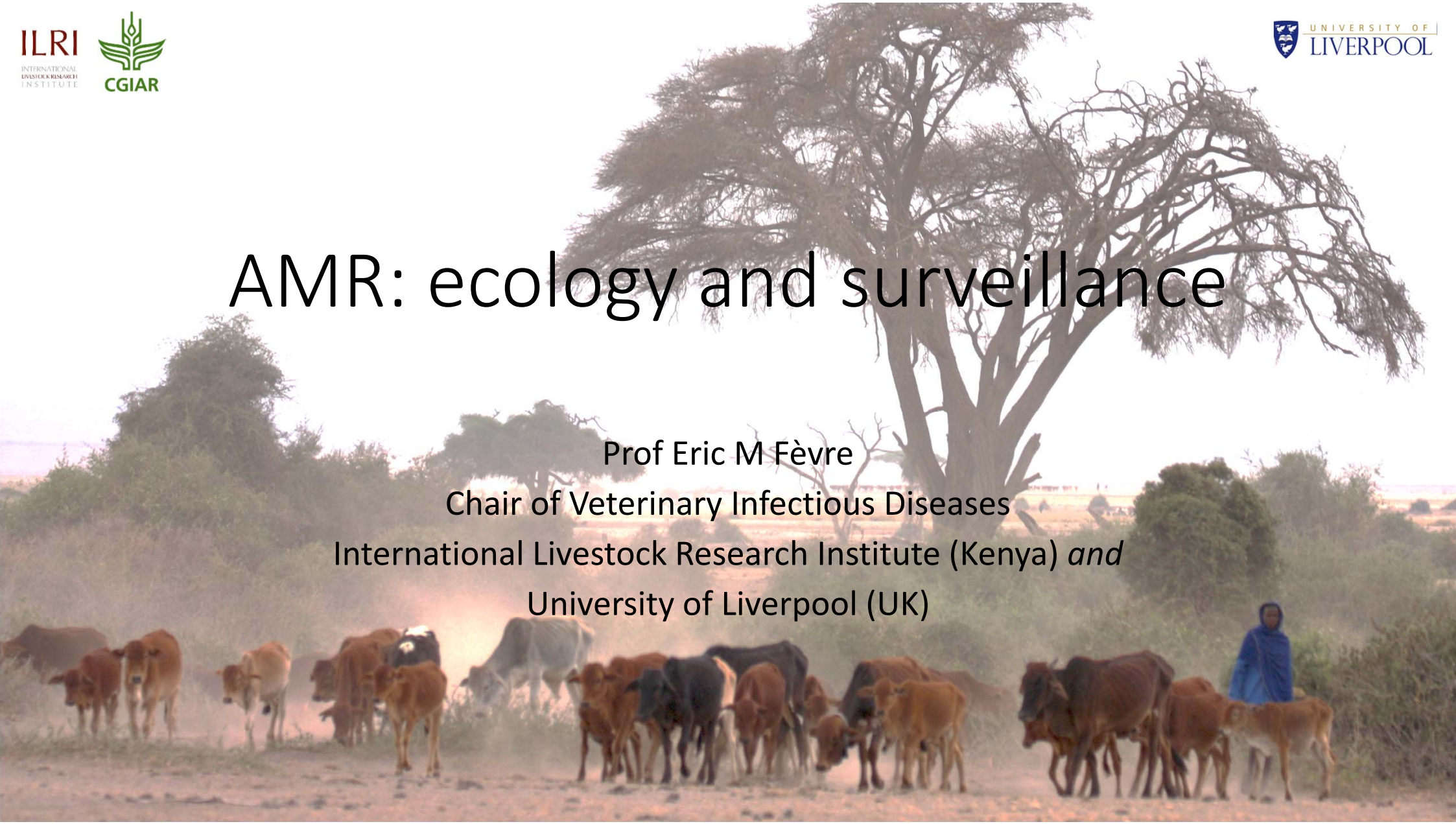


AMR: ecology and surveillance

Prof Eric M Fèvre
Chair of Veterinary Infectious Diseases
International Livestock Research Institute (Kenya) *and*
University of Liverpool (UK)

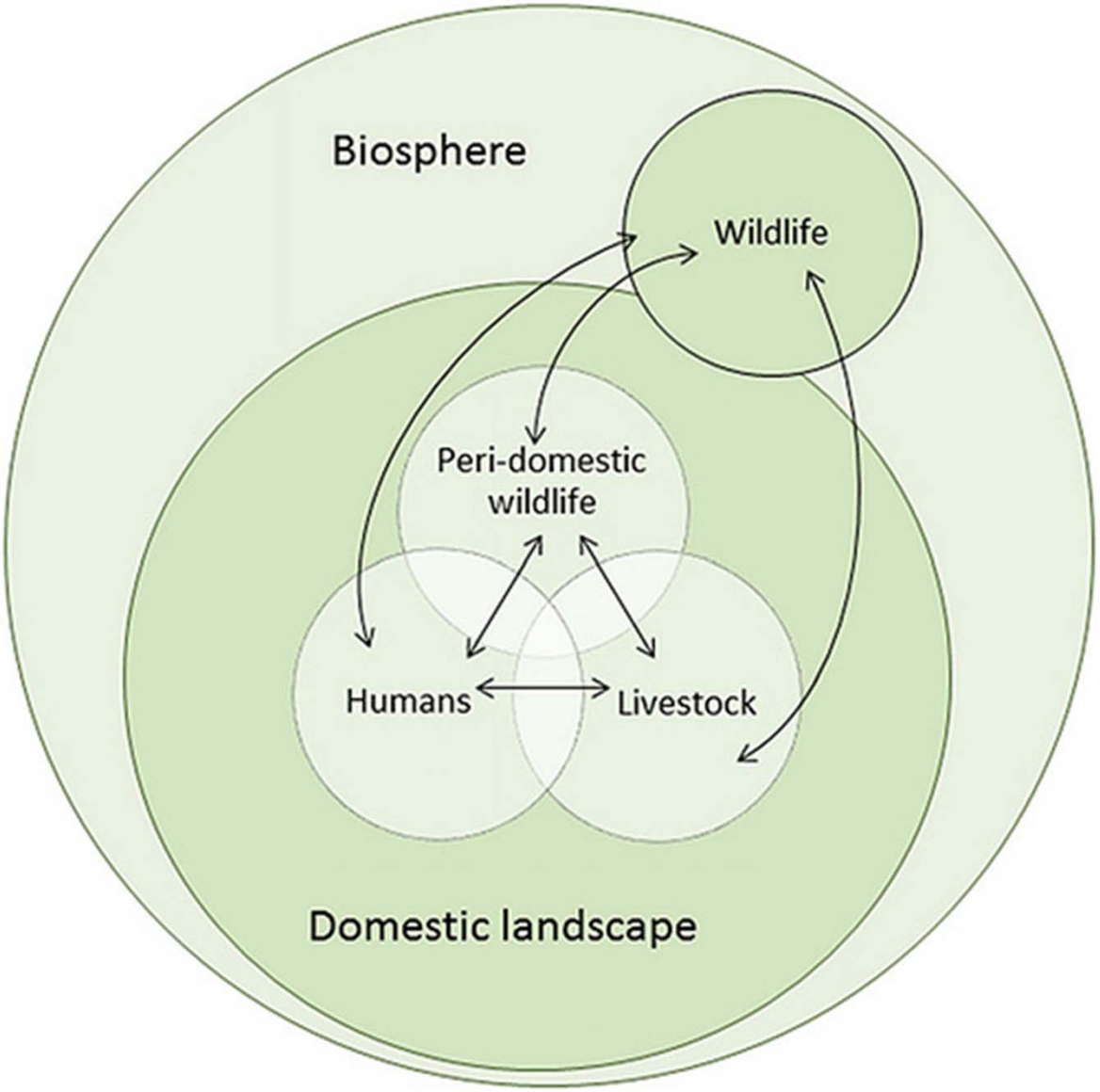
AMR is an ecological issue

- Keeping up with resistance to antimicrobials is about race against nature – swimming against the river
- Bacteria inside people, animals and in the environment are being selected by evolutionary forces. People and animals are ‘just’ environments where selection happens
- Exposure to antimicrobials within complex ecological environments drives this selection
- We have to undertake **surveillance** to understand these natural dynamics and **make clinical and policy decisions**

AMR as an ecological issue

Surveillance must help us to…

- …understand the structure of ecosystems
- …design sampling activities to capture the diversity of habitats within that structured environment
- …capture the ecological diversity in bacterial populations



