18): 5649–5654, doi: 10.1073/

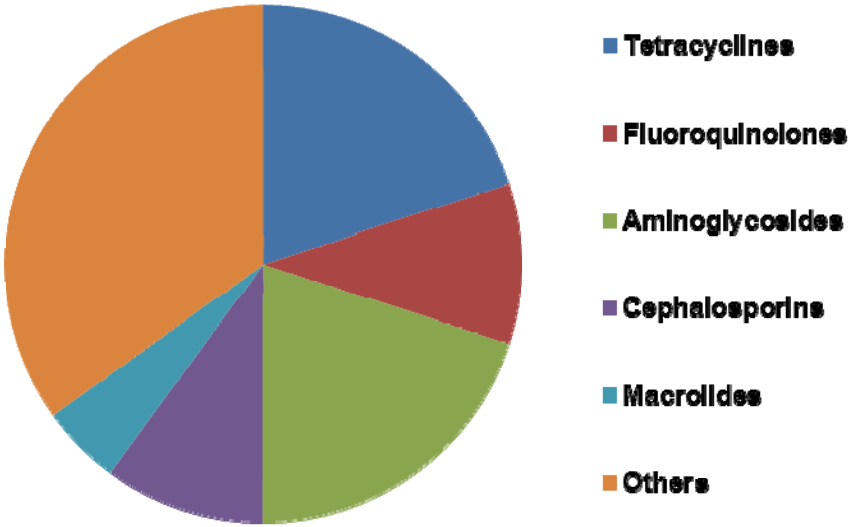
Global trends in antimicrobial use in food animals



