FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

Food Safety and One Health:
Approaches to Reducing Foodborne Pathogens and Zoonotic Diseases

Feed the Future Innovation Lab for Food Safety

Nov 19, 2020

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Moderator

Paul Ebner, Feed the Future Innovation Lab for Food Safety and Purdue University

Dr. Paul Ebner is a professor in the Department of Animal Sciences at Purdue University. His research focuses on food safety and the development of practical and effective production methods and technologies to limit bacterial pathogens in both live animals and different types of food animal products. He uses his comprehensive understanding of livestock production and processing systems to deliver high impact extension programs targeted to producers, government officials, and consumers at local, national, and international levels. His areas of expertise are phage therapy and biology, the development of safe and effective antibacterial therapies for use in food animals, and characterization of the roles different management practices play in foodborne disease transmission.

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Agenda

Shawn Baker – 15 min.

U.S. Agency for International Development (USAID)

Martin Wiedmann – 10 min.

Feed the Future Innovation Lab for Food Safety/Cornell University

Thumbi Mwangi – 15 min.

Feed the Future Innovation Lab for Animal Health/Washington State University

Barbara Kowalcyk – 15 min.

Feed the Future Innovation Lab for Food Safety/The Ohio State University

Panel discussion – 20 min.

Dr. Wiedmann, Dr. Mwangi, & Dr. Kowalcyk

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Speaker

Shawn Baker, U.S. Agency for International Development (USAID)

Shawn K. Baker is the Chief Nutritionist for the U.S. Agency for International Development (USAID). In this position, he chairs the Agency's Nutrition Leadership Council, oversees the vision and strategy of the Agency's Center for Nutrition in the Bureau for Resilience and Food Security, and coordinates related efforts across USAID. He also guides USAID's investments and engagement with partners to address malnutrition in developing countries. Prior to joining USAID, Baker was the first director of nutrition at the Bill and Melinda Gates Foundation. He has over 30 years' experience in global public health nutrition, including 25 years living in sub-Saharan Africa and South Asia.

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Speaker

Martin Wiedmann, Food Safety Innovation Lab/Cornell University

Dr. Wiedmann is the Gellert Family Professor in Food Safety at Cornell University. He holds both a Veterinary Doctorate (DVM equivalent) from the Ludwig-Maximilians University in Munich and a Ph.D. in food science from Cornell University. Dr. Wiedmann is also the co-director of a CDC-funded Food Safety Center of Excellence, which is a joint effort between Cornell University and the New York State Department of Health. His work addresses food safety from primary production to the consumer, and his professional career has focused on comprehensive farm-to-table approaches to food safety and food security.

Cornell University
College of Agriculture and Life Sciences

The Intersection of Food Safety, Zoonotic Diseases, and One Health in Creating Resilient Food Systems

Martin Wiedmann
Department of Food Science, Cornell University, Ithaca, NY
Email: mw16@cornell.edu
Phone: 607-254-2838

Take home messages

- **Zoonoses have multifaceted impacts**
  - Impacts include human illness, animal illness and deaths (as well as reduced productivity), trade, food distribution (wet markets), tourism
  - Resilient food systems need improved control of zoonotic diseases

- **Lack of proper surveillance is a major impediment to controlling zoonoses**
  - *If you can't measure it, you can't improve it*
  - *Measure what you treasure*

Take home messages

- **Many zoonotic pathogens can be transmitted through different means (food, direct contact, airborne)**
  - Need to know the contributions of different transmission routes to improve control

- **Many challenges lie ahead (e.g., changes in transmission pathways, new hazards, such as antimicrobial resistance genes, and organism)**
  - A multifaceted systems approach is needed (surveillance + vaccines + traditional food safety practices)

Outline and key points

- **What's a zoonosis?**
- **The past**: tuberculosis, brucellosis, Q fever, etc.
- **Today**: SARS-CoV-2, *Salmonella*, *Salmonella*, *E. coli*, and the past
- **The future**: The past + today + emerging and re-emerging organisms + "zoonotic AMR genes"

Zoonotic diseases

A zoonotic disease is a disease which can be transmitted from animals to humans. The organism may or may not produce clinical illness in the animal.

Zoonotic diseases include:

- Direct transmission from animals to humans (e.g., rabies)
- Indirect transmission to humans through ingestion, inhalation, or contact with environments that have been contaminated with animal waste or a dead animal (e.g., leptospirosis, anthrax)
  - May include a singular (?) initial transmission event (SARS-CoV-2) or continued animal – human transmission (bovine Tb)
- A disease which has an animal reservoir but requires a mosquito or other arthropod to transmit the disease to humans (e.g., St. Louis encephalitis)

https://odh.ohio.gov/wps/portal/gov/odh/know-our-programs/zoonotic-disease-program/zdp

Zoonotic diseases - alternative definition

Zoonotic diseases are diseases caused by infectious agents that can be transmitted between (*or are shared by*) animals and humans

The microbial past…
is still the present in some parts of the world

- **Tuberculosis:** *Mycobacterium bovis*
- **Q fever**
- **Brucellosis**
- ***Salmonella***
- **Parasites:** (e.g., *Cryptosporidium* species, *Toxoplasma* species, *Giardia* species, and *Trypanosoma* species)
- **Viruses**: typically not foodborne

Q fever ("Query fever")

- Caused by *Coxiella burnetii*, which can infect a large range of animals
  - Sheep and cattle as key hosts
  - Nearly worldwide distribution

"Q fever, which is caused by the bacterium Coxiella burnetii, has rapidly emerged in French Guiana since 1996 (1). The incidence of acute Q fever in the capital, Cayenne, is one of the highest in the world. The annual incidence of Q fever was estimated at 37 cases/100,000 persons in 1996 (2) and increased to 150 cases/100,000 persons in 2005 (3)."

Mahamat et al. Emerg Infect Dis. 2013 Jul; 19(7): 1102-4.

Zoonotic tuberculosis

- Zoonotic tuberculosis (TB) is caused by *Mycobacterium bovis*
  - Primarily affects cattle but can impact wildlife
  - Important cause of economic losses and trade barriers that can create negative outcomes for poor and marginalized populations

- In 2016, 147,000 new cases of human zoonotic TB were estimated globally (12,500 deaths)
  - Africa most heavily affected, followed by Southeast Asia

- Insufficient surveillance data suggest that the true burden of zoonotic TB is likely underestimated

https://www.who.int/tb/areas-of-work/zoonotic-tb/ZoonoticTBfactsheet2017.pdf

Zoonotic tuberculosis

- *M. bovis* transmission to humans occurs most commonly through contaminated food (often dairy or meat products), though airborne transmission can occur for those in contact with infected animals or animal products

- Lab procedures typically utilized to detect TB do not differentiate between *M. tuberculosis* and *M. bovis*, which leads to underdiagnosis of zoonotic TB

- Zoonotic TB can be challenging to treat, as *M. bovis* is naturally resistant to pyrazinamide, one of the four medications used in the standard anti-TB treatment
  - As health professionals do not typically conduct drug susceptibility testing before starting a medication regimen, zoonotic TB patients may receive inadequate treatment

https://www.who.int/tb/areas-of-work/zoonotic-tb/ZoonoticTBfactsheet2017.pdf

Key current microbial food safety hazards

Bacteria

- *Salmonella, Campylobacter, Enterohaemorrhagic Escherichia coli, Listeria, Vibrio cholerae*
  - 3.4 million cases of non-typhoidal *Salmonella* bloodstream (invasive) infections are estimated to occur annually, resulting in an estimated 681,316 deaths.
- Antimicrobial resistance

Viruses

- Norovirus, Hepatitis A virus

Parasites

- Fish-borne trematodes (only transmitted through food), tapeworms (e.g., *Echinococcus* spp., or *Taenia solium), Ascaris, Cryptosporidium, Entamoeba histolytica, Giardia*

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4451910/

https://www.who.int/en/news-room/fact-sheets/detail/food-safety

The microbial future

- Some of the past + today + emerging and re-emerging organisms (species and subtypes) + "zoonotic genes"

- Need early warning systems (i.e., surveillance of both human and animal populations)

Foodborne Illness Acquired in the United States—Unspecified Agents

Elaine Scallan,[1] Patricia M. Griffin, Frederick J. Angulo, Robert V. Tauxe, and Robert M. Hoekstra

Emerging Infectious Diseases • www.cdc.gov/eid • Vol. 17, No. 1, January 2011

- 31 major known pathogens were estimated to cause **9.4 million** episodes of foodborne illness

- Episodes of illness caused by unspecified agents, including known agents with insufficient data to estimate agent-specific illness, known agents not yet recognized as causing foodborne illness, and substances known to be in food but of unproven pathogenicity were estimated to cause **38.4 million** episodes of foodborne illness and 1,686 deaths

Cornell University
College of Agriculture and Life Sciences

ARTICLE

https://doi.org/10.1038/s41467-019-11844-z OPEN

An African *Salmonella* Typhimurium ST313 sublineage with extensive drug-resistance and signatures of host adaptation

Sandra Van Puyvelde[1,2,3], Derek Pickard[2,4], Koen Vandelannoote[1], Eva Heinz[2,5], Barbara Barbé[6], Tessa de Block[1], Simon Clare[2], Eve L. Coomber[2], Katherine Harcourt[2], Sushmita Sridhar[2,4], Emily A. Lees[2,4], Nicole E. Wheeler[7], Elizabeth J. Klemm[2], Laura Kuijpers[6,8], Lisette Mbuyi Kalonji[9,10], Marie-France Phoba[9,10], Dadi Falay[11], Dauly Ngbonda[11], Octavie Lunguya[9,10], Jan Jacobs[6,8,12], Gordon Dougan[2,4,12] & Stijn Deborggraeve[1,12]

Bloodstream infections by *Salmonella enterica* serovar Typhimurium constitute a major health burden in sub-Saharan Africa (SSA). These invasive non-typhoidal (iNTS) infections are dominated by isolates of the antibiotic resistance-associated sequence type (ST) 313. Here, we report emergence of ST313 sublineage II.1 in the Democratic Republic of the Congo. Sublineage II.1 exhibits extensive drug resistance, involving a combination of multidrug resistance, extended spectrum β-lactamase production and azithromycin resistance. ST313 lineage II.1 isolates harbour an IncHI2 plasmid we name pSTm-ST313-II.1, with one isolate also exhibiting decreased ciprofloxacin susceptibility. Whole genome sequencing reveals that ST313 II.1 isolates have accumulated genetic signatures potentially associated with altered pathogenicity and host adaptation, related to changes observed in biofilm formation and metabolic capacity. Sublineage II.1 emerged at the beginning of the 21st century and is involved in on-going outbreaks. Our data provide evidence of further evolution within the ST313 clade associated with iNTS in SSA.