All the compartments are interlinked and resistance can flow between them

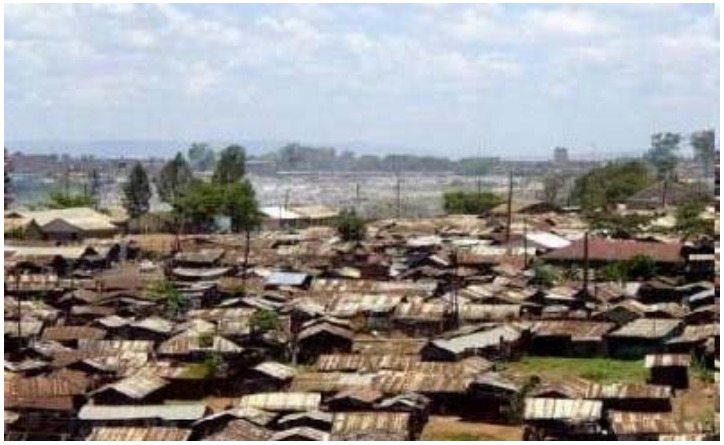
This is a perfect example of One Health

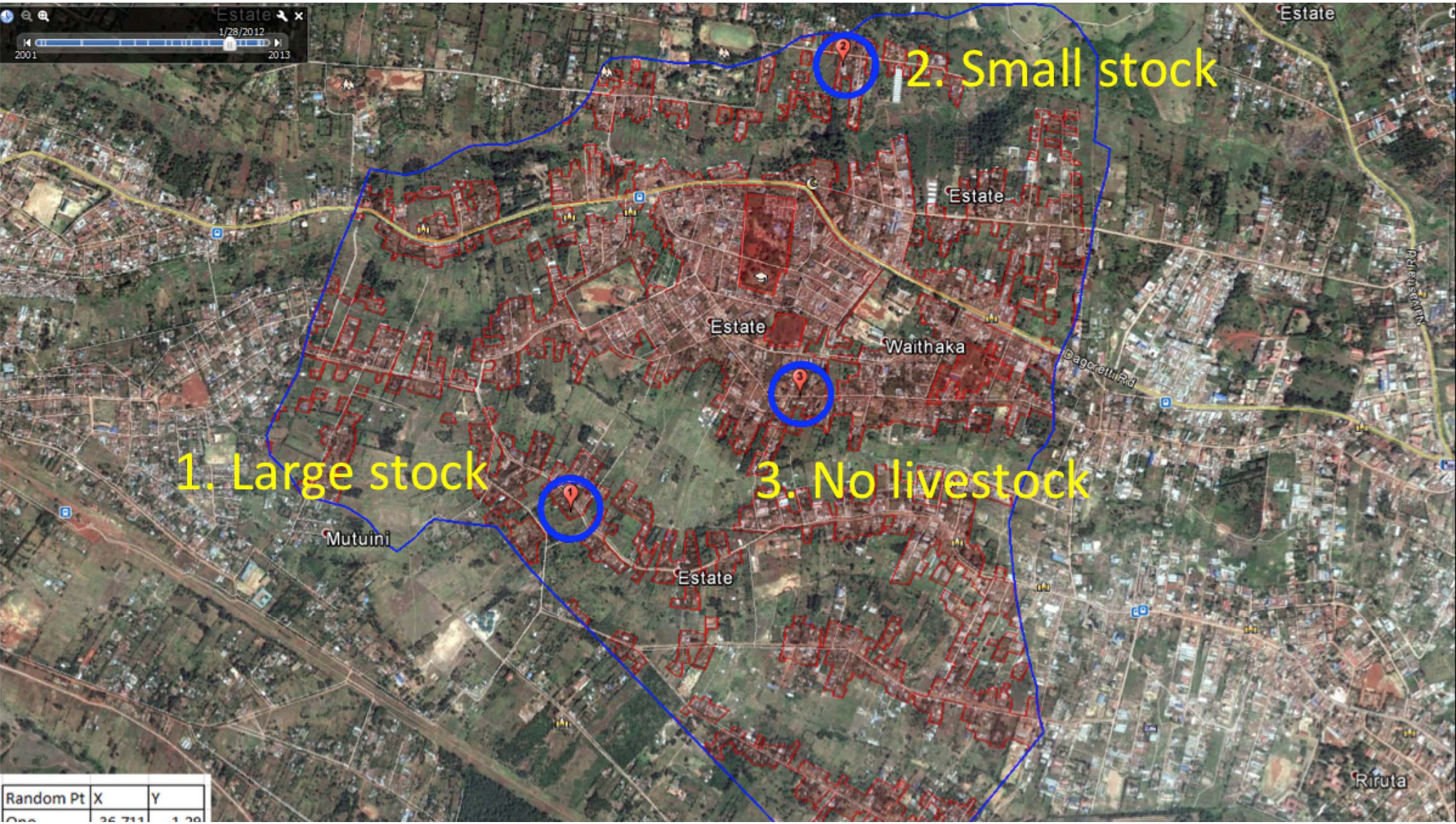
Example of urbanisation

- Massive increases in the population of urban and peri-urban (UPU) zones in Africa: from 35% of total population 2007 to 51% by 2030

- Impacts on
  - human welfare
  - healthcare provision and delivery
  - sanitation
  - demography
  - economics
  - trade
  - development
  - food production
  - planning

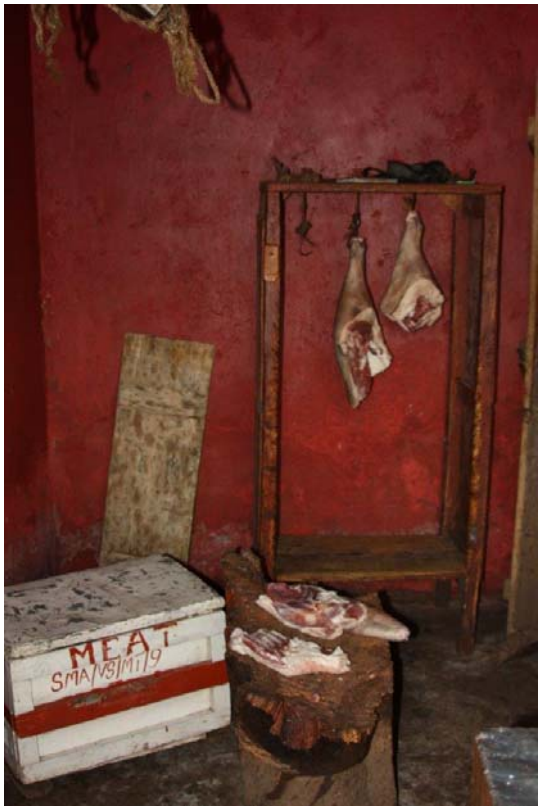
  - And all these affect transmission




2. Small stock
1. Large stock
3. No livestock
Estate
Estate
Estate
Estate
Waithaka
Mutuini
Estate
Riruta
Dagoretti Rd
1/28/2012
2001
2013
Random Pt
X
Y

Ecology of transmission

Urbanisation



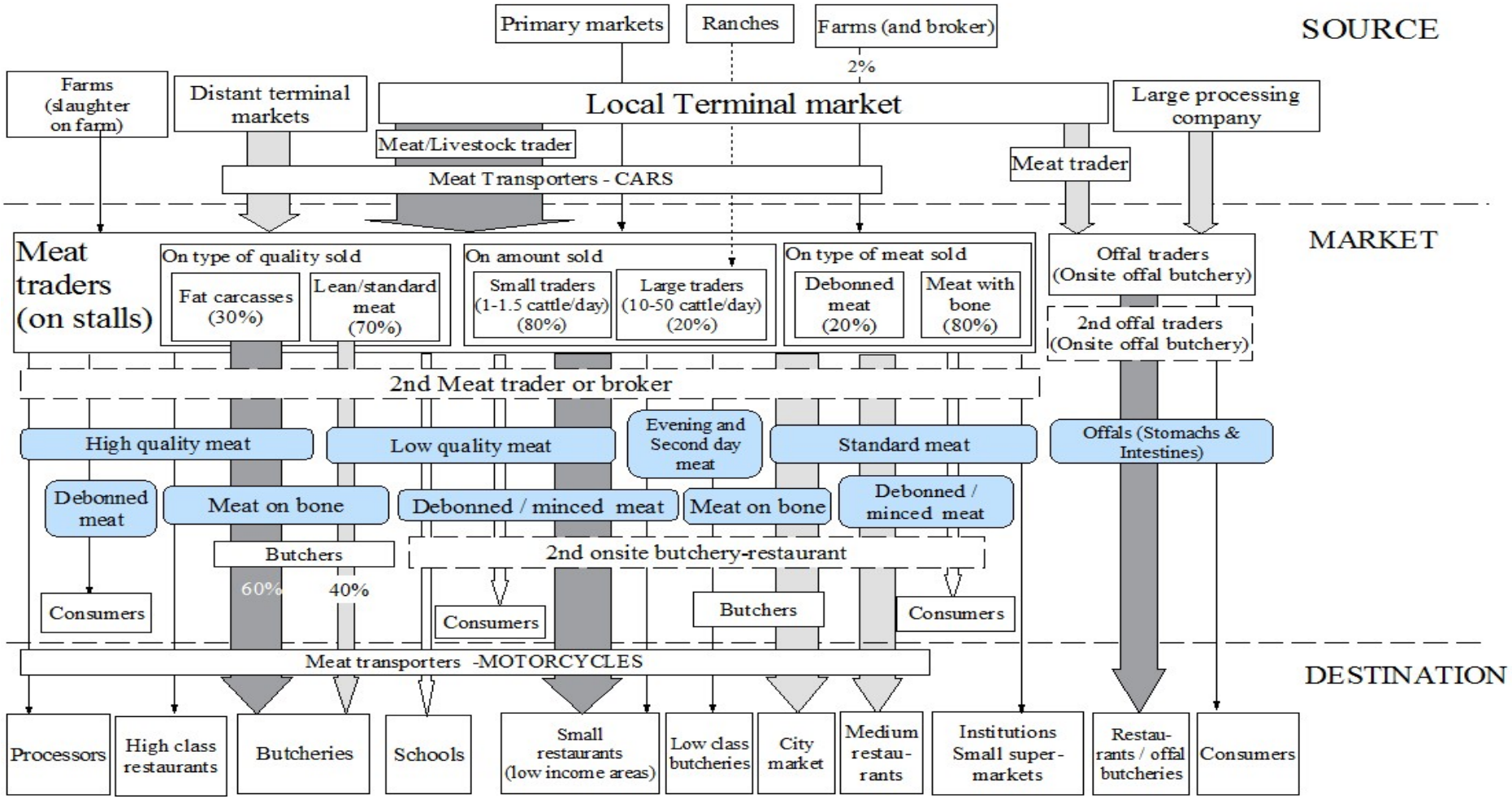
Trajectories in African animal source food - consumption