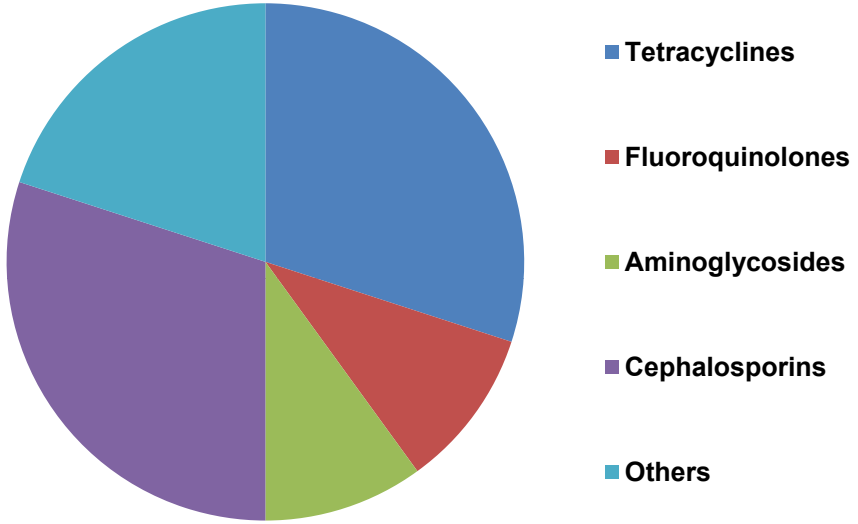
Presumed to increase by 67%

Boeckel et al., 2015, PNAS 112(18): 5649–5654, doi: 10.1073/pr

No quantifiable data is available for use of antimicrobials in animals



Poultry



Lactating cattle

Proportion of different classes of antibiotics used in animals, WB,

Data based on personal communication in few areas of WB, India

AMR surveillance

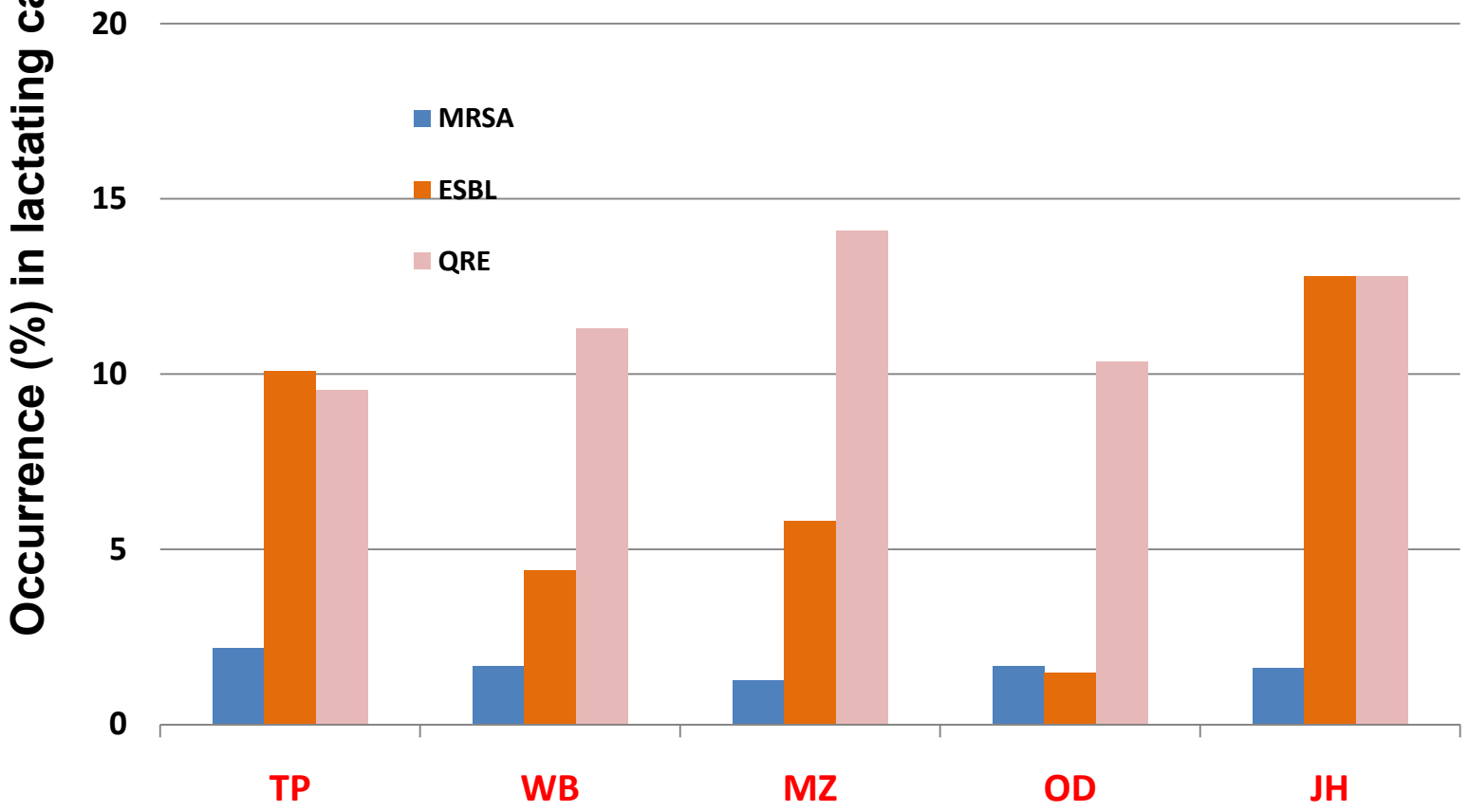
- (INSAR) (2009-2012) network of 20 labs with WHO support
- MoHFW/NCDC : AMR surveillance network (10 labs)
- ICMR : AMR Surveillance Network (4 institutions/6 labs)
- Veterinary/Agriculture sector – no organized AMR surveillance and at its infancy

Bad Bugs in animal

- Extended spectrum β-lactamase producers
- AmpC type β-lactamase producers
- Fluroquinolone resistant *enterobacteriaceae*
- Methicillin resistant *S. aureus* and CoNS
- Mettalo-β-lactamase producing *enterobacteriaceae* (EC & KP)
- Vancomycin resistant and intermediate *S. aureus*
- Colistin resistant *enterobacteriaceae*

Their trends .

MRSA, ESBL and quinolone resistant *enterobacteriaceae* in lactating cattl in eastern and NE India during 2012 to till date, ICAR-IVRI



TP: Tripura, WB: West Bengal, MZ: Mizoram, OD: Odisha, JH: Jharkhan

The occurrence of MRSA in food animal in India is s

Sl No	States	Species	Occurrence mean (%) (range with 95% CI)**	SCC*mec* c*	SPA*	MLST*
1	Tripura	Lactating cattle	2.17 (1.14-3.74)	SCC*mec* type IVa,V and NT	t005, t202, t267, t524, t527, t740, t800, t852, t3626, t4463, t4931, and t6297	ST-63, ST-71, ST-97, ST-2219, ST-1297,
2	Mizoram	Lactating cattle	1.26 (0.46 – 2.78)			
3	Haryana	Lactating cattle	5.64 (2.4-10.8)			
4	West Bengal	Lactating cattle and goats	1.66 (1.06 -2.9)		**Novel spa type** t15798 (caprine) t16344 (buffalo)	
		Pigs	3.27 (1.5-6.13)			
		Buffalo	0.84 (0.3-2.01)			
5.	Odisha	Lactating cattle	1.66 (0.28 – 5.3)			

* The data reflects analysis from representative samples ** Fisher Exact test (Clopper-Pearson)

olone resistant *enterobacteriaceae* (*E. coli* and *K. pneumoniae*) in fo

Sl No	States	Species	Occurrence mean (%) (range with 95% CI)*	PMQR	Efflux pumps	QRDR
1	Tripura	Lactating cattle	9.56 (6.03-14.8)[a]	qnrA, qnrB, qnrS, aac(6′)-Ib-cr	QepA AcrAB	Mutation in *gyrA* and *ParC*
2	Mizoram	Lactating cattle	14.1 (8.06–23.5)[a]			
3	West Bengal	Lactating cattle	11.3 (7.28 - 17.1)[a]			
		Poultry	19.56 (15.2-24.7) [b]			
		Buffalo	2.3 (1.29-4.09)[a]			
4	Jharkhand	Lactating cattle	12.8 (6.6-22.7)[a]			
		poultry	20.9 (12.9 – 32) [b]			

*Score(Wilson) with Fleiss Quadratic Correction

[a] Among ESBL producers only; [b] on basis of Phe
[b] differs significantly (P =0.01)

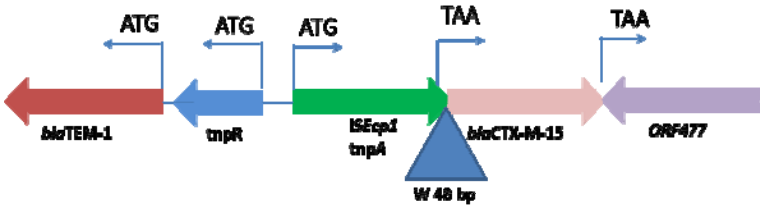
L and MBL *enterobacteriaceae* (*E. coli* and *K. pneumoniae*) in fo