Nature Communications (2019) 10:4280
https://doi.org/10.1038/s41467-019-11844-z

An example of possible "Zoonotic genes": antibiotic resistance genes

Scientists at two European Union agencies have combined their expertise to analyze Member State data and compile the first joint EU report on antimicrobial resistance in zoonotic bacteria affecting humans, animals, and food. Compiled by the European Food Safety Authority (EFSA) and the European Centre for Disease Prevention and Control (ECDC), the report indicates that resistance to antimicrobials was observed in zoonotic bacteria, such as *Salmonella* and *Campylobacter*, which may cause infectious diseases transmissible between animals and humans and which can be found in foods.

The report also presents antimicrobial resistance data for non-disease causing bacteria such as indicator *E. coli* and *Enterococci*, which usually do not cause disease in humans.

EFSA News Story 12 July 2011

Take home messages

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  - Multifaceted systems approach is needed (surveillance + vaccines + traditional food safety practices)

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Speaker

Thumbi Mwangi, Feed the Future Innovation Lab for Animal Health and Washington State University

Thumbi Mwangi is an infectious disease epidemiologist with interest in use of epidemiological analytical and modelling tools for the control and prevention of animal diseases and improvement of human health and welfare. He trained as veterinarian at the University of Nairobi and received a Ph.D. in Infectious Disease Epidemiology from the University of Edinburgh. Based in East Africa, Thumbi is the Director of the Feed the Future Innovation Lab for Animal Health and holds the positions of Clinical Associate Professor at the Paul G Allen School for Global Animal Health, Washington State University, Senior Research Fellow at the University of Nairobi Institute of Tropical and Infectious Diseases and Chancellors Fellow in Global Health at the University of Edinburgh.

FSIL Webinar Series

Food Safety and Zoonoses in East Africa

Thumbi Mwangi DVM, MSc, PhD

Director, Feed the Future Innovation Lab for Animal Health
Associate Professor, Washington State university
Senior Research Fellow, University of Nairobi Institute of Tropical and Infectious Diseases

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FEED THE FUTURE INNOVATION LAB FOR ANIMAL HEALTH

WASHINGTON STATE UNIVERSITY

UNIVERSITY OF NAIROBI

ILRI | CGIAR

KALRO
Kenya Agricultural & Livestock Research Organization

KENYA MEDICAL RESEARCH INSTITUTE
KEMRI

Livestock for human nutrition, welfare & health

Research

- Development of **pen-side diagnostics**
- **Improvement of vaccines** against East Coast fever
- Integration of socio-economics to **improve adoption** of animal health interventions
- **Quantifying effect** of animal health interventions human health and nutrition

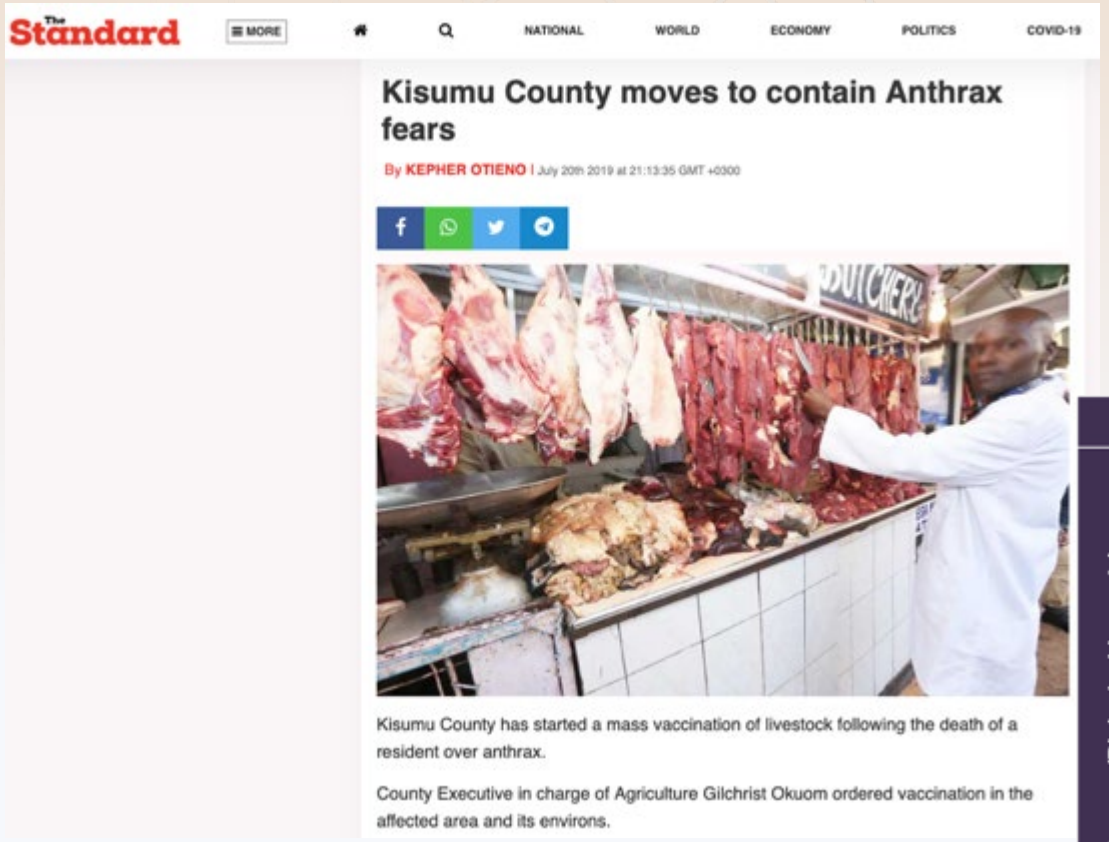
Human Capacity Development for animal health research

- 10 PhD, 6 Masters **graduate scholarships**
- 3 post-doctoral **research fellowships**
- **Research attachments** for undergraduate students
- **Modular courses** to improve research quality
- Faculty collaborative **exchange programs**

Institutional capacity development

- Fully equipped **molecular and diagnostics lab for animal diseases** at the University of Nairobi
- Support for **animal health research systems** at the University

Food Safety and Zoonoses



Category		Clinical syndromes	Examples
Infectious disease (Biological hazards)	Acute	Gastroenteritis	*Campylobacter sp.* Non-typhoidal *Salmonella sp.* *Cryptosporidium sp.* Norovirus Bacterial toxins, marine biotoxins
		Meningitis	*Listeria monocytogenes* *Salmonella sp.*
		Septicaemia	*Brucella* *Salmonella sp.* *Listeria monocytogenes*
		Acute neurological symptoms	*Clostridium botulinum* Marine biotoxins
		Perinatal loss	*Listeria monocytogenes* *Toxoplasma gondii*
		Acute hepatitis	Hepatitis A, hepatitis E

- High prevalence and likely high burden due to foodborne zoonotic pathogens
- The main clinical manifestations of foodborne diseases such as diarrhoea, septicaemias do not get laboratory diagnosis

Delia G (2015) Food safety in developing countries: an overview

Food Safety and Zoonoses surveillance

- Simultaneous multi-year syndromic surveillance studies in humans and their animals in 1600 households, Western kenya.