Herrero, M., Havlik, P., McIntire, J., Palazzo, A. and Valin, H. 2014. African Livestock Futures: Realizing the Potential of Livestock for Food Security, Poverty Reduction and the Environment in Sub-Saharan Africa. Office of the Special Representative of the UN Secretary General for Food Security and Nutrition and the United Nations System Influenza Coordination (UNSIC), Geneva, Switzerland, 118 p.

http://un-influenza.org/?q=content/press-release-african-livestock-futures-realizing-potential-livestock-food-security-poverty

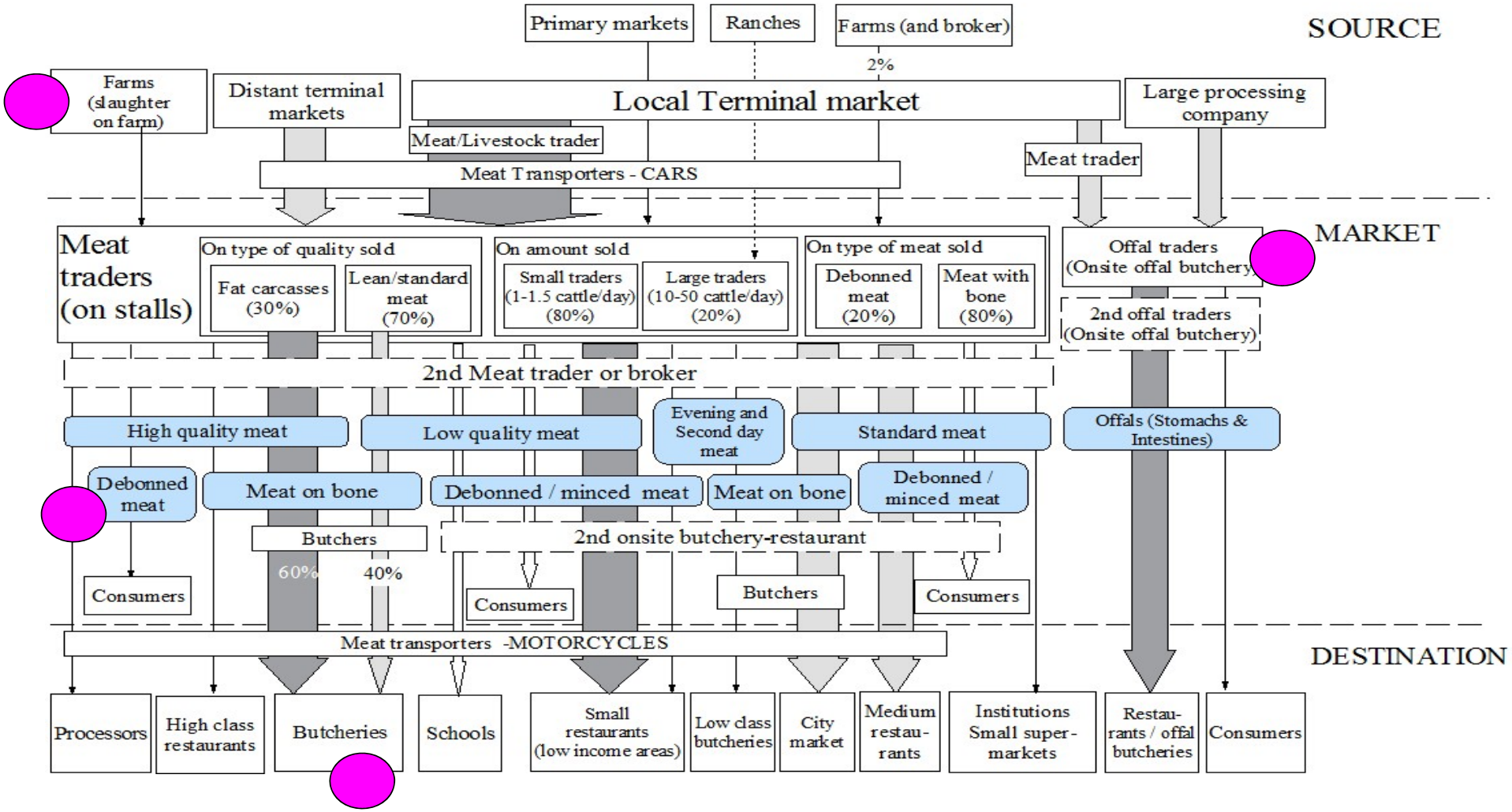
Figure 38 - The total consumption of livestock products (tons 000s) in different regions of sub-Saharan Africa to 2050 by SSP scenario.

Complex food systems: Ruminant meat



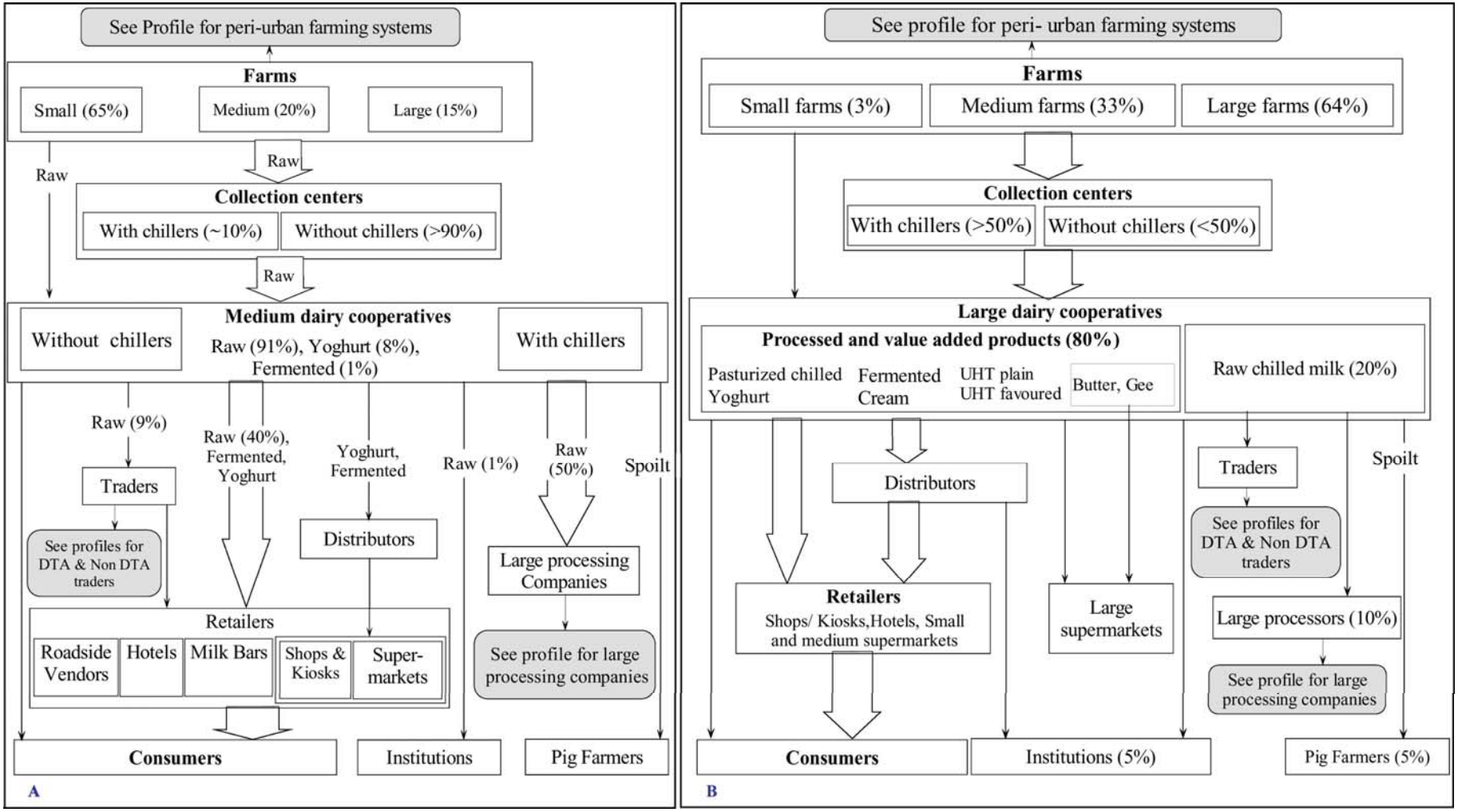
Alarcon et al (2017) *Frontiers in Veterinary*
Alarcon et al (2017) *Agricultural Systems*