Sl No	States	Species	Occurrence mean (%) (range with 95% CI)*			
			ESBL	**ACBL**	**MBL**	**Resistance determinants**
1.	Tripura	Lactating cattle	10.1 (6.6-15)	6.06 (3.5-10.3)	NDM-5 (2) *bla*NDM was reported in diary animals (Ghatak et al., 2013) and in pigs (Pruthvishree et al., 2017)	*bla*CTXM-15, *bla*CTX-M-63, *bla*CTX-M-9, *bla*TEM-1, *bla*SHV-12, *bla*AmpC, *bla*MOX, *int1* possessing *dfrA12/17* and *aad2/aad5* *sul-1*
2.	Mizoram	Lactating cattle	5.8 (2.4-12.7)	4.8 (1.8-11.5)		
3.	West Bengal	Lactating cattle	4.4 (1.9-9.2)	4.4 (1.9-9.2)		
		Buffalo	2.3 (1.29-4.09)	1.47 (0.6-3.14)		
		Poultry	14.5 (9.5-21.1)	20.1 (14.6-27)		
		pigs	6 (3.2-10.5)			
4.	Jharkhand	Lactating cattle	12.8 (6.6-22.7)	10.2 (4.8-19.7)		

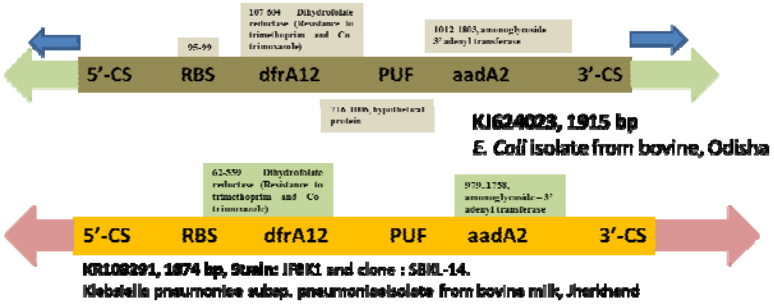
*Score(Wilson) with Fleiss Quadratic Correction

teristics of ESBL producers in food animals fro

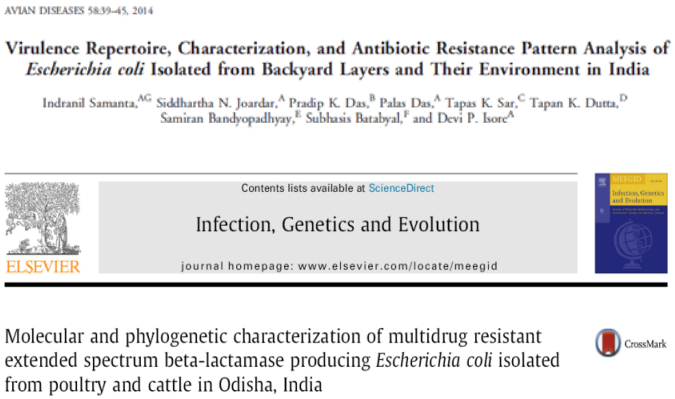
- The isolates were detected among dairy animals, organized poultry and piggery sector
- Most of the isolates carried multiple ESBL genes.
- The genes *bla*CTX-M-15, *bla*CTX-M-9, *bla*SHV-12 and non ESBL gene *bla*TEM-1 were more common.
- Presence of multiple resistance gene cassettes (*dfrA* and *aadA*) leads to MDR phenomenon



Genetic environment of *bla*CTX-M-15 gene of bovine isolate from eastern and north eastern States, India, KT824860, KT824861



Organization of gene cassette in the class 1 integron of MDR ESBL producing *Klebsiella pneumoniae* isolates from cattle milk of Eastern and North-eastern India



AVIAN DISEASES 58:39–45, 2014

Virulence Repertoire, Characterization, and Antibiotic Resistance Pattern Analysis of *Escherichia coli* Isolated from Backyard Layers and Their Environment in India

Indranil Samanta,[AG] Siddhartha N. Joardar,[A] Pradip K. Das,[B] Palas Das,[A] Tapas K. Sar,[C] Tapan K. Dutta,[D] Samiran Bandyopadhyay,[E] Subhasis Batabyal,[E] and Devi P. Isore[A]

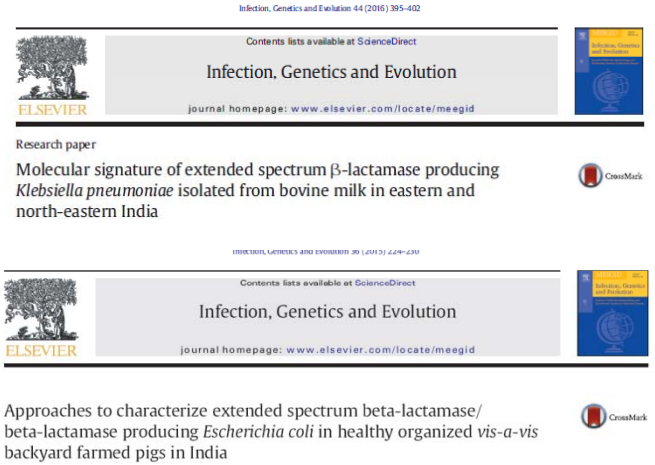
Contents lists available at ScienceDirect