1. Population Based Infectious Diseases Surveillance (PBIDS) study - HUMANS
2. Population Based Animal Syndromic Surveillance (PBASS) study - ANIMALS

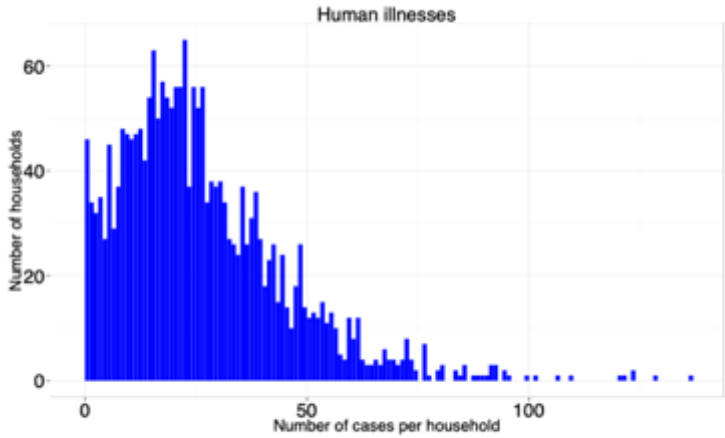
- **Syndromic surveillance at community**
  - High incidence of fever, diarrhoea, respiratory illness and deaths – in people and their animals
  - Strong correlations between human and animal illnesses from same households

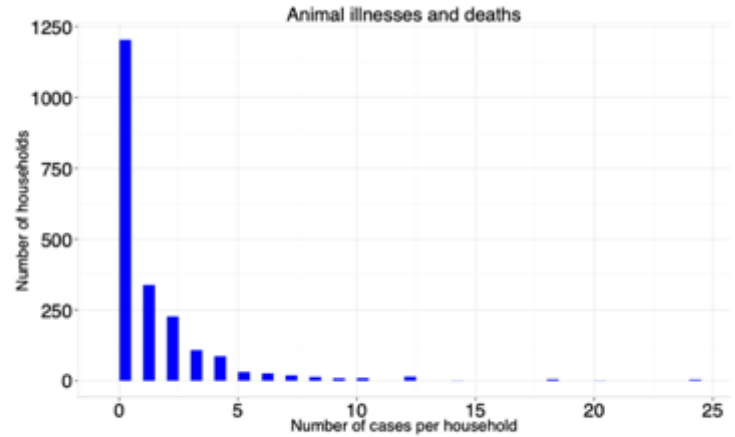
PLOS ONE

RESEARCH ARTICLE

Linking Human Health and Livestock Health: A "One-Health" Platform for Integrated Analysis of Human Health, Livestock Health, and Economic Welfare in Livestock Dependent Communities

S. M. Thumbi[1,2]*, M. Kariuki Njenga[3], Thomas L. Marsh[1,4], Susan Noh[1,5], Elkanah Otiang[2], Peninah Munyua[3], Linus Ochieng[2], Eric Ogola[2], Jonathan Yoder[1,4], Allan Audi[2], Joel M. Montgomery[3], Godfrey Bigogo[2], Robert F. Breiman[6], Guy H. Palmer[1], Terry F. McElwain[1]



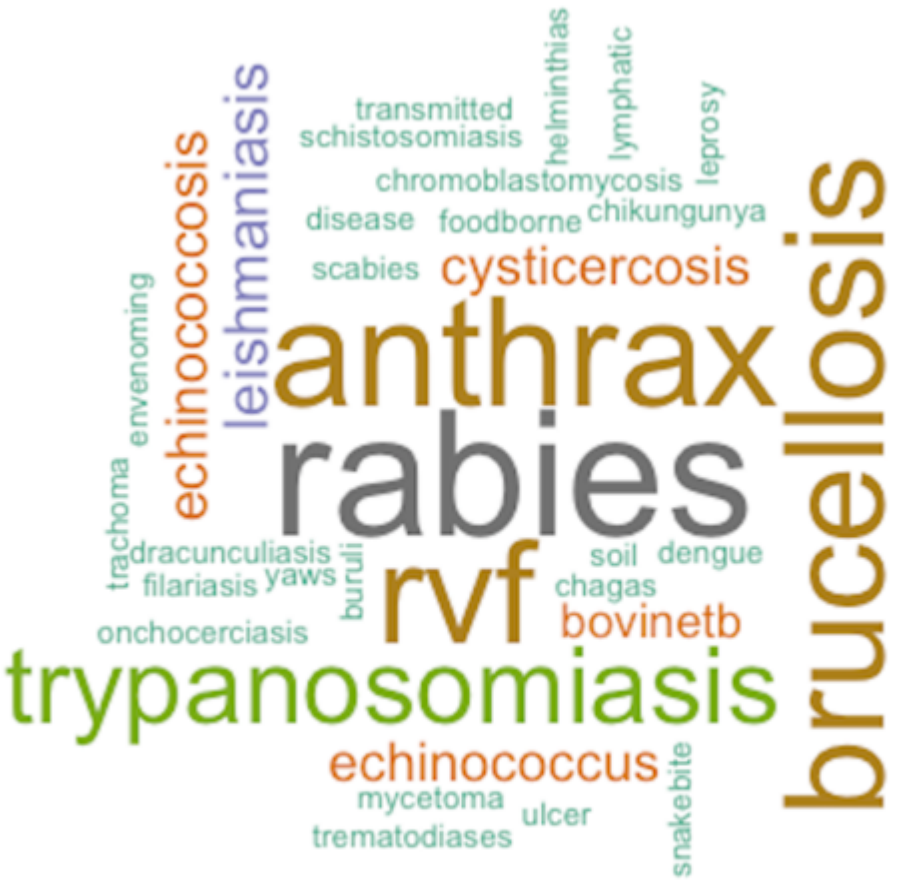


glm.nb(formula = (Total Household illnesses) ~ I(animal illness and death/10) + household size)

	Estimate	2.5 %	97.5 %	p-value
(animal illness and death/10)	1.31	1.16	1.49	< 0.001 ***
Household size	1.08	1.07	1.10	< 0.001***

- correlation between households with sick people and those with sick animals

Country-level Prioritization of zoonotic diseases



- WHO has a list of 20 NTDs half of which are zoonotic

- 36 different zoonotic diseases suspected or known to be in Kenya or the East African region

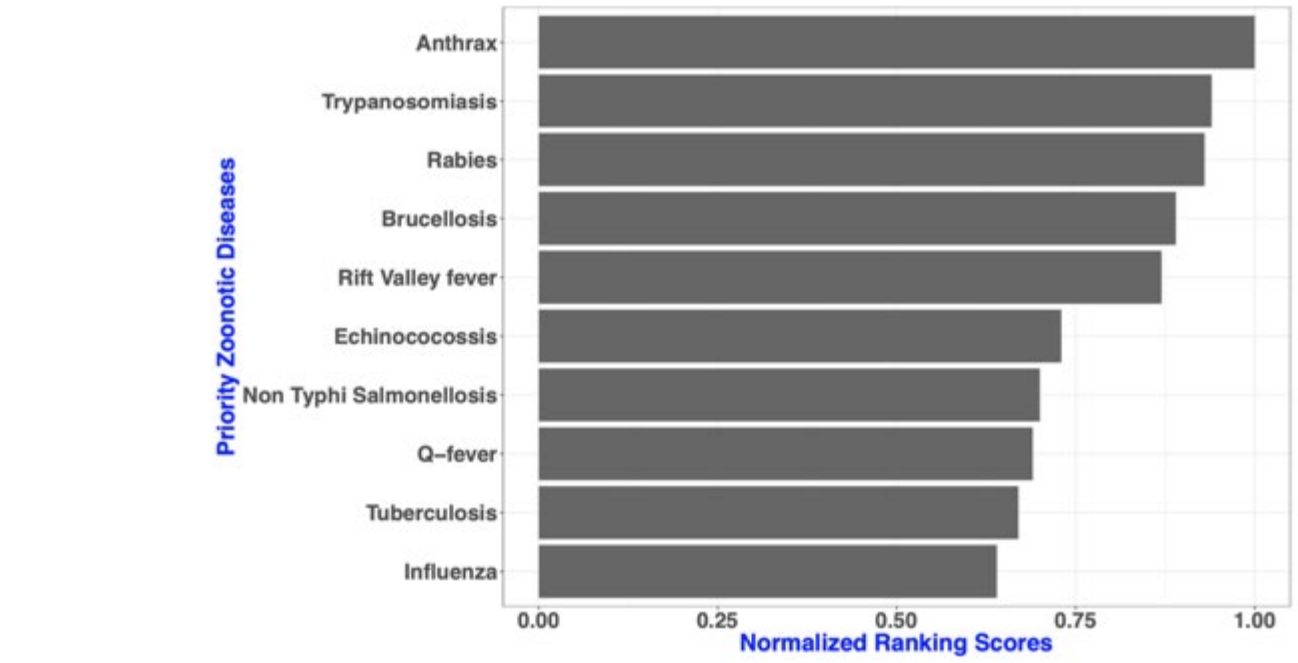
- **Which diseases should be priority for Kenya?**

  Semi-quantitative prioritization process

  1. Identifying diseases to be prioritized
  2. Selection of a ranking criteria for diseases
  3. Assigning weights to the ranking criteria
  4. Scoring each disease and aggregation of scores

Country-level Prioritization of zoonotic diseases

Kenya's top priority zoonotic disease



[1]Eight of 10 top zoonotic diseases are endemic

PLOS ONE

RESEARCH ARTICLE

Prioritization of Zoonotic Diseases in Kenya, 2015

Peninah Munyua[1]*, Austine Bitek[2], Eric Osoro[3], Emily G. Pieracci[4,5], Josephat Muema[2,6], Athman Mwatondo[3], Mathew Kungu[2], Mark Nanyingi[7,8], Radhika Gharpure[4], Kariuki Njenga[9,10], Samuel M. Thumbi[9,10]

Table 2. Ranking of criteria using analytical hierarchical process: criteria weight and rank for each of the groups.