Complex food systems: Ruminant meat



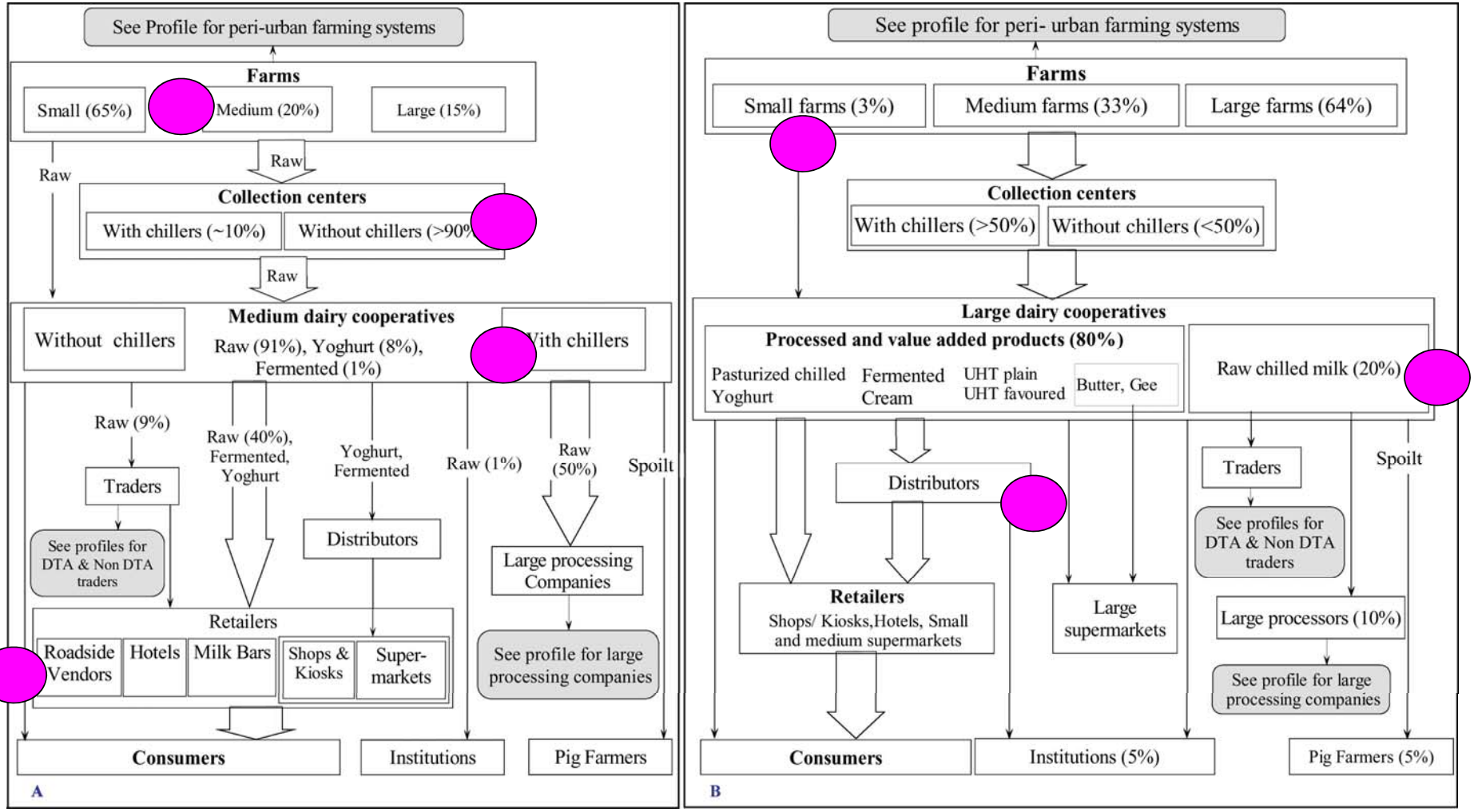
Alarcon et al (2017) *Frontiers in Veterinary*
Alarcon et al (2017) *Agricultural Systems*

Complex food systems: Milk

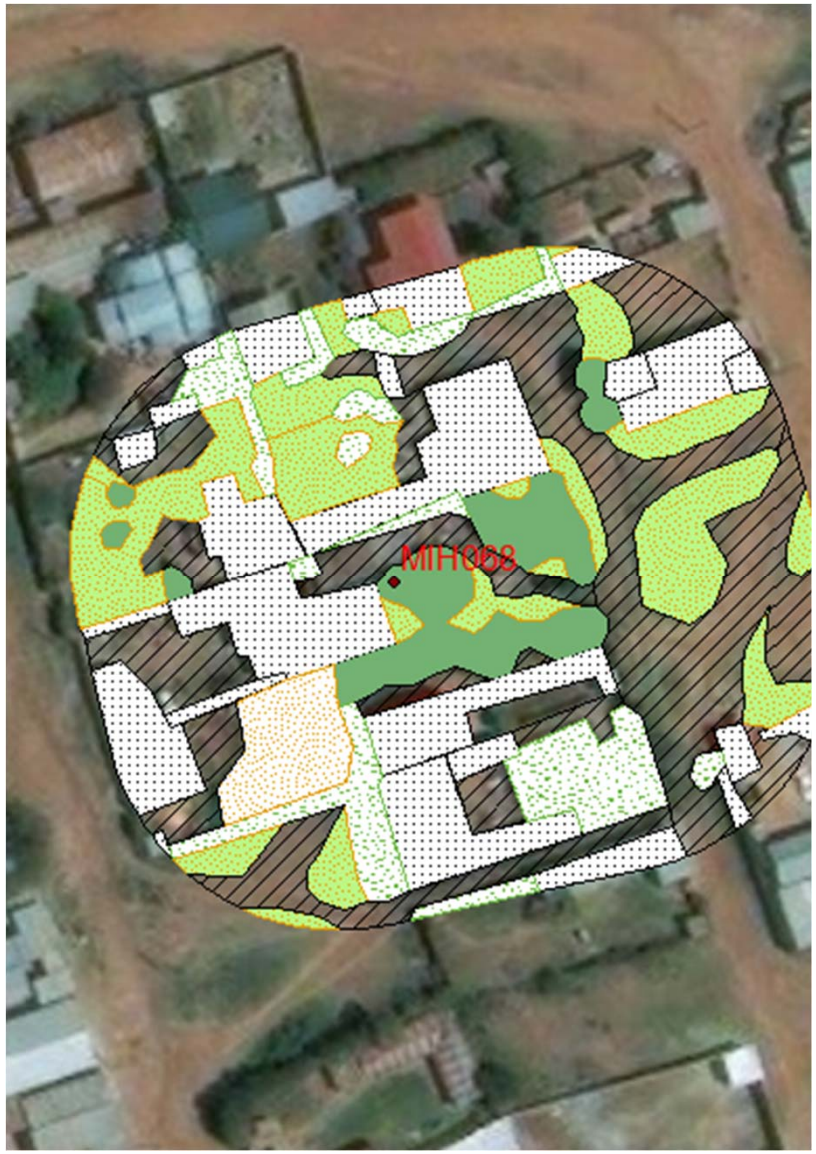


Kiambi *et al* (2018) Agricultural Systems

Complex food systems: Milk chain



Kiambi *et al* (2018) Agricultural Systems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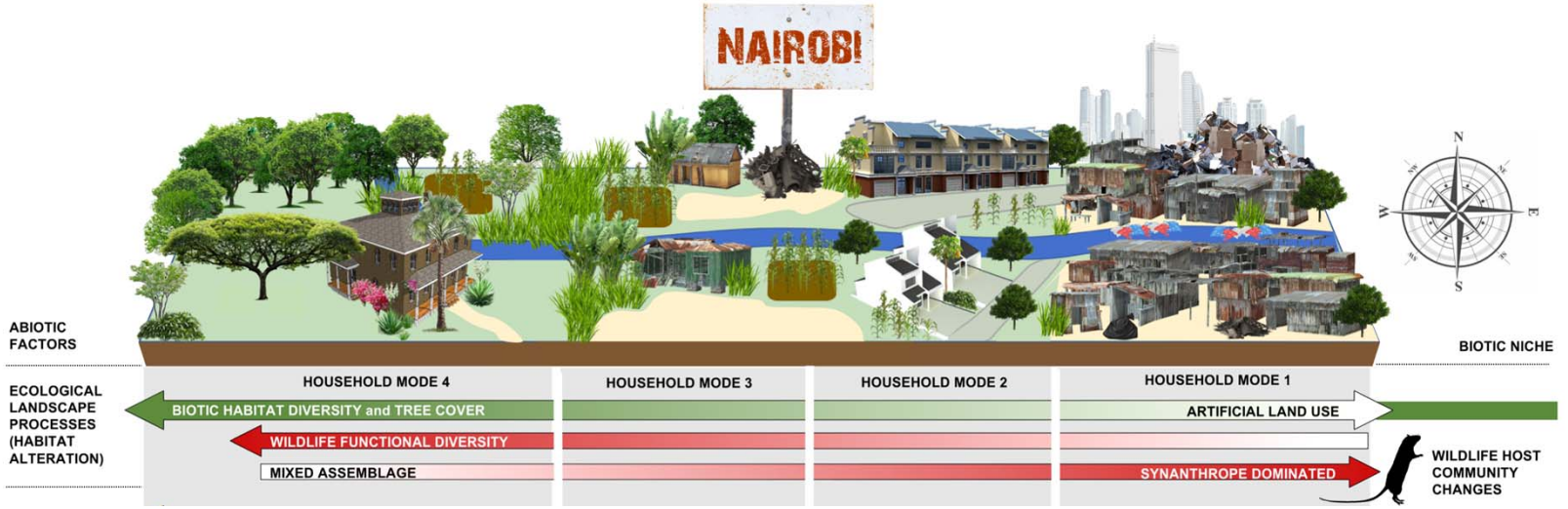
Ecologies

- Livestock production systems
- Livestock value chains
- On farm environments
- Households
- Hospitals