Infection, Genetics and Evolution

journal homepage: www.elsevier.com/locate/meegid

ELSEVIER

Molecular and phylogenetic characterization of multidrug resistant extended spectrum beta-lactamase producing *Escherichia coli* isolated from poultry and cattle in Odisha, India



Infection, Genetics and Evolution 44 (2016) 395–402

Contents lists available at ScienceDirect

Infection, Genetics and Evolution

journal homepage: www.elsevier.com/locate/meegid

ELSEVIER

Research paper

Molecular signature of extended spectrum β-lactamase producing *Klebsiella pneumoniae* isolated from bovine milk in eastern and north-eastern India

Contents lists available at ScienceDirect

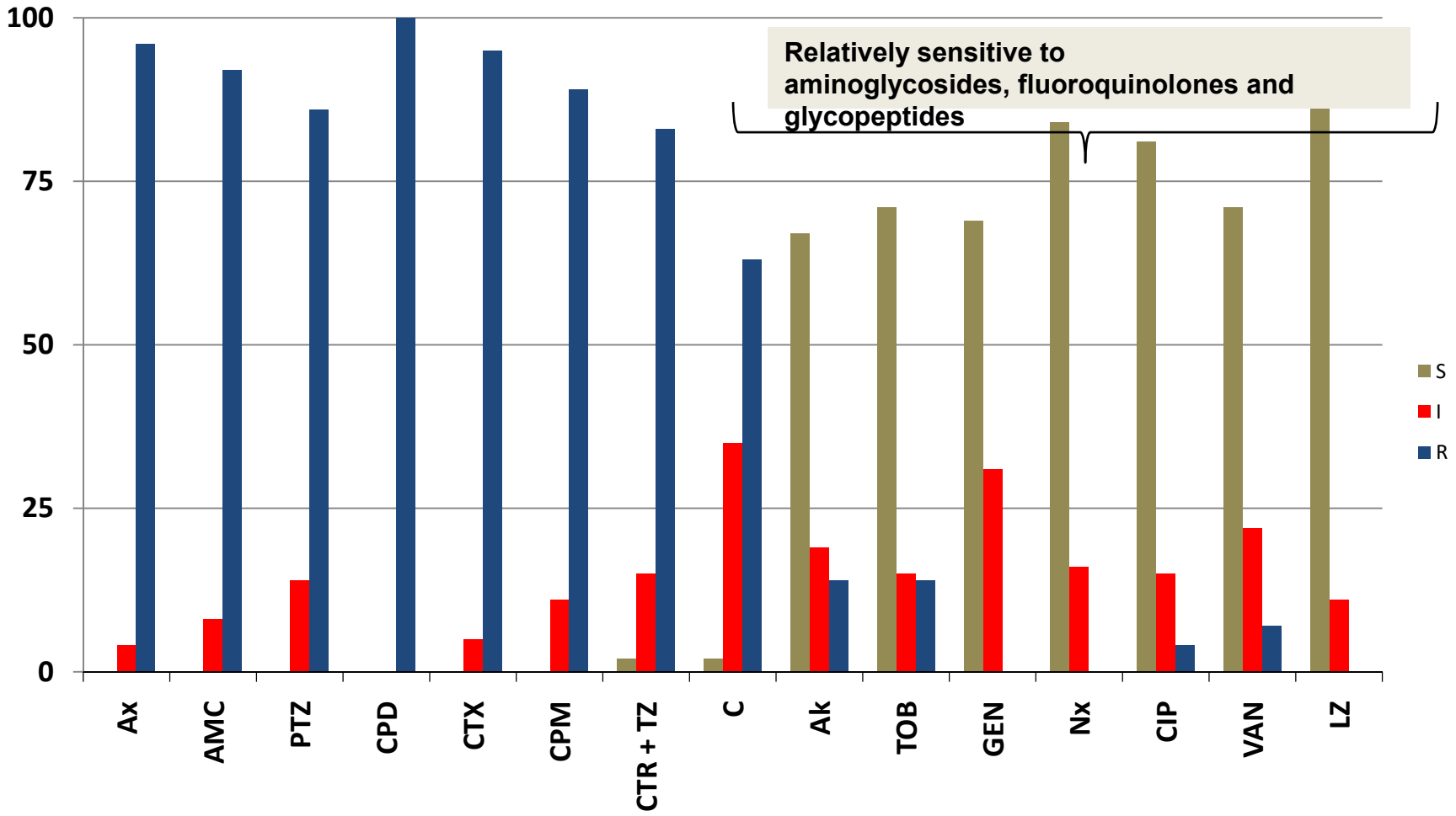
Infection, Genetics and Evolution

journal homepage: www.elsevier.com/locate/meegid

ELSEVIER

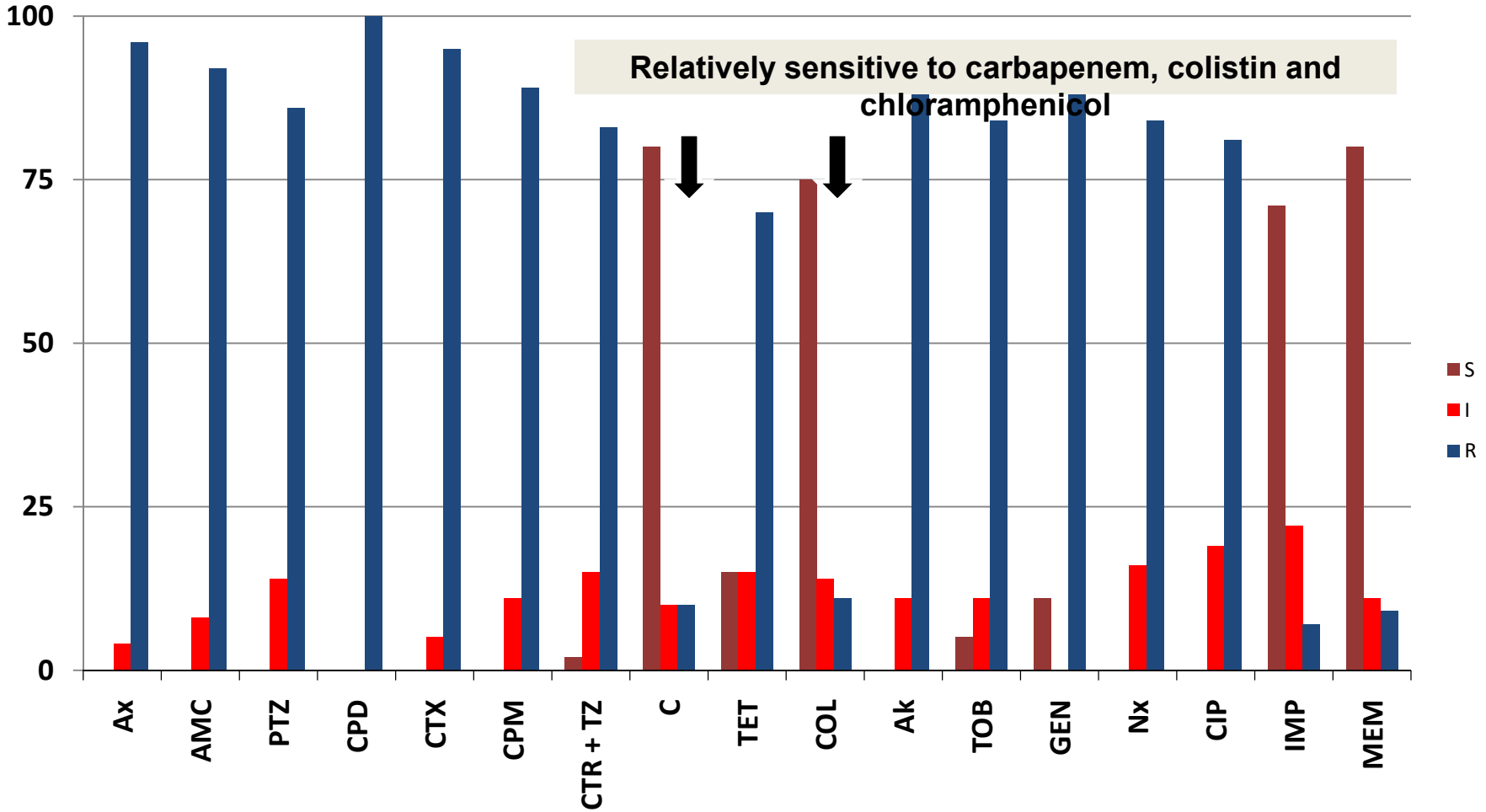
Approaches to characterize extended spectrum beta-lactamase/ beta-lactamase producing *Escherichia coli* in healthy organized *vis-a-vis* backyard farmed pigs in India

# of resistance pattern of MRSA isolates from lactating cattle of eastern and N (2012- till date, ICAR-IVRI)



Resistant to beta-lactam or potentiated beta-lactam and macrolides