Group	Group 1	Group 2	Group 3	Group 4	Group 5	Overall ranking
Severity of illness	0.43–1	0.24–2	0.49–1	0.35–1	0.28–2	1
Epidemic potential	0.28–2	0.44–1	0.19–3	0.25–2	0.14–3	2
Socio-economic impact	0.17–3	0.10–4	0.07–4	0.21–3	0.48–1	3
Prevalence of disease in humans or animals	0.07–4	0.04–5	0.21–2	0.03–5	0.06–4	4
Interventions	0.05–5	0.18–3	0.04–5	0.16–4	0.05–5	4

- Priority food-borne zoonoses
  - Anthrax
  - Brucellosis
  - Rift Valley fever
  - Echinococossis (Hydatidosis)
  - Non-typhi salmonellosis
  - Q-fever

Country-level Prioritization of zoonotic diseases

Priority zoonotic diseases in 7 countries

Table 4. Final combined prioritized list of zoonoses by the One Health Zoonotic Disease Prioritization Tool for 7 countries, 2014–2016*

	No. countries listing disease, by rank order						
Zoonosis	1	2	3	4	5	6	Total no. countries
Rabies	4		2				6
Zoonotic influenza			3		2		5
Anthrax	2	2					4
Brucellosis (*Brucella abortus and B. melitensis*)		1	2†*	2†*			4†*
Hemorrhagic fevers (Ebola/Marburg)		2		1			3
Salmonellosis		1		1			2
Zoonotic tuberculosis (*Mycobacterium bovis*)	1				1		2
Arbovirus infections (e.g., yellow fever and West Nile virus)						1	1
Crimean-Congo hemorrhagic fever				1			1
Echinococcosis					1		1
Leptospirosis				1			1
Monkeypox					1		1
Rift Valley fever					1		1
Trypanosomiasis		1					1

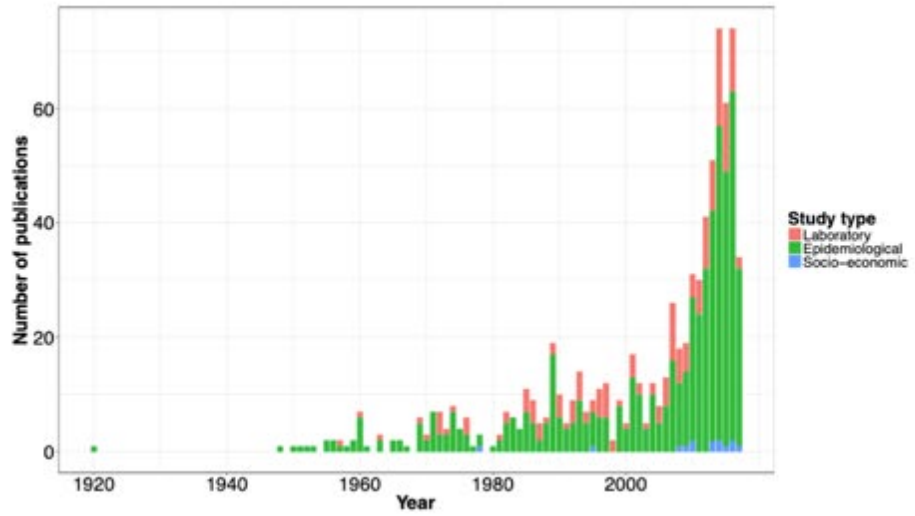
*Countries: Thailand, Kenya, Ethiopia, Azerbaijan, Cameroon, South Africa, Democratic Republic of the Congo.
†One country had both *B. abortus* and *B. melitensis* ranked separately on the final prioritized list.

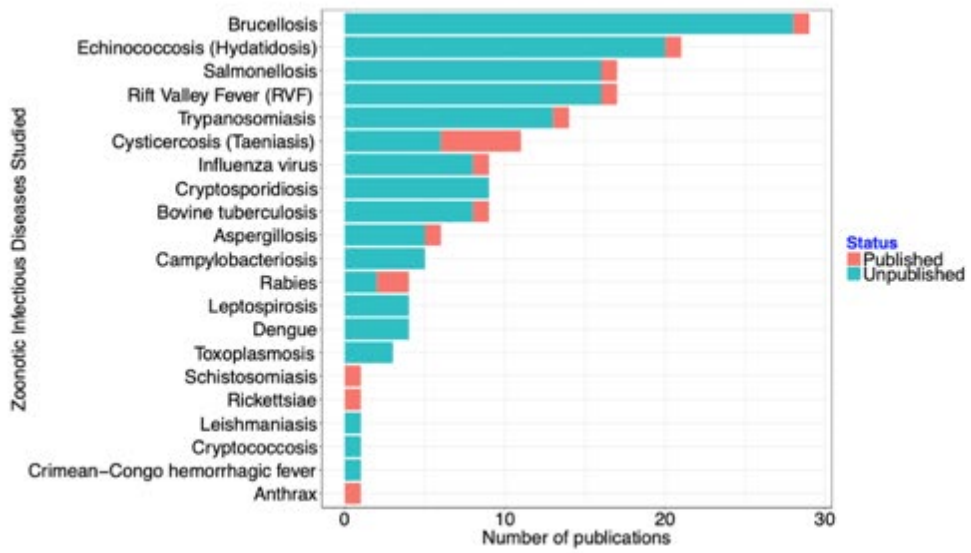
- Most prioritized zoonoses were endemic diseases[2]
- Building capacity on endemic zoonoses can enhance rapid detection and response to outbreaks of emerging zoonotic diseases[3]

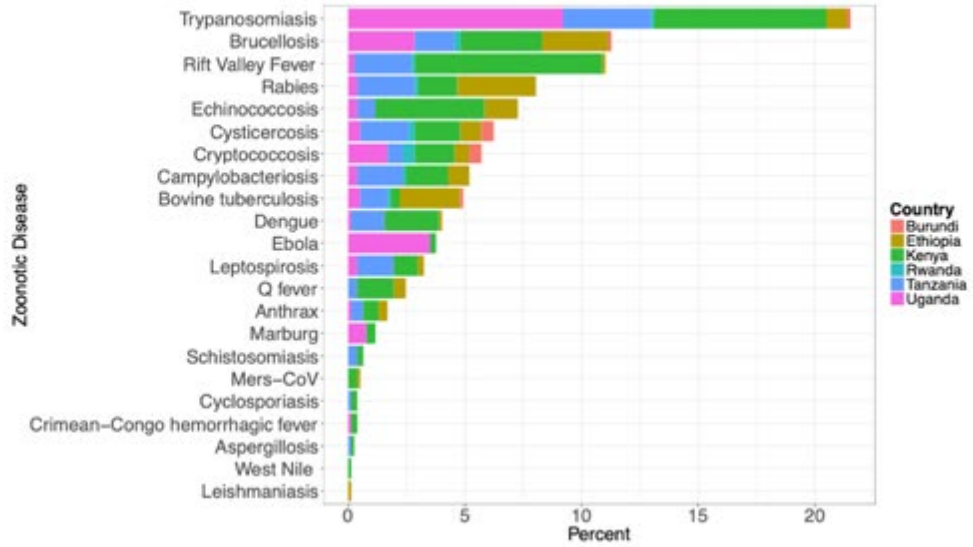
[2]Salyer *et al* (2017) Emerging Infectious Diseases 23:13
[3]Halliday *et al.* (2017), Science 357: 146–148

- Priority food-borne zoonoses
  - Anthrax
  - Brucellosis
  - Salmonellosis
  - Zoonotic TB
  - Echinococossis
  - Leptospirosis
  - Rift Valley fever

Research on Zoonoses in East Africa



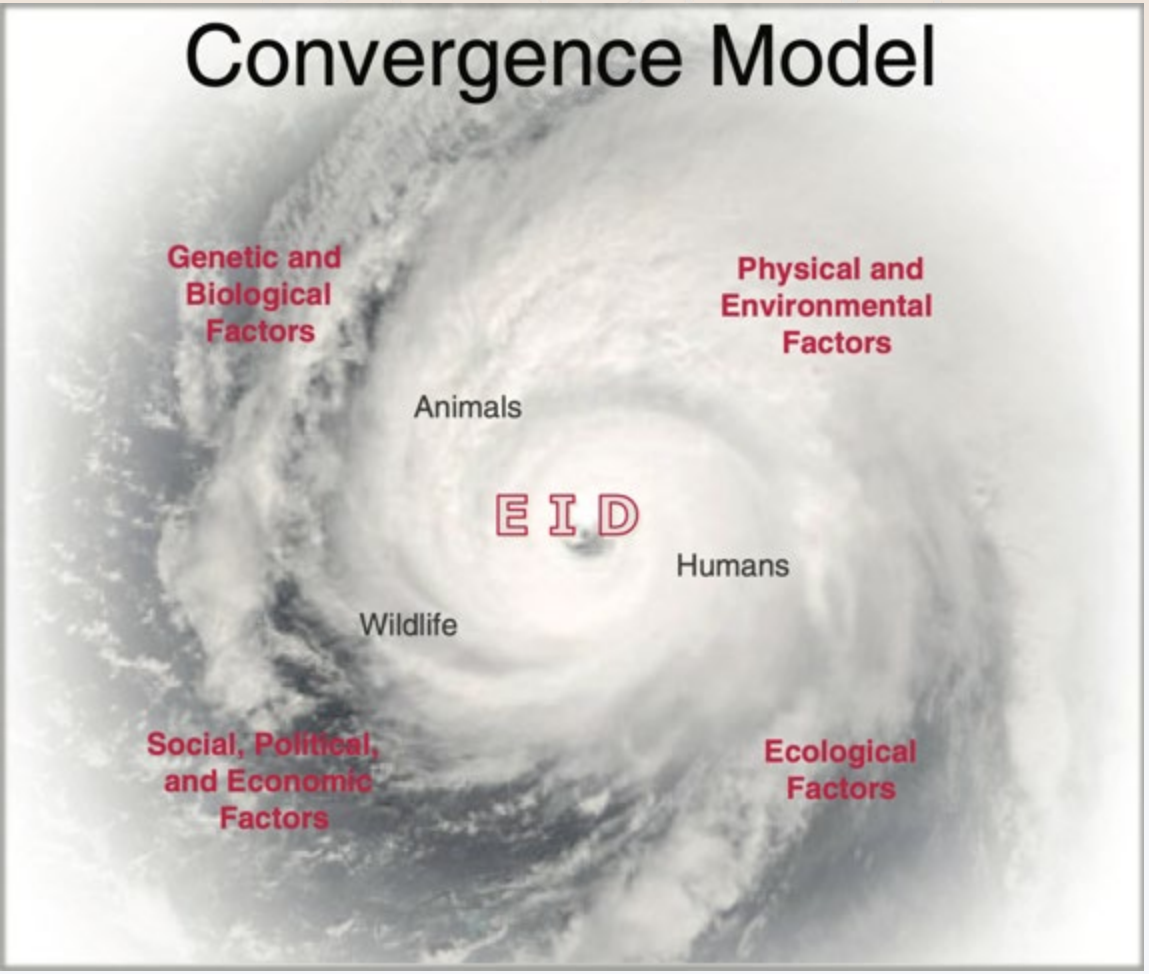




- Growth in zoonotic disease research
- Focus is largely on endemic diseases
- Only 11% of thesis research is published,
- Average 2.5years from thesis production to manuscript publication

Kemunto et al 2018 BMC Infectious Diseases

What are the food-borne zoonoses issues in the region?