- All sites where resistance can be generated

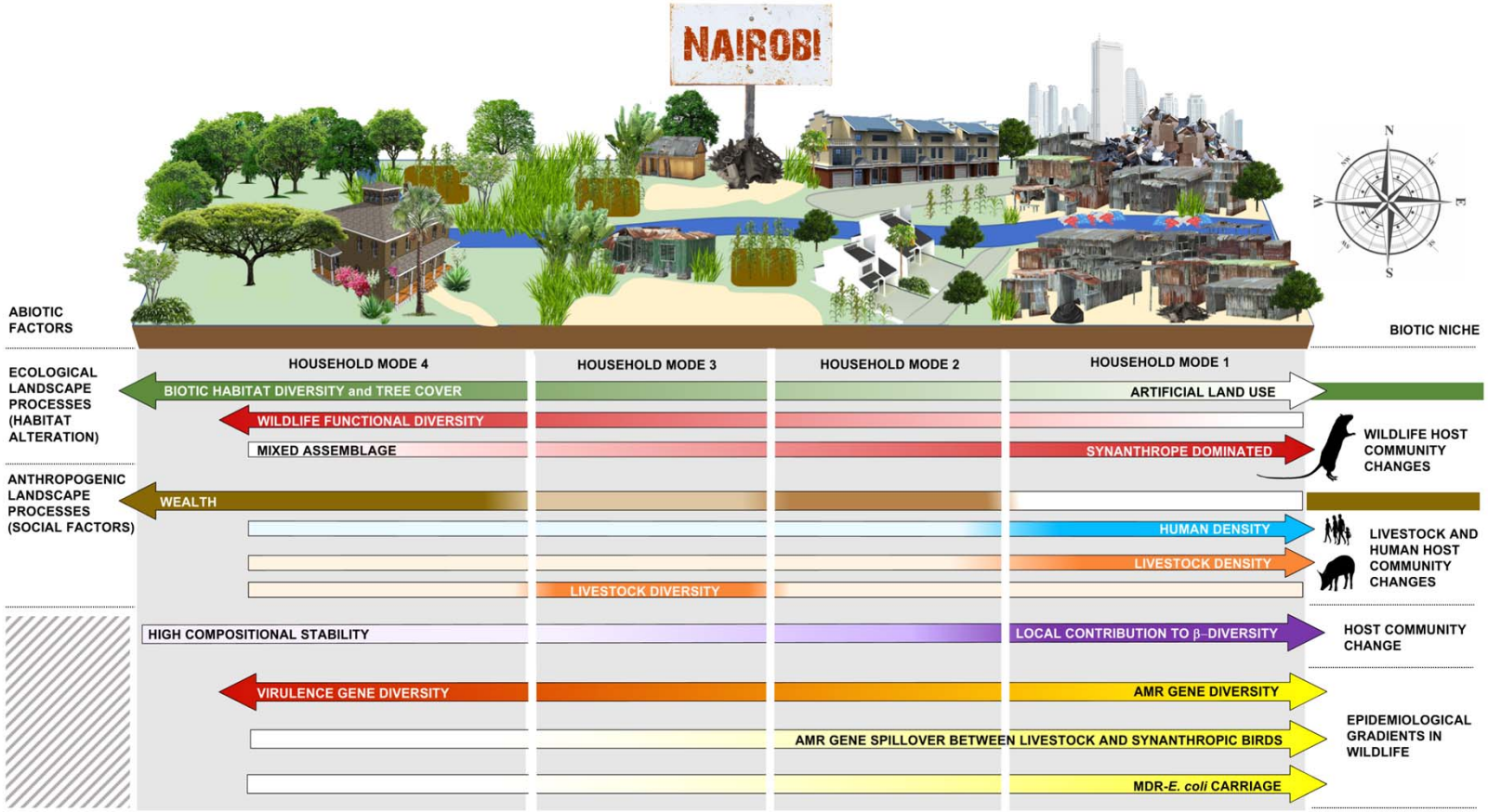


City-wide urban land-use change linked to structural change in wildlife host populations at household interfaces

Hassell et al (Nature Communications)

Change in household wildlife host communities related to change in livestock and human communities

Hassell et al (Nature Communications)



Epidemiological processes in wildlife-borne *E. coli* are linked to their drivers across the urban landscape

- role of urban wildlife in epidemiology of clinically relevant AMR
- influence of ecological and anthropogenic change on diversity of *E. coli* genes in wildlife

Hassell et al (Nature Communications)

Drugs for sale: surveillance of use

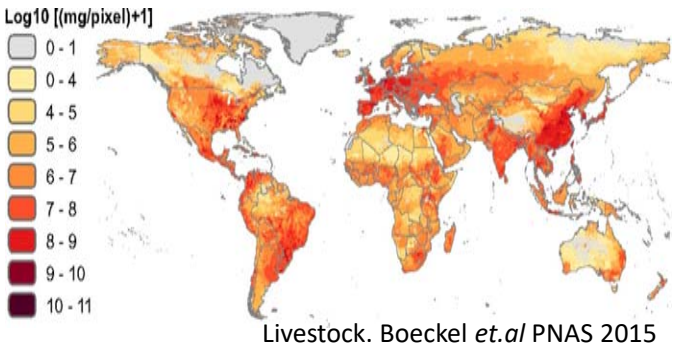
Nairobi city:

- ✓ Rapid urbanisation, poor sanitation
- ✓ High disease burden/rising incomes = high antibiotic use
- ✓ Livestock keeping is rife
- ✓ Ease in antibiotic access (over the counter)

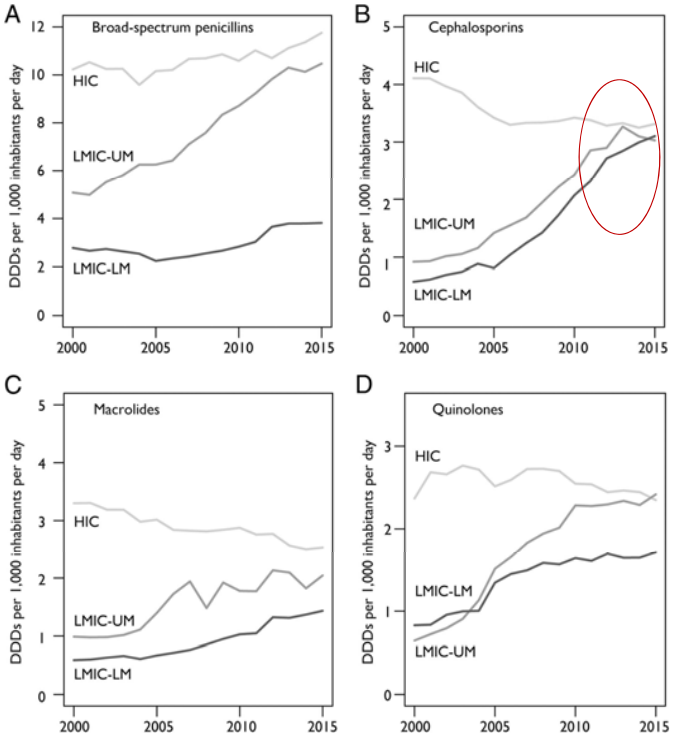
- Antibiotic consumption in both human and

  livestock populations largely undocumented

Human population (rising incomes) = demand for meat = livestock intensification = antibiotic use = **AMR ???**



Livestock. Boeckel *et.al* PNAS 2015

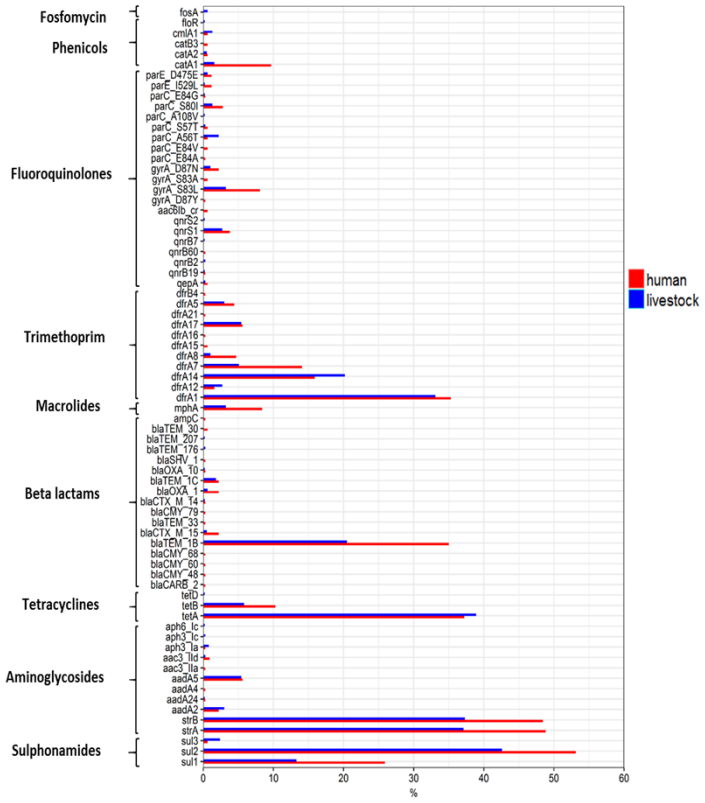


Humans. Klein *et.al* PNAS 2018

Surveillance activity to investigate the patterns of antibiotic use in humans and animals in urban Nairobi

i. Antibiotics sold and sale dynamics (types of antibiotics , overlapping patterns in supply, demand and consumption)
ii. Characteristics of antibiotic customers
iii. Antibiotic prescribing practices

Secondary aim was to survey the level of awareness and common behaviours related to AMR amongst human and veterinary pharmacists



Distribution of AMR genes by antibiotic class in human and livestock isolates

Methods: Approach

Target: Human and veterinary pharmacies

Rationale:

- Pharmacies are the primary level of outpatient/veterinary care (consultation, diagnosis, and prescription of antibiotics) for most of urban dwellers in Nairobi, thus focusing on them provides important insights into the antibiotic usage patterns at the consumer level

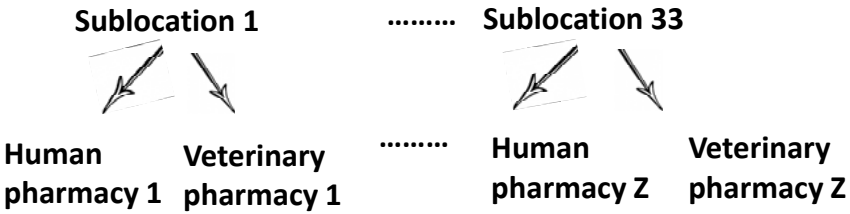
- Ease of administering questionnaires

Assumption: Qualitative sales data interpreted as representing antibiotic consumption.