of resistance pattern of ESBL producers from lactating cattle of eastern and
(2012- till date, ICAR-IVRI)



to beta-lactam or potentiated beta-lactam, tetracycline, aminoglycosides and fluoroc

o-infection of . \ . and . producers are frequent cause of therapeutic failure in animals

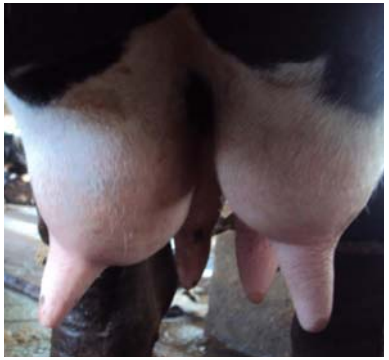
Veterinary Quarterly, 2014
http://dx.doi.org/10.1080/01652176.2014.984365

Taylor & Francis

CASE SERIES

Co-infection of methicillin-resistant *Staphylococcus epidermidis*, methicillin-resistant *Staphylococcus aureus* and extended spectrum β-lactamase producing *Escherichia coli* in bovine mastitis – three cases reported from India

Samiran Bandyopadhyay[a]*, Indranil Samanta[b], Debaraj Bhattacharyya[a], Pramod Kumar Nanda[a], Debasish Kar[a], Jayanta Chowdhury[c], Premanshu Dandapat[a], Arun Kumar Das[a], Nayan Batul[d], Bimalendu Mondal[a], Tapan Kumar Dutta[c], Gunjan Das[c], Bikash Chandra Das[a], Syamal Naskar[a], Uttam Kumar Bandyopadhyay[a], Suresh Chandra Das[a] and Subhasish Bandyopadhyay[a]



VRSA and VISA in animals; possible Zooanthroponosis or other mechanism lying ?