- Are they an important public health problem?
- What are the key scientific questions to improve their prevention and control?
- What interventions are most appropriate and how can they be optimized?

Food-borne zoonoses as a public health threat

FAO/WHO Project Report

Improving Food Safety in Meat Value Chains in Kenya

SAMUEL KARIUKI,[1]* ROBERT ONSARE,[1] JOYCE MWITURIA,[1] RONALD NG'ETICH,[1] CYNTHIA NAFULA,[1] KENNETH KARIMI,[1] PURITY KARIMI,[1] FRIDAH NJERUH,[1] PATRICK IRUNGU[2] AND ERIC MITEMA[3]

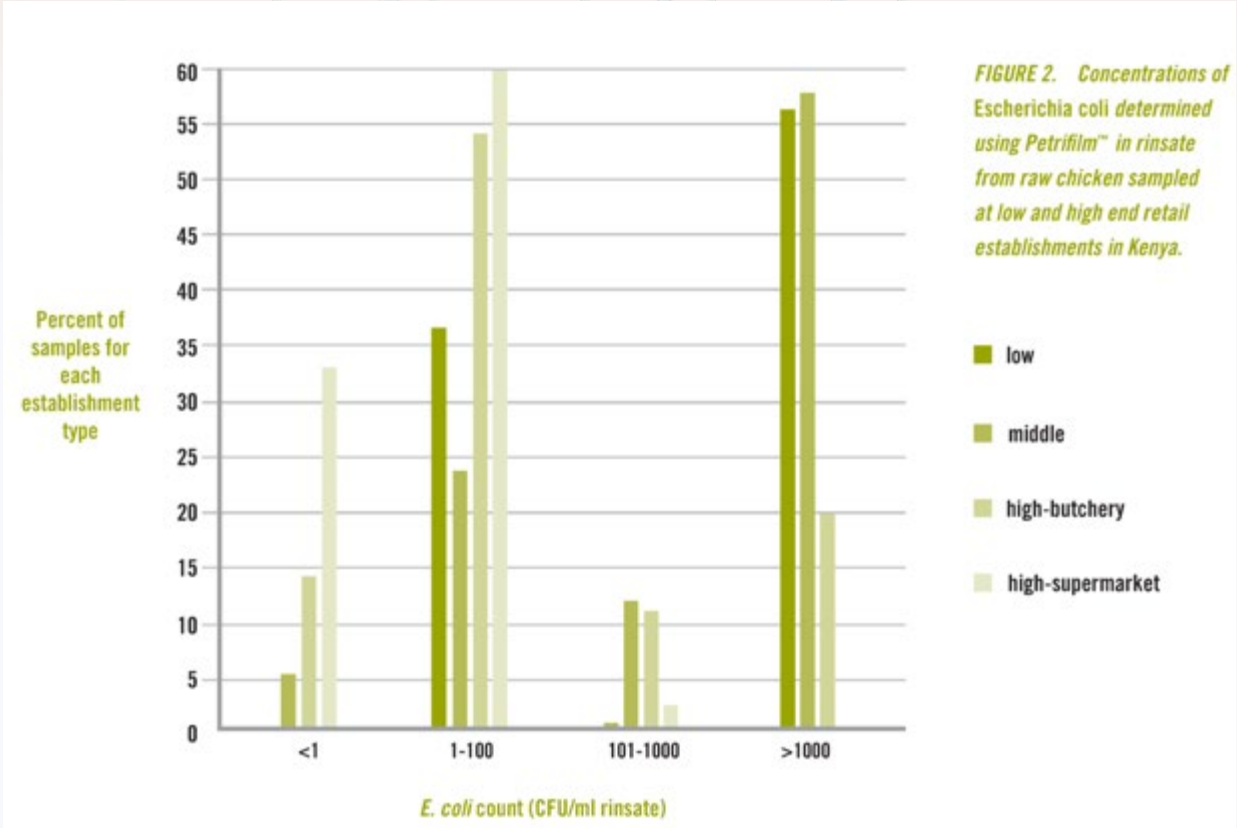


FIGURE 2. Concentrations of Escherichia coli *determined using Petrifilm™ in rinsate from raw chicken sampled at low and high end retail establishments in Kenya.*

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE
IFPRI

PROJECT NOTE | MARCH 2018

FOOD SAFETY IN KENYA: FOCUS ON DAIRY

DELIA GRACE, SILVIA ALONSO, FLORENCE MUTUA, VIVIAN HOFFMANN, TEZIRA LORE, JOSEPH KARUGIA

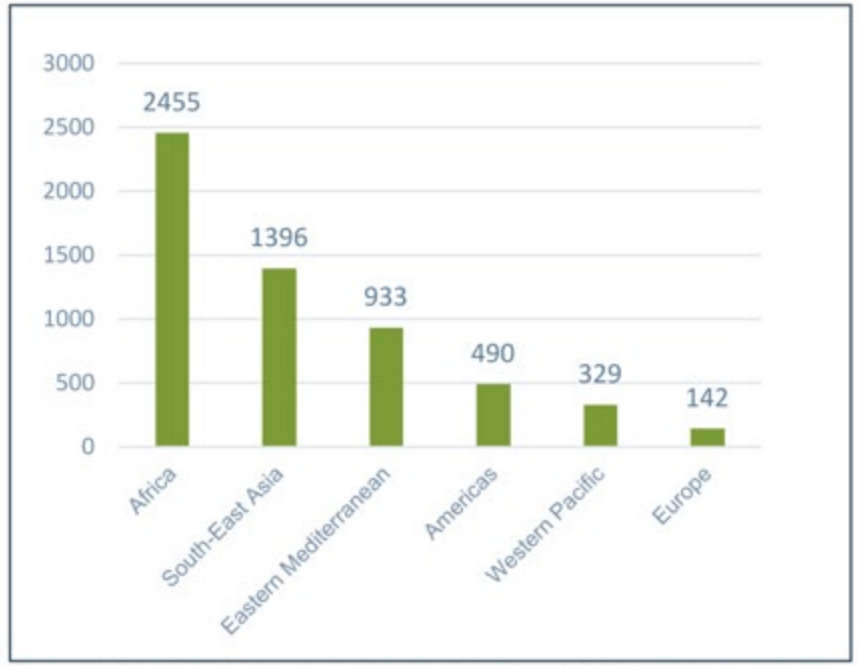


Figure 2. Estimated years of healthy life (DALYs) lost to death or illness per 100,000 population, by region

Scarce data on estimates of the **health and economic burden of** foodborne zoonoses

Key research questions to improve surveillance, prevention and control

Rift Valley fever

RESEARCH ARTICLE

Predictive Factors and Risk Mapping for Rift Valley Fever Epidemics in Kenya

Peninah M. Munyua[1], R. Mbabu Murithi[2], Peter Ithondeka[2], Allen Hightower[3], Samuel M. Thumbi[4], Samuel A. Anyangu[5], Jusper Kiplimo[6], Bernard Bett[6], Anton Vrieling[7], Robert F. Breiman[1], M. Kariuki Njenga[1]*

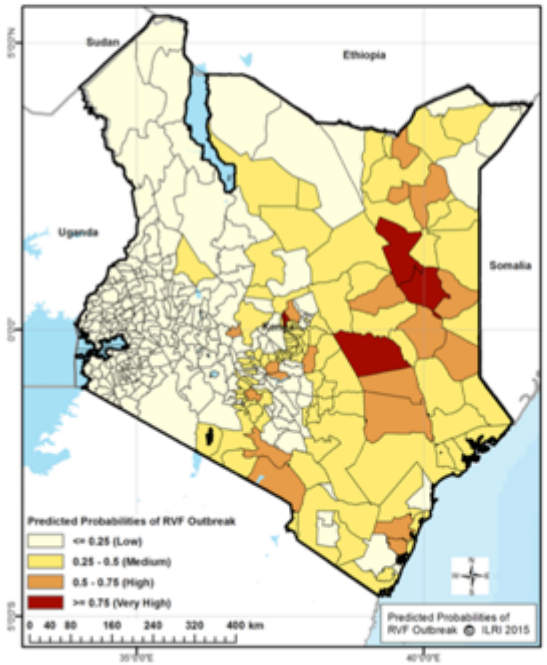


Fig 3. RVF risk map for Kenya generated from predicted probabilities by administrative divisions based on Centre Merged Analysis of Precipitation (CMAP).