Sales data useful in showing the overall patterns (qualitatively)

Jan to Feb 2018

Hierarchical sampling design – 2 pharmacies in each of 33 sub-locations – to capture differences in socioeconomics of the city



Pharmacy selection criteria:

i) Random point

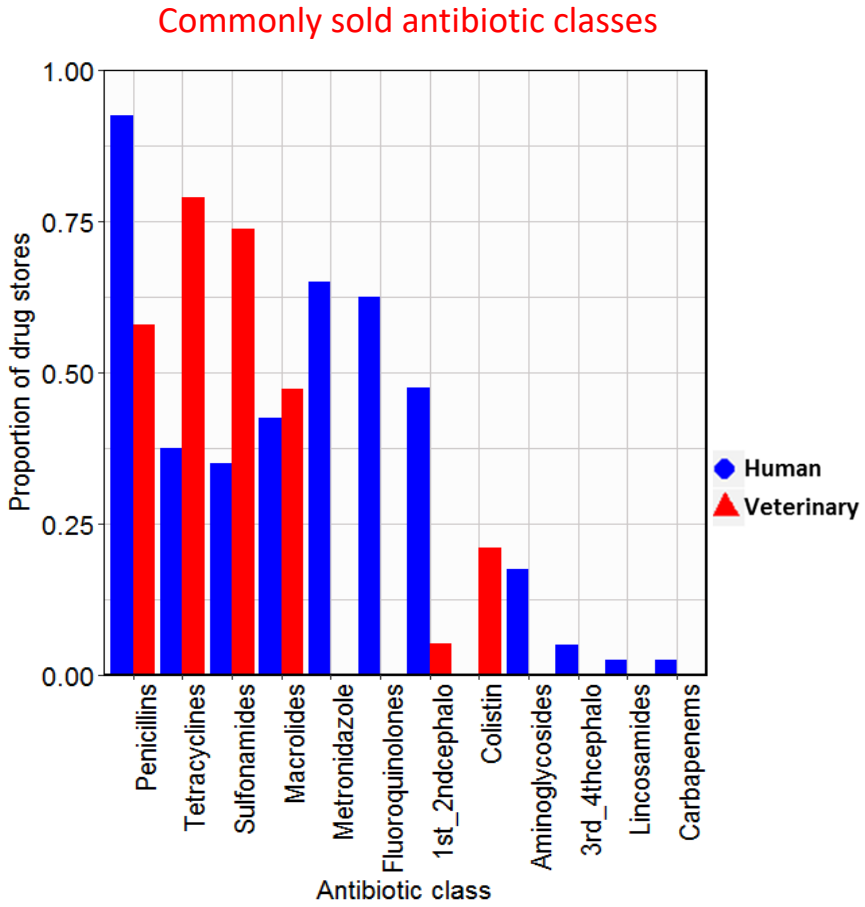
ii) Locate the nearest pharmacy

iii) Ask for permission

iv) If granted, administer a questionnaire

Questionnaire in ODK – all tools electronic

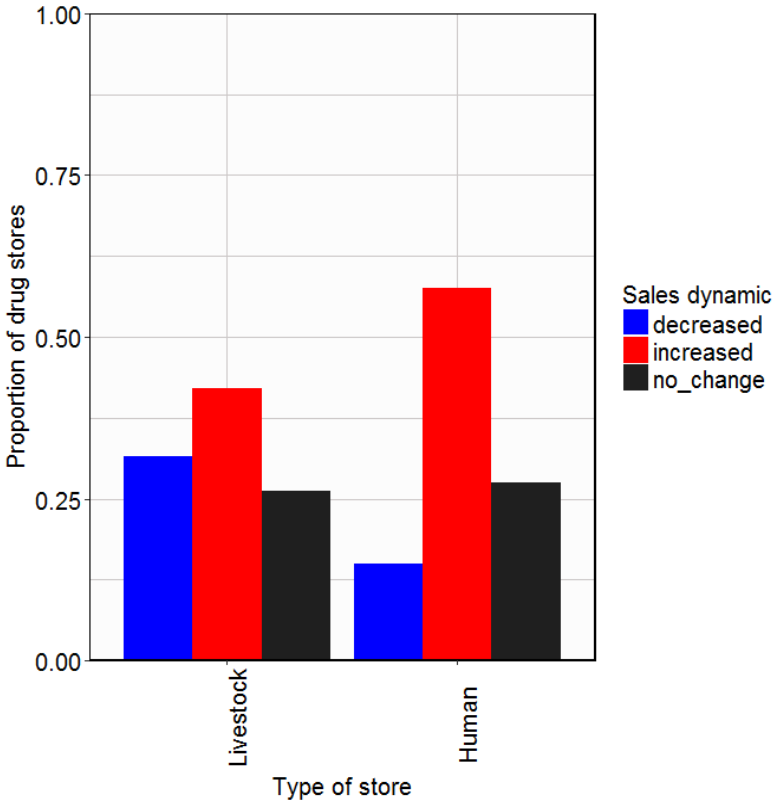
Antibiotics sold….



Proportion of drug stores reporting the top three commonly purchased antibiotic classes

- Human drug stores – penicillins (92.5%), metronidazole (65%), fluoroquinolones (62.5%), and first and second generation cephalosporins (42.5%)
- Veterinary drug stores – tetracyclines (79%), sulfonamides (73.7%) and penicillins (57.9%) and macrolides (47.4%)
- Of note, 21% of veterinary stores reported colistin as a commonly sold antibiotic

Sale dynamics….



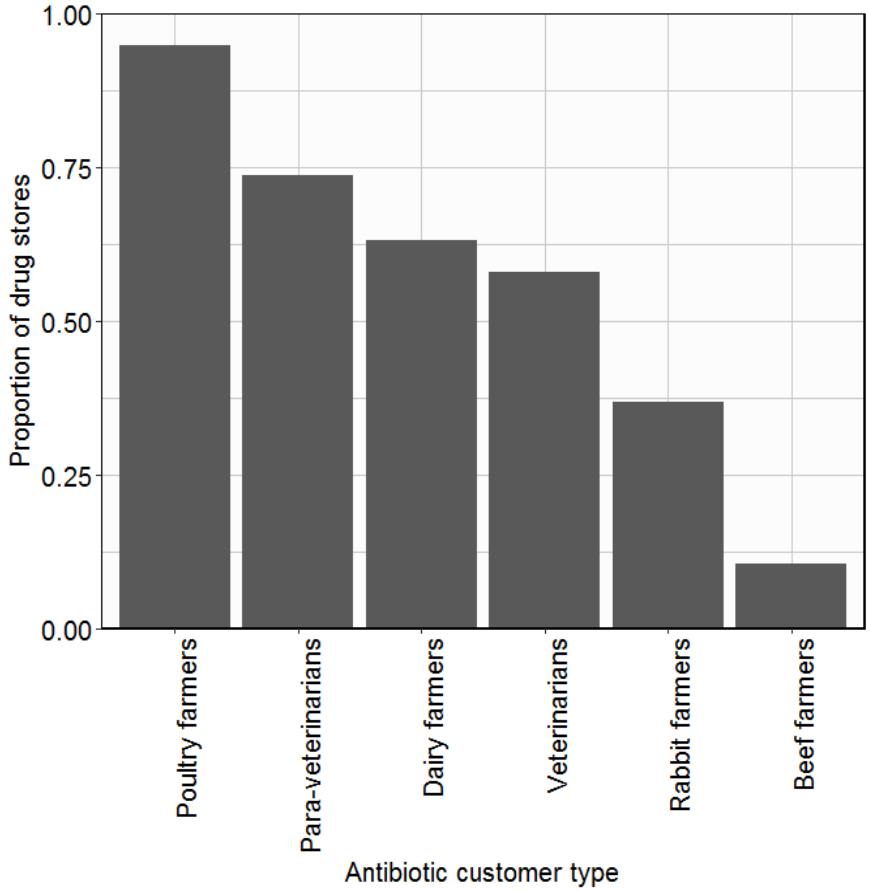
- Human (57.5%) and veterinary (42.1%) drug stores reported a rise in antibiotic sales compared to the same period a year earlier

- Increased customer demand for antibiotics - main driver of the increase - by 80% and 60% of human and veterinary pharmacists respectively

Characteristics of antibiotic customers

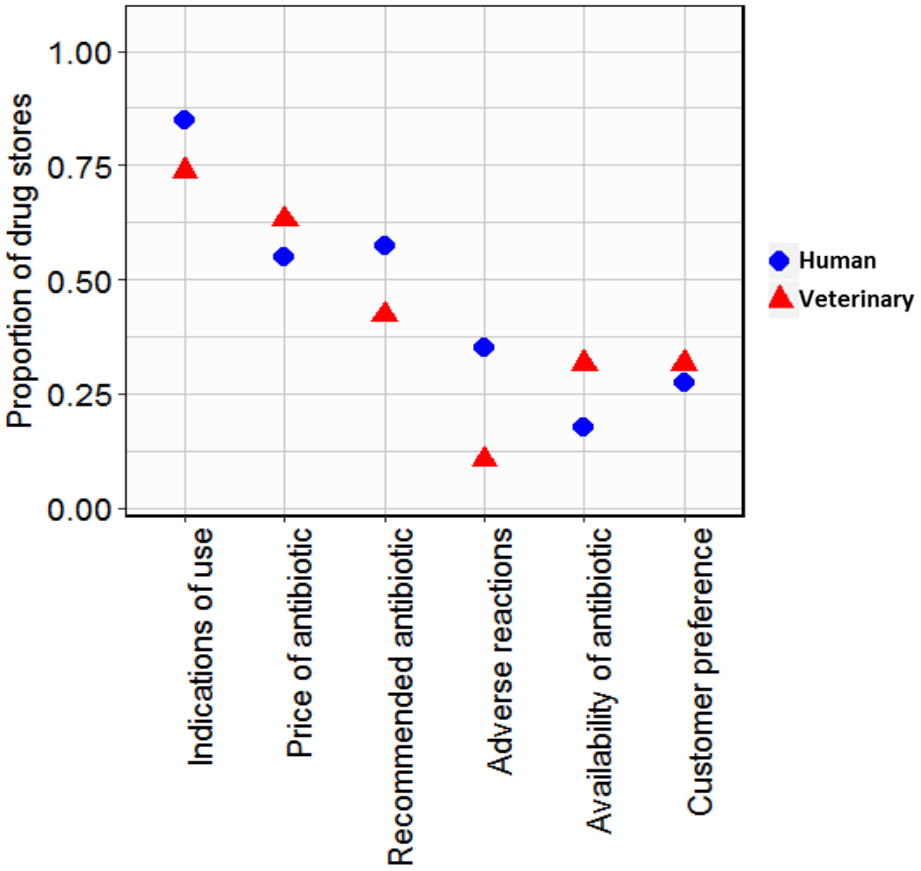
- Average daily purchase of antibiotics not significantly different (p=0.2; Mann-Whitney-Wilcoxon test) between human drug stores (25 customers, range 2 - 130) and veterinary drug stores (14 customers, range 2 - 113)