MICROBIAL DRUG RESISTANCE
Volume 00, Number 00, 2016

DOI: 10.1089/mdr.2015.0330

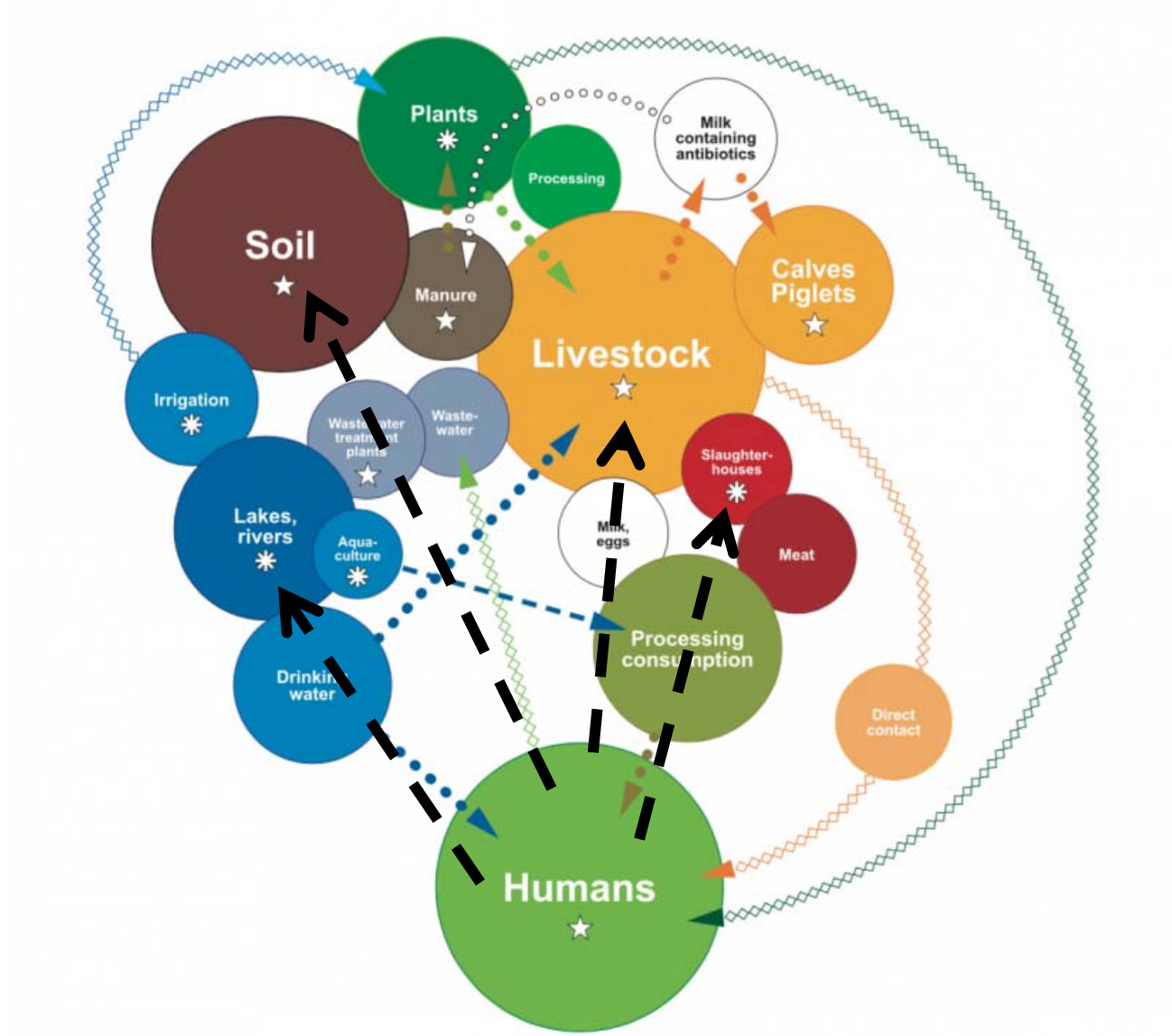
First Report on Vancomycin-Resistant *Staphylococcus aureus* in Bovine and Caprine Milk

Debaraj Bhattacharyya,[1] Jaydeep Banerjee,[1] Samiran Bandyopadhyay,[1] Bimalendu Mondal,[1] Pramod K. Nanda,[1] Indranil Samanta,[2] Achintya Mahanti,[2] Arun K. Das,[1] Gunjan Das,[3] Premanshu Dandapat,[1] and Subhasish Bandyopadhyay[1]

TABLE 1. CHARACTERISTICS OF VANCOMYCIN-RESISTANT AND INTERMEDIATE *STAPHYLOCOCCUS AUREUS* ISOLATED FROM MILK OF BOVINE AND CAPRINE CLINICAL AND SUBCLINICAL MASTITIS