PLOS | NEGLECTED TROPICAL DISEASES

RESEARCH ARTICLE

Randomized Controlled Field Trial to Assess the Immunogenicity and Safety of Rift Valley Fever Clone 13 Vaccine in Livestock

M. Kariuki Njenga[1,2]*, Leonard Njagi[3], S. Mwangi Thumbi[2], Samuel Kahariri[3], Jane Githinji[3], Eunice Omondi[3], Amy Baden[1], Mbabu Murithi[3], Janusz Paweska[4], Peter M. Ithondeka[3], Kisa J. Ngeiywa[3], Baptiste Dungu[3], Meritxell Donadeu[5], Peninah M. Munyua[1]

- Identification of RVF hotspots to target surveillance[a]
- No licensed vaccine for humans, and livestock vaccines have safety concerns - "One Health" vaccine[b]
- Testing efficacy of RVF vaccines as an intervention tool[c]

[a]Munyua *et al* (2016) PLoS One 11:1
[b]Warimwe *et al* (2016) Scientific Reports 6:1
[c]Njenga *et al* (2015) PLoS NTD 9:3

- Improving national and sub-national **surveillance** for foodborne zoonosis
- Identification of geographical and value chain **hotspots** for infection
- **Efficacy of interventions** against food-borne zoonoses

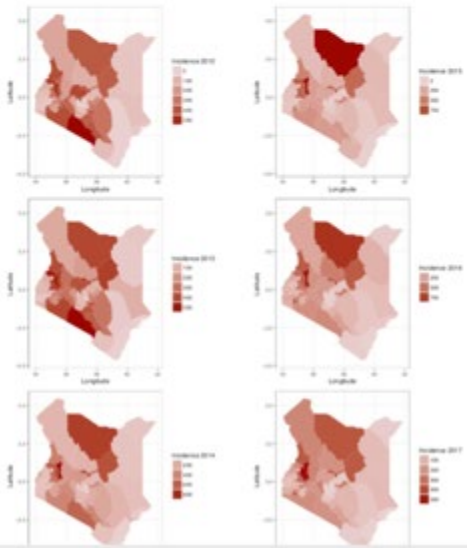
Optimization and delivery of interventions against foodborne zoonoses

Brucellosis

Seroprevalence of brucellosis in humans and livestock species by county, 2012–2013

Seroprevalence	All counties % (95% CI)	Kajiado% (95% CI)	Kiambu % (95% CI)	Marsabit % (95% CI)
Human	16.4 (13.5–19.6)	15.3 (10.5–21.8)	2.4 (1.9–3.0)	46.5 (39.0–54.1)
Livestock	8.0 (6.8–9.4)	3.3 (2.8–4.1)	1.2 (1.0–1.5)	13.5 (11.2–16.2)
Cattle	4.1 (3.4–4.8)	3.3 (3.0–3.5)	0.8 (0.5–1.1)	11.2 (9.2–13.7)
Goat	10.7 (9.3–12.3)	3.6 (2.7–4.7)	1.3 (1.0–1.8)	16.1 (13.9–18.5)
Sheep	7.3 (6.1–8.8)	3.4 (2.8–4.1)	2.4 (1.9–3.1)	11.9 (10.2–13.5)
Camel	11.1 (7.1–17.0)	–	–	11.1 (9.4–15.0)

CI = confidence interval.



- 6-fold odds of human seropositivity in households with sero-positive animals[a]
- Risk factors: ingestion or raw milk, handling infected material
- Brucellosis national incidence 214(range 0 - 983) cases/100,000 people (hotspots in pastrolist regions)[b]
- *Next: Develop Kenya's Brucellosis Control Strategy*

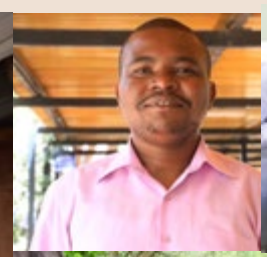
[a]Osoro *et al* (2015) Am. J. Trop. Med. Hyg
[b]Thumbi *et al* (in-preparation)

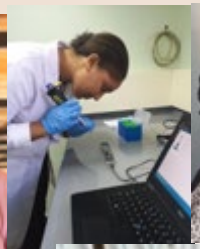
- Multi-host most-pathogen systems
  - Which is (are) the reservoir species?
- Cost-effectiveness of interventions against foodborne interventions
  - Who funds and why should they?
- Planning and effectively rolling out interventions
  - Adoption of interventions and reduction/elimination of foodborne disease burden

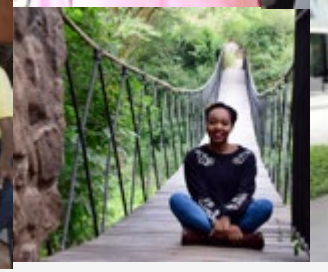
Summary

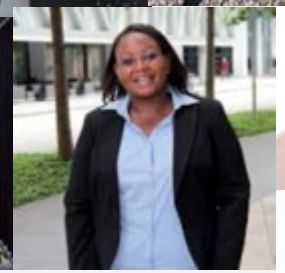
- Estimates of the health and economic burden of foodborne zoonoses is a critical need
  - Surveillance systems that improve detection and attribution of the foodborne zoonoses
  - Multidisciplinary approaches to addressing impact of foodborne zoonoses
- Research on the hotspots (spatial and food-value chain) and drivers for foodborne zoonoses
  - Focus surveillance and intervention efforts
  - Identify drivers that can be manipulated to minimize risk of transmission and burden
- Implementation science for control of foodborne zoonoses
  - Optimization of delivery of available interventions (biological and behavioral)
  - Integration of these programs to existing national human and animal health programs

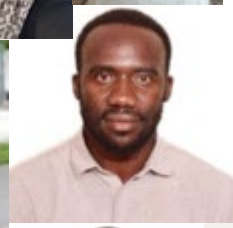
Acknowledgements











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Speaker

Barbara Kowalcyk, Feed the Future Innovation Lab for Food Safety and The Ohio State University

Barbara Kowalcyk, Ph.D., is faculty at The Ohio State University in the Department of Food Science and Technology and director of the Center for Foodborne Illness Research and Prevention. She is also affiliated with Ohio State's Translational Data Analytics Institute, Global One Health initiative, and College of Public Health. An expert in food safety with experience and training in epidemiology, biostatistics, risk analysis, and public policy, Kowalcyk works to advance more systems-based approaches to food safety that promote evidence-based decision-making from farm to fork to physician; and considers the connectedness of human, animal, and environmental health.

Chakula Salama: A Risk-based Approach to Reducing Foodborne Disease and Increasing Production of Safe Foods in Kenya

Barbara Kowalcyk, PhD

CENTER FOR FOODBORNE ILLNESS RESEARCH AND PREVENTION

The Ohio State University
Food Science & Technology

Food Safety is a Global Public Good

- Critical to food security, nutrition.
- Serious public health issue.
  - 600 million illnesses/year
  - Children bear most of burden
  - Associated with long-term health outcomes
- Significant economic impact.
  - Medical costs, lost productivity
  - Loss of consumer confidence
  - Reduced market access
  - Increased food loss and waste

The Burden of Foodborne Disease

Every year foodborne diseases cause:

almost **1 in 10** people to fall ill

33 million healthy life years lost

Foodborne diseases can be deadly, especially in children <5

420 000 deaths

Children account for almost **1/3** **of deaths from foodborne diseases**

For more information: **www.who.int/foodsafety**

#SafeFood

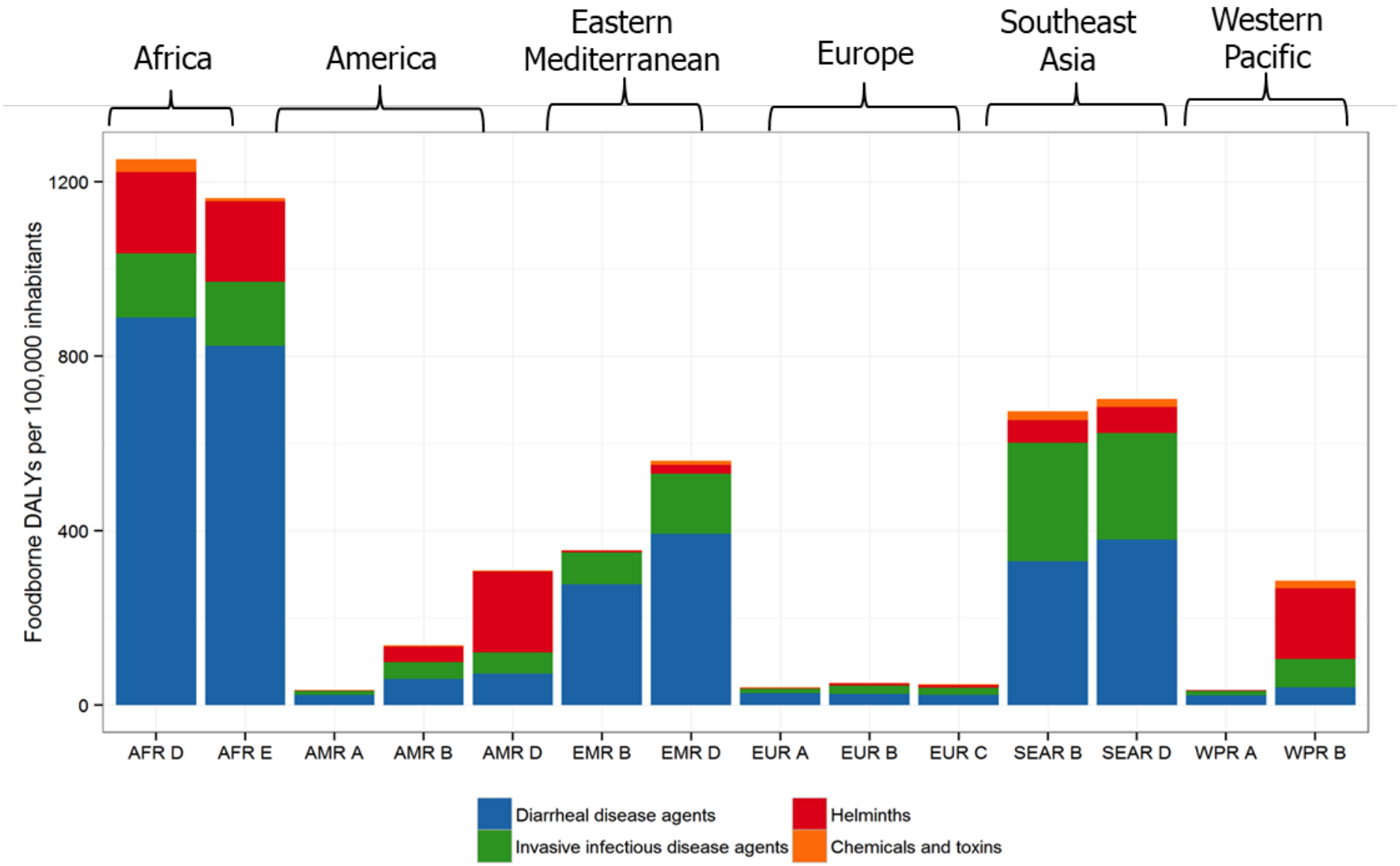
Source: WHO Estimates of the Global Burden of Foodborne Diseases. 2015.