- Poultry farmers highest customers of antibiotics



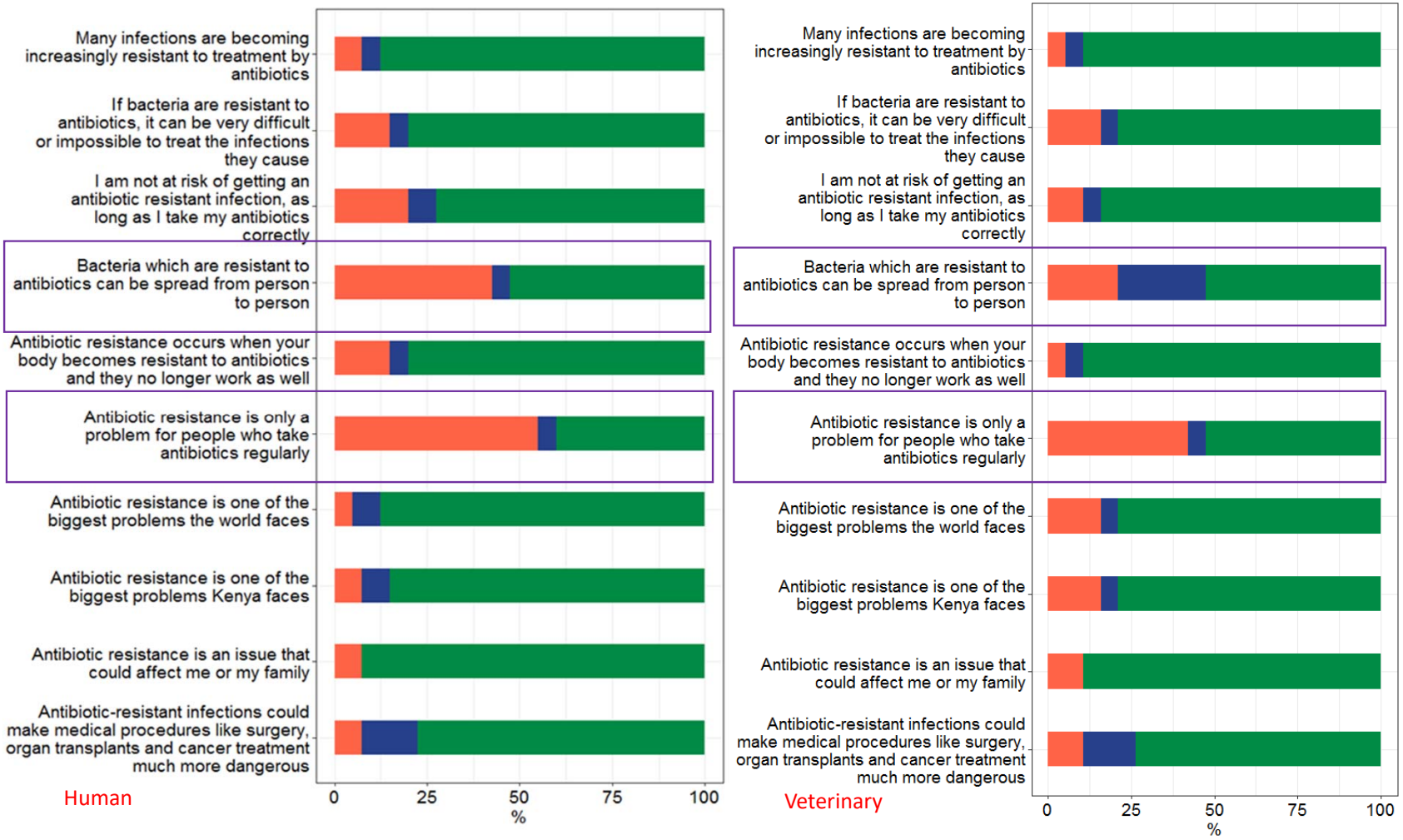
Antibiotic prescribing practices….

Factors influencing antibiotic prescription



- Most - indication of use and price
- Of note, 27.5% and 31.6% of human and veterinary pharmacists respectively considered customer preference as an important factor when prescribing antibiotics

Aim 4: Level of awareness and common behaviours related to AMR



- 10 statements to assess level of knowledge on AMR
- Slight variation in responses given. Most agree on AMR as a problem and its impact
- Low level of knowledge on the relationship between antibiotic consumption, subsequent development of AMR and spread.

Drugs on the farm: surveillance of use

AMUSE Tool – Anti-Microbial Use tool

Harmonisation of data collection on antimicrobial use in livestock production

Applicable to multiple production systems

AMUSE…

- A tool that can be used for different production systems and species in different countries
- Collate and compare data of different sources
- Enable collation and comparison of data from different countries
- Provide a minimal set of questions to be used
- Can be complimented with site-specific questions
- Assess baseline of current levels of access and use of AMs in different production systems where projects take place

AMUSE…

- 30 min questionnaire
- Field tested and validated in Kenya, Uganda, Ethiopia and Vietnam

- **What is is not:**
  - Tool to capture everything about a sample of farms
  - Tool to replace all other tools

- **What it is:**
  - Set of minimum questions to gather key farm level data
  - Basic understanding of farmers, animals, management, drug use and access to services

AMUSE…

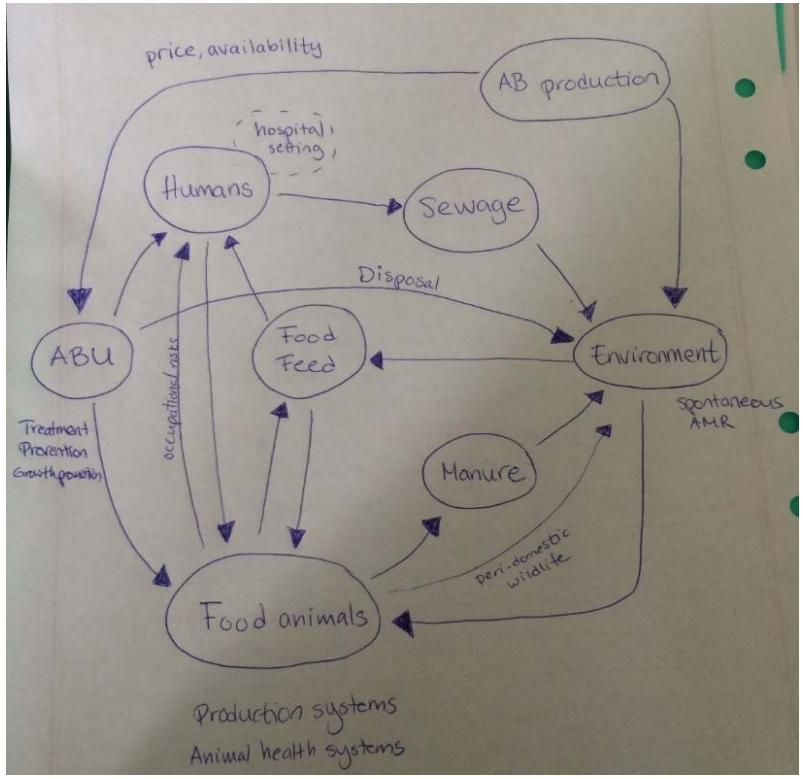
Common tool to be used in different settings

Use the same questions for basic data collection

- Use, access, knowledge

Simplify collation of data across production systems

Provide important ***comparable*** information on trends of antimicrobial use



Criteria for selecting respondent: person who plays a major role in the management of livestock **INFORMATION ON ENUMERATION**	
1. Questionnaire ID	
2. Date of Survey (DD/MM/YYYY)	
3. Enumerator's name (First Name and Last Name)	List of names of enumerators
4. Interview done via interpreter	☐1=yes ☐2=now
5. Enumerator's sex	☐1=Male, (If list available then this should be automatically filed) ☐2=Female
6. Time interview started (HH:MM)	Will be automatically generated by the tablets
7. Time interview ended (HH:MM)	Will be automatically generated by the tablets
8. Consent received (signature on form if literate)	☐1=yes ☐2=no
FARM BASICS AND LOCATION	
9. District	List of all districts pre-coded
10. Sub-county	List of all sub counties pre-coded
11. Parish	List of all parishes pre-coded
12. Village	List of all village pre-coded
13. GPS Coordinates	Will be automatically generated by the tablets
HOUSEHOLD DEMOGRAPHICS	

25. Characteristics of livestock production systems (single choice/most common practice throughout the year)		
1. PIGS		☐ 1= free-range ☐ 2= tethered ☐ 3= housed
2. POULTRY		☐ 1= free-range ☐ 2= housed
3. Cattle	☐Beef	☐1 = Zero grazing ☐2 = Fenced individual farm grazing ☐3 = Communal grazing ☐4 = Pastoral
	☐ Dairy	☐1 = Zero grazing ☐2 = Fenced individual farm grazing ☐3 = Communal grazing ☐4 = Pastoral
4. Small ruminants		☐1 = Zero grazing ☐2 = Fenced individual farm grazing ☐3 = Communal grazing ☐4 = Pastoral
5. Equines		☐1 = Zero grazing ☐2 = Fenced individual farm grazing ☐3 = Communal grazing ☐4 = Pastoral
6. Camels		☐1 = Zero grazing ☐2 = Fenced individual farm grazing ☐3 = Communal grazing ☐4 = Pastoral