				Genetic characterization							*Antibiotic resistance profile*[a]							
Sl. no.	*Isolates*	*Districts*	*Host*	*mecA*	*mecC*	*coa*	*nuc*	*spa*	*vanA*	*vanB*	*Resistant to*	MIC_{van} (μg/ml)	MIC_{oxa} (μg/ml)	MIC_{cef} (μg/ml)	*SCC*mec	*ERIC profile*	*Ridom/spa type (allelic variation)*
1	VRSA1	Nadia	Cow	P	N	P	P	P	N	N	AK (I), AMC, CTR, CIP (I), PB, PIT, TET	8.0	64	16	NT	B	NT[b]U1:K1:G1: J1:A1:E1r07:r16: r12:r23:r02:r13
2	VRSA2	Malda	Goat	P	N	P	P	P	N	N	AK (I), AMC, Co, CTR (I), PB,	32.0	>256	64	V	A	t527U1:J1:G1:F1:M1: B1:B1:B1:B1:B1: P1:B1r07:r23:r12: r21:r17:r34:r34:r34: r34:r34:r33:r34
3	VRSA3	Kolkata	Cow	P	N	P	P	P	N	N	AK, AMC (I), Co, CTR(I), Cd	16.0	64	64	V	B	t267U1:J1:G1:F1:M1: B1:B1:B1:P1:B1 r07:r23:r12:r21:r17: r34:r34:r34:r33:r34
4	VRSA4	Kolkata	Cow	P	N	P	P	P	N	N	Co, PIT (I)	8.0	32.0	16.0	V	B	t267U1:J1:G1:F1:M1: B1:B1:B1:P1:B1 r07:r23:r12:r21:r17: r34:r34:r34:r33:r34
5	VRSA5	North 24 Parganas	Cow	P	N	P	P	P	N	N	CTR (I), Cd	8.0	32.0	32.0	NT	C	t3626U1:J1:G1:F1: M1:B1:B1:B1:P1 r07:r23:r12:r21:r17: r34:r34:r34:r33
6	VRSA6	Nadia	Cow	P	N	P	P	P	N	N	AMC (I), Cd, Co, CTR(I)	8.0	>256	16.0	NT	D	t800U1:K1:G1: J1:A1:G1: J1:A1:B1r07:r16: r12:r23:r02:r12:r23: r02:r34
7	VRSA7	Hooghly	Goat	P	N	P	P	P	N	N	AMC, Co, CTR (I),PIT	8.0	32	32	IV	A	NT [b]B1:B1:B1:P1:B1 r34:r34:r34:r33:r34
8.	*S. aureus* ATCC 29213										Reference strain	0.5	0.5	1.0	—	—	t021W1:G1:K1:A1: K1:A1:O1:M1:Q1 r15:r12:r16:r02:r16: r02:r25:r17:r24

[a]All the isolates were sensitive to gatifloxacin and levofloxacin, but resistant to cefpodoxime, cefepime, and ceftazidime.
[b]A sequence that is a *spa* repeat, but does not exist in database.
CIP: ciprofloxacin (5 μg), TET: tetracycline (15 μg), AMC: amoxyclav (30/10 μg), CTR: ceftriaxone (30 μg), PIT: piperacillin+tazobactam (100/10 μg), AK: amikacin (30 μg), TOB: tobramycin (10 μg), PB: polymyxin B (300 U), Co: co-trimoxazole (1.25/23.75 μg), Cd: clindamycin (2 μg).
I, intermediate as per CLSI guidelines; MIC_{van}, MIC for vancomycin; MIC_{oxa}, MIC for oxacillin; MIC_{cef}, MIC for cefoxitin; NT, nontypeable; ERIC, enterobacterial repetitive intergenic consensus; P, positive; N, negative; MIC, minimum inhibitory concentration; VRSA, vancomycin-resistant *S. aureus*.



Adopted pathway map of antimicrobial resistance (AMR) dissemination within agriculture, the environment, and the food processing industry. Movement of antimicrobial agents and AMR is indicated by overlapping circles and arrows, respectively; different colors define different groups of reservoirs . Thanner et al., mBio 7(2):e02227-15

Suggestions for future fram

Surveillance framework in food a

What is the target population ?

1. Dairy and poultry sector should be given major emphasis for systematic surveillance
2. Others include pigs, sheep and goat

In case of meat producing animals, both on-farm and slaughter house sampling are required.

What should be the target organisms ?

1. Indicator: *E. coli, S. aureus*
2. Food borne pathogens: *Salmonella, Campylobactor*
3. Sentinel organism: *E. coli, Enterococcus*
4. Others: *Claustridium*

Surveillance in food animals: roa

Sampling

1.Many potential sampling points in the production and processing
2. Production/holding/processing slaughter/retail continuum
3. Environmental sampling - manure, water, feed etc
4. Slaughter house: caecal content, floor, slaugter house drainage, hand swab
5. **Sample information:** animal species, time and place of collection and clinical status of the animal/ AMU

Cross-sectional / time-series / case-control/ cohort analysis- what will be appropriate ? – a very pertinent question to understand
Prospective/passive/random/systematic
Sentinel surveillance

Surveillance in food animals: roa

Sample size

1. Precision
2. CI
3. Target population
4. Expected prevalence

Sampling frequency

1.To understand trend analysis sampling should be continuous or at regular interval

- Quarterly throughout the year.

2. Based on incidence and seasonality of the bacteria or diseases

Surveillance : how to proceed ...

Desired number of animals from every possible represtative farms/ individual owners from each state/districts/block

For a zone with 40 farms with 1000 birds - for AMR studies with respect to *E. coli*
Sample size : 385 with 95% CI and precision of 0.05 (expected level: 30%)

Samples check points at poultry/broiler production unit

samples/ farm

1. Cloacae swab/ freshly voided droop
2. Water
3. Feed samples
4. Farm floor
5. Farm disposal/ drainage/ sewage

Surveillance : Sampling points and s

Dairy animals...