World Health Organization

Long-term Health Impact

Autoimmune Disorders	**Reactive Arthritis** – associated with many foodborne pathogens; rates vary from 2.3% to 15%. **Guillain-Barre Syndrome** – *Campylobacter* is common trigger and accounts for 40% of cases in U.S.
Digestive Disorders	**Irritable Bowel Syndrome** – associated with many foodborne pathogens; causes estimated 17% of cases. **Irritable Bowel Disease** – includes Crohn's Disease, Ulcerative Colitis.
Neurological Disorders	**Sepsis, Meningitis, Respiratory distress** **Paralysis, palsies, seizures, epilepsy** **Cognitive impairment, visual/hearing impairment**
Renal Failure & Associated Sequelae	**Hemolytic Uremic Syndrome (HUS)** – severe, life-threatening illness; leading cause of acute kidney failure in children under age 5 in U.S.; associated with STEC, *Shigella*. **Chronic kidney disease, End stage renal failure, Chronic hypertension, Pancreatitis, Diabetes mellitus** – often secondary to HUS.
Emerging Issues	**Schizophrenia, psycho-social disorders** – recent studies have found increased risk for toxoplasmosis but not well understood. **Urinary tract infections**

Global Burden by Hazard Groups and by Subregion



Havelaar AH, Kirk MD, Torgerson PR, Gibb HJ, Hald T, et al. (2015) World Health Organization Global Estimates and Regional Comparisons of the Burden of Foodborne Disease in 2010. PLoS Med 12(12): e1001923. doi:10.1371/journal.pmed.1001923
http://journals.plos.org/plosmedicine/article?id=info:doi/10.1371/journal.pmed.1001923

Managing the Risks

Failures in the System

South Africa and the World's Worst Listeriosis Outbreak

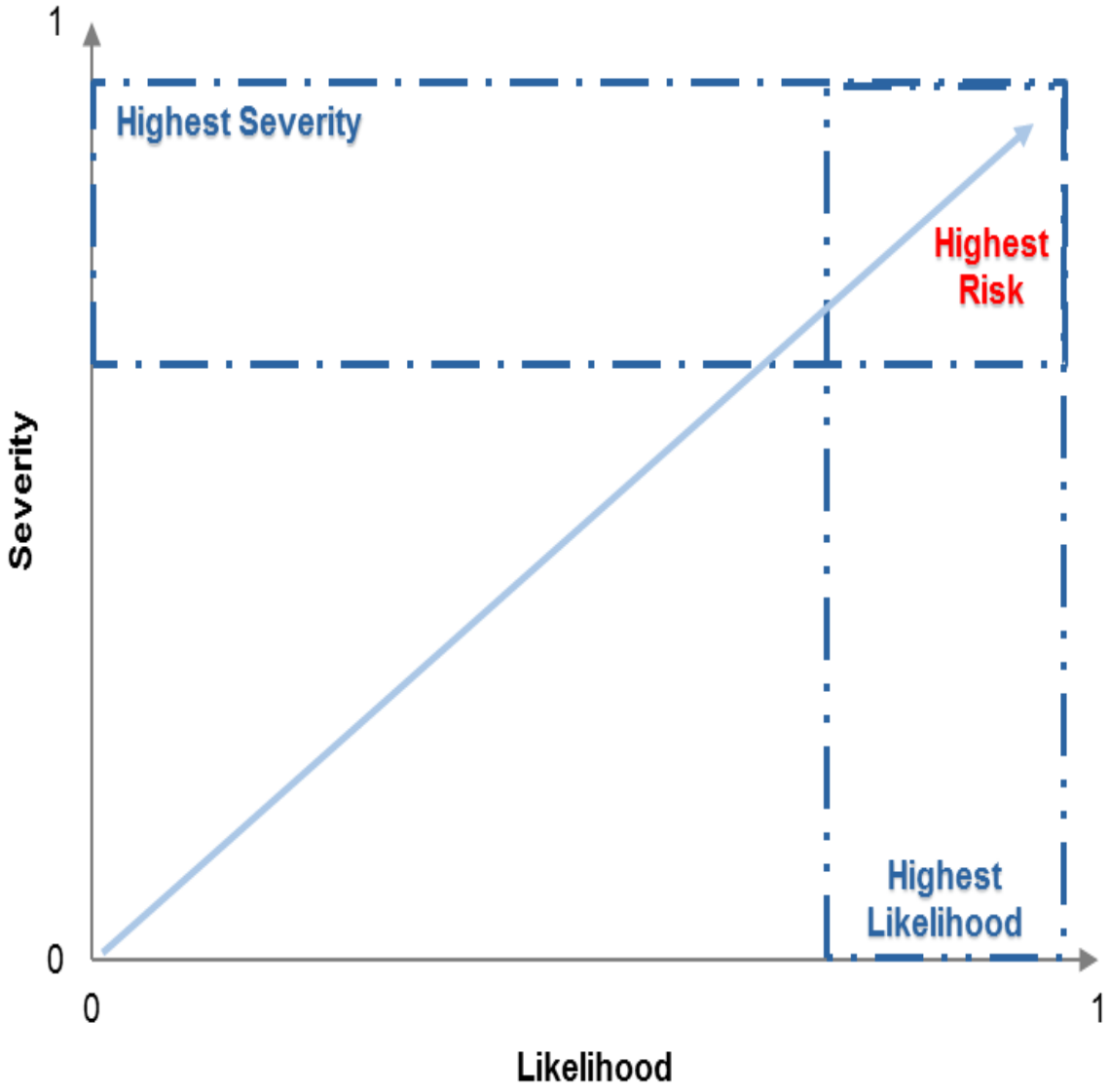
Ethiopia: Genesis Farm Dumps 3,000 Liters Of Milk Per Day

A Risk-Based Approach

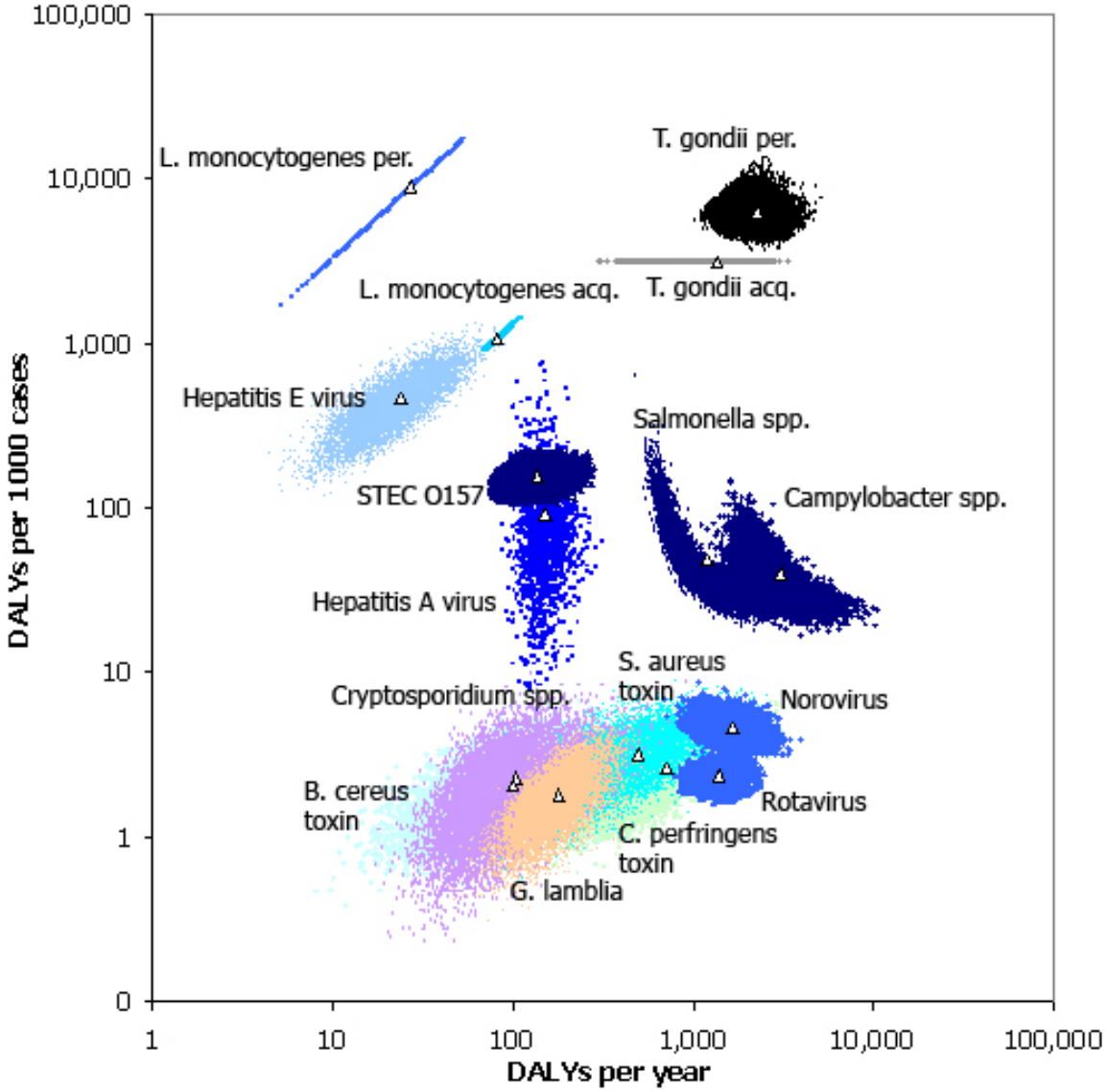
- Proactive and data-driven
- Grounded in risk analysis
- Systematic and transparent
- Ranks risks based on public health impact
- Prioritizes allocation of resources to manage risk most effectively
- Considers other factors in decision-making (i.e. perception, cost, environmental/market impacts)
- Evaluates efficacy of risk management on continuous basis
- Involves all stakeholders