MANAGEMENT OF MANURE, FEED AND WATER						
32. Manure management (by species), tick the **most common** option for each species (single choice).						
Activity	1.Cattle	2.Small ruminants	3. Equines	4. Poultry	5. Pigs	6. Camel
a. Leave on farm, do nothing						
b. Discard into environment						
c. Open air						
d. Used as fertilizer						
e. Use for fuel (incl. biogas)						
f. Sold for cash						
g. Taken by other farmers						
h. Other (specify)						
33. Feed products used per species (mulpile answers per species possible) , tick						
Type of feed	1.Cattle	2.Small ruminants	3. Equines	4. Poultry	5. Pigs	6. Camel
Pasture/scavenging						
Waste (household/restaurant, etc)						
grains/crop residues						
Feed mixed at farm						
Commercial/pre-mix						
Other						

ANIMAL HEALTH AND DISEASE PREVENTION

34. What was the **main animal disease problem** during the last 12 months (one disease per species)-if the farmers says FEVER, probe for more clinical signs because fever is common for most diseases

Clinical signs	1.Cattle	2.Goats	3. Sheep	4. Poultry	5. Pigs	6. Equines	7. Camel
a) Respiratory							
b) Digestive tract/intestinal							
c) Reproductive							
d) Mastitis							
e) Sudden death							
f) Skin disease/wounds							
g) External parasites							
h) Neurologic signs							
j) Other							
j) no disease problem							

35. Have any animals been sick in the last 2 weeks?

☐ 1 YES
☐ 2 NO

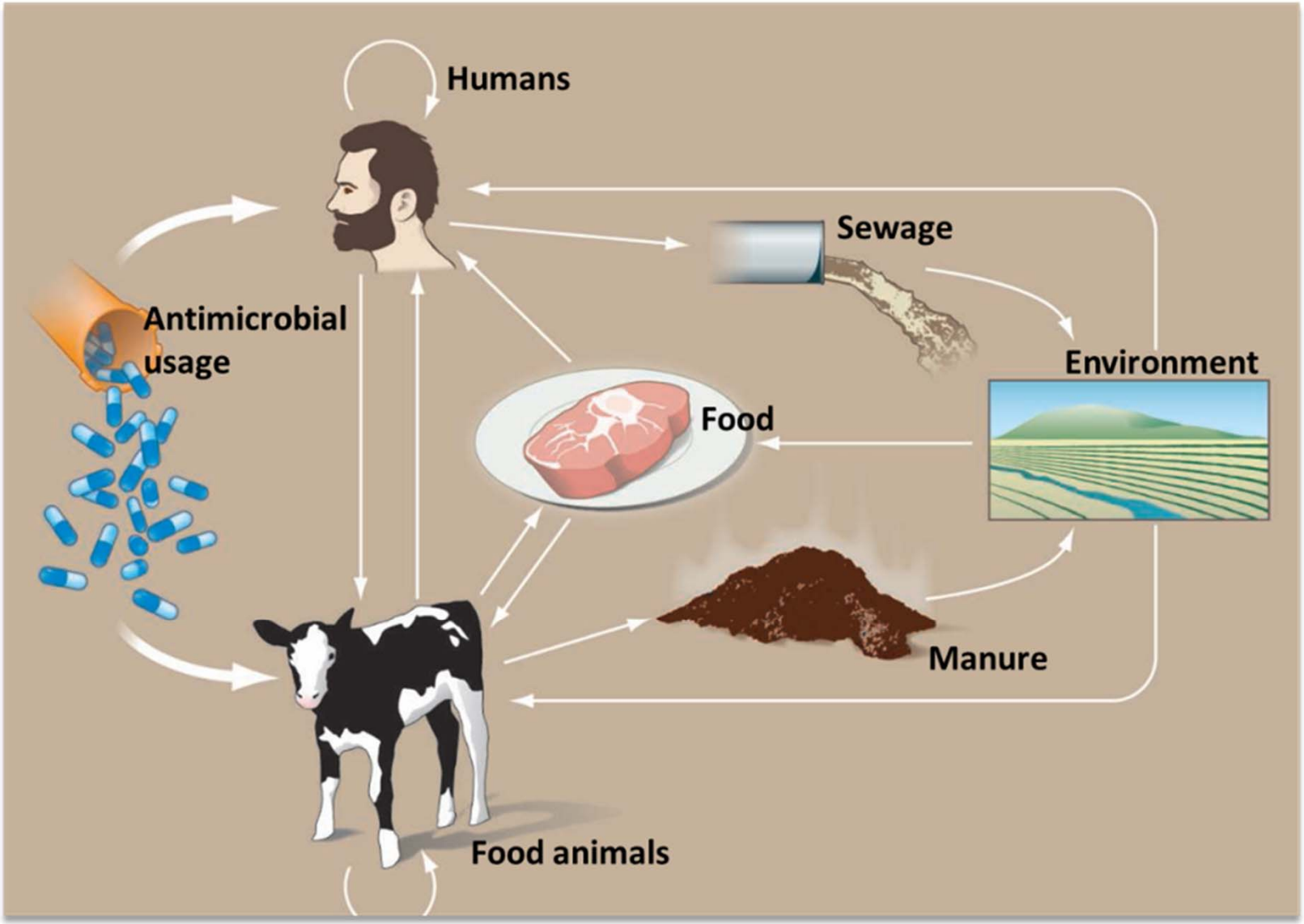
36. If yes, which animal and kind of disease?

Optional: Use a table of clinical signs by species and key diseases in annex

Clinical signs	1.Cattle	2.Goats	3. Sheep	4. Poultry	5. Pigs	6. Camel
a) Respiratory						
b) Digestive tract/ intestinal						
c) Reproductive						
d) Mastitis						
e) Sudden death						
f) Skin disease						

ANIMAL HEALTH SERVICES						
43. Does the farm have access to professional animal health services?	☐ Yes 1 ☐ No 2					
44. If your farm access to animal health services, which ones?	☐1 State or government: ☐a) Fully trained veterinarian (BSc level) ☐b) Paraveterinarian ☐c) Other animal health care provider; ☐d) Don't know the training or qualification ☐2 Private full time animal health worker: ☐a) Fully trained veterinarian (BSc level) ☐b) Paraveterinarian ☐c) Other animal health care provider; ☐d) Don't know the training or qualification ☐3 Both state/government and private ☐a) Fully trained veterinarian (BSc level) ☐b) Paraveterinarian ☐c) Other animal health care provider; ☐d) Don't know the training or qualification ☐4 Other (specify)…….					
45. If you have access to animal health services, do the animal service include laboratory testing?	☐ Yes 1 ☐ No 2					
46. If you have access to laboratory services, do you use it?	☐ 1 Yes, when needed ☐ 2 Rarely ☐ 3 No					
47. If yes, for diagnosis in which species?						
1.Cattle	2.small ruminants	3.Equines	4.Poultry	5.Pigs	6. Camels	
48. If you don't use them, why?	☐ 1 Not available ☐ 2 Not efficient ☐ 3 Too expensive ☐ 4 Would like more ☐ 5 Other (specify)……					
49. Is the farm involved in a regular animal health service program, like vaccination campaign etc run by government and/or NGO?	☐ 1 Yes ☐ 2 No					

VETERINARY DRUG USE: THE FOLLOWING QUESTIONS FOR EACH SPECIES PRESENT IN THE FARM (ONE DRUG)	
53. Which of the drugs is the most commonly used? (pictures or drug samples) (refer to Q51)	DROP DOWN LIST WITH VET DRUGS
54. Why do you use this drug?	☐ 1 Disease prevention ☐ 2 Treatment sick animal ☐ 3 Fattening ☐ 4 Other (specify)
55. Via which channel do you access this pharmaceuticals/veterinary drugs	☐ 1 Private vet ☐ 2 Public/official vet ☐ 3 Animal health worker ☐4 Veterinary drug store ☐ 5 From human pharmacies ☐ 6 At markets ☐ 7 Feed providers ☐ 8 Other farmers ☐ 9 Via NGOs☐ 10 Other (specify)
56. To which animals do you give the drug?	☐ All of the same species ☐ Sick animals only ☐ Sick and in contact animals ☐ Before selling an animal ☐ Animals newly introduced into herd ☐ All animals in household
57. How long do you use the drug?	☐ As advised ☐ Until animal(s) cured ☐ Until package empty ☐ As long as I can afford ☐ One time treatment ☐ Continiously over extended period Estimated average number days……..
58. Who adminster the drug?	☐ 1 Myself ☐ 2 Vet ☐ Other (specify)……
59. How is the drug applied/given?	☐ 1 Injection ☐ 2 Oral ☐ 3 with feed ☐ 4 with water ☐ 5 on skin



Collect surveillance data on each element of the system in a systematic and coherent way

Compare between ecosystems, production systems and countries

Ward and Woolhouse (2013)

Video on AMR produced in Kenya

Fin

Thanks for your attention!

Eric Fèvre

Email: Eric.Fevre@liverpool.ac.uk

Web: www.zoonotic-diseases.org

Twitter: @ZoonoticDisease

Tel (VOIP): +44 151 324 1241

Tel: +254 722 545 345

Institute of Infection and Global Health
University of Liverpool
Leahurst Campus
Neston
CH64 7TE
United Kingdom
UK

International Livestock Research Institute
Old Naivasha Road
Po Box 30709-00100
Nairobi
Kenya