PRODUCTION

Dairy animals
Freshly collected milk from each individual quarter
Separately collected milk from affected / unaffected quarter (SCM/ CM)
Farm floor
Milking machine
Hand swab of milkman
Animal attendants/ handler

Adjunct samples
Rectal swab
Calf pen
Manure/ litter
Pooled milk
Feeding / water trough

PROCESSING

Milk processing unit
Collecting utensils
Packaging unit
Spraying machine
Drainage

RETAIL

Finished products
Milkman
Milk-stalls

Surveillance : Sampling points and s

Poultry animals...

PRODUCTION

Poultry
Cloacae swab/ freshly voided dropping
Farm floor
Animal attendants/ handler
Utensils
Drainage/ sewage
Dust, Fluff

Adjunct samples
Feed
Water
Dust, Fluff
Environmental samples (litter/ manure)

HOLDING

Holding pen
Excreta / litter
Cage/ crate/vehicle
Drainage

POST SLAUGHTER

Caecal content
Carcass rinsate
Carcass swab
Lymph nodes
Meat juice
Liver
Floor/ground sample

RETAIL

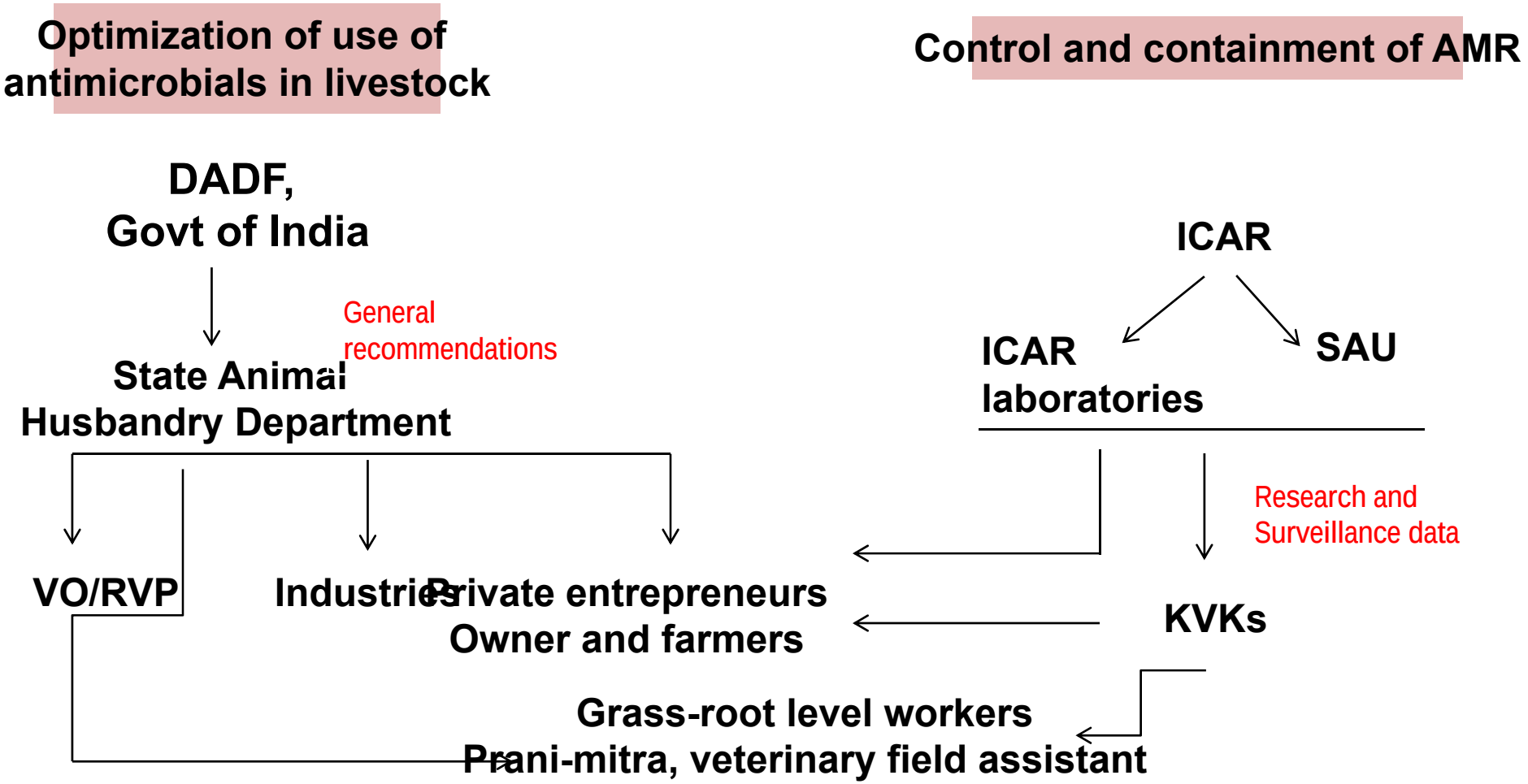
Finished product processed / unprocessed

Hadlers
Packaging units

What new you may get?

1. Unexpected resistance characteristics….
2. Abrupt variation from what others say
3. AMU/AMR may not be linear here
4. Risk factor analysis – status- reservoir indication
5. Three tier – farm/individual owner/ backyard

Roadmap – implementation and sensitization



Thank you


भाकृअनुप-भारतीय पशु चिकित्सा अनुसंधान संस्थान
ICAR-Indian Veterinary Research Institute
IVRI
भाकृअनुप
ICAR