Source:
https://www.ncbi.nlm.nih.gov/books/NBK220408/pdf/Bookshelf_NBK220408.pdf

Assessing and Ranking the Risks

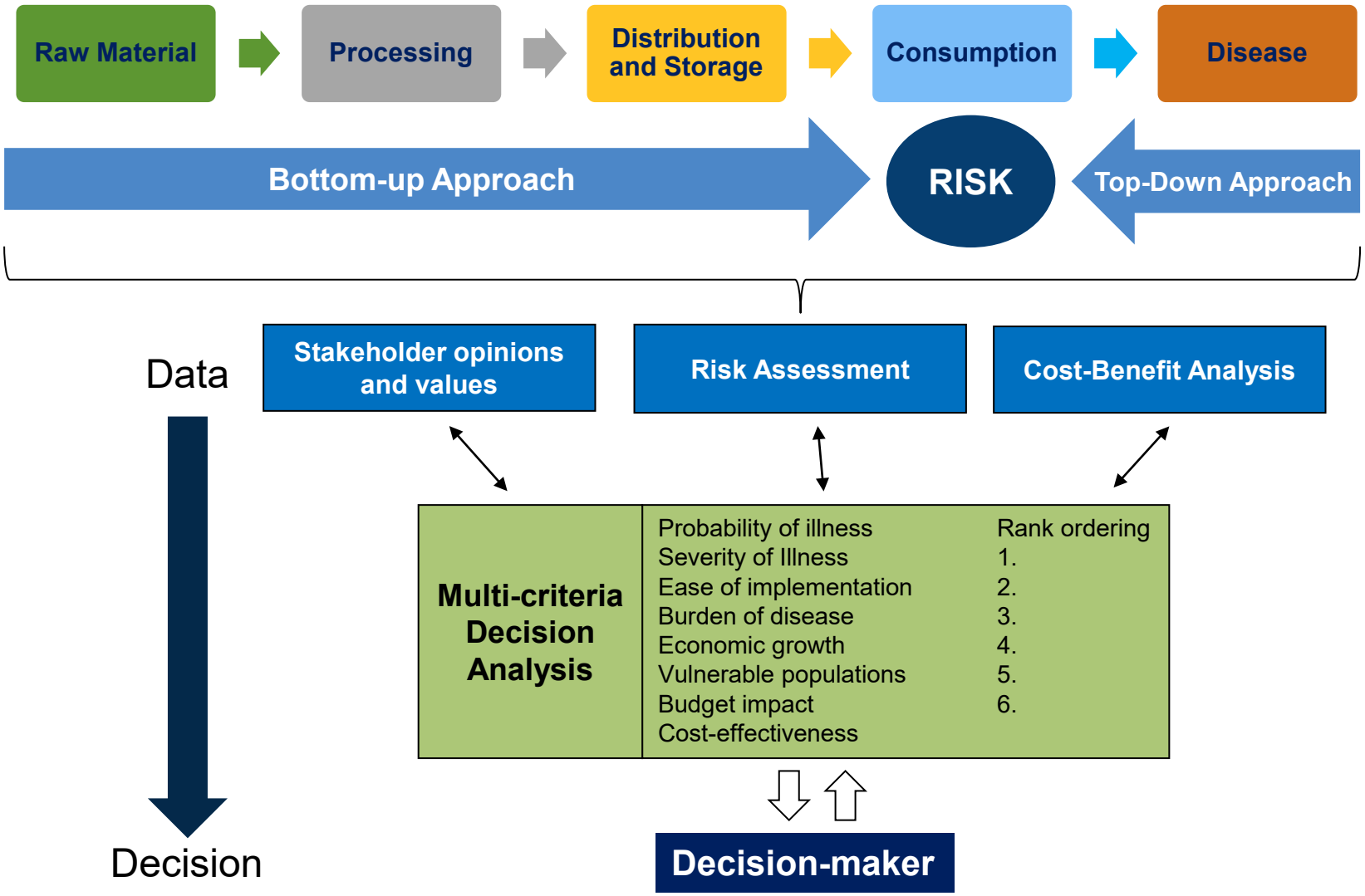


Assessing and Ranking the Risks

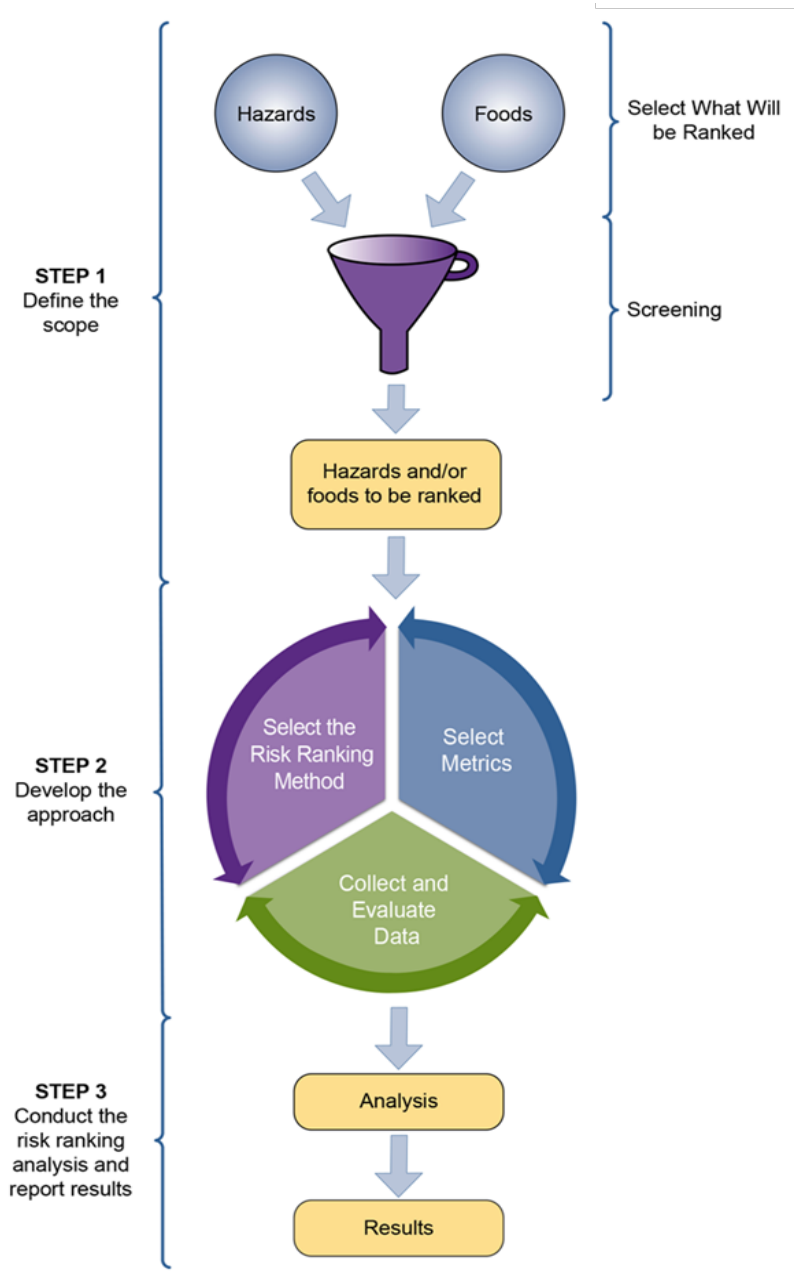


Source: Havelaar et al., Zoon Publ Health 2007;54:103-117

From Data to Decision



Risk Ranking can be Challenging



- **Several methods/tools out there**
- **But where do we start?**
  - Multitude of hazards/foods
  - Number, complexity of methods
  - Resource needs
- **Quantitative approach not always feasible or appropriate**
- **Need structure so risk ranking efforts can be built upon**
- **Developed preliminary guidance with FAO on how to start ranking food safety risks**

Chakula Salama

- **Goal:** Improve food security and nutrition in Kenya by developing capacity for risk-based approaches to food safety, reducing risk of FBD, increasing production of safe food, and improving economic outcomes.
- **Key outcomes:**
  - Roadmap for making risk-based decisions and allocating food safety resources that can be extended to other value chains, pathogens, and/or LMIC
  - Increased resources in Kenya to implement such an approach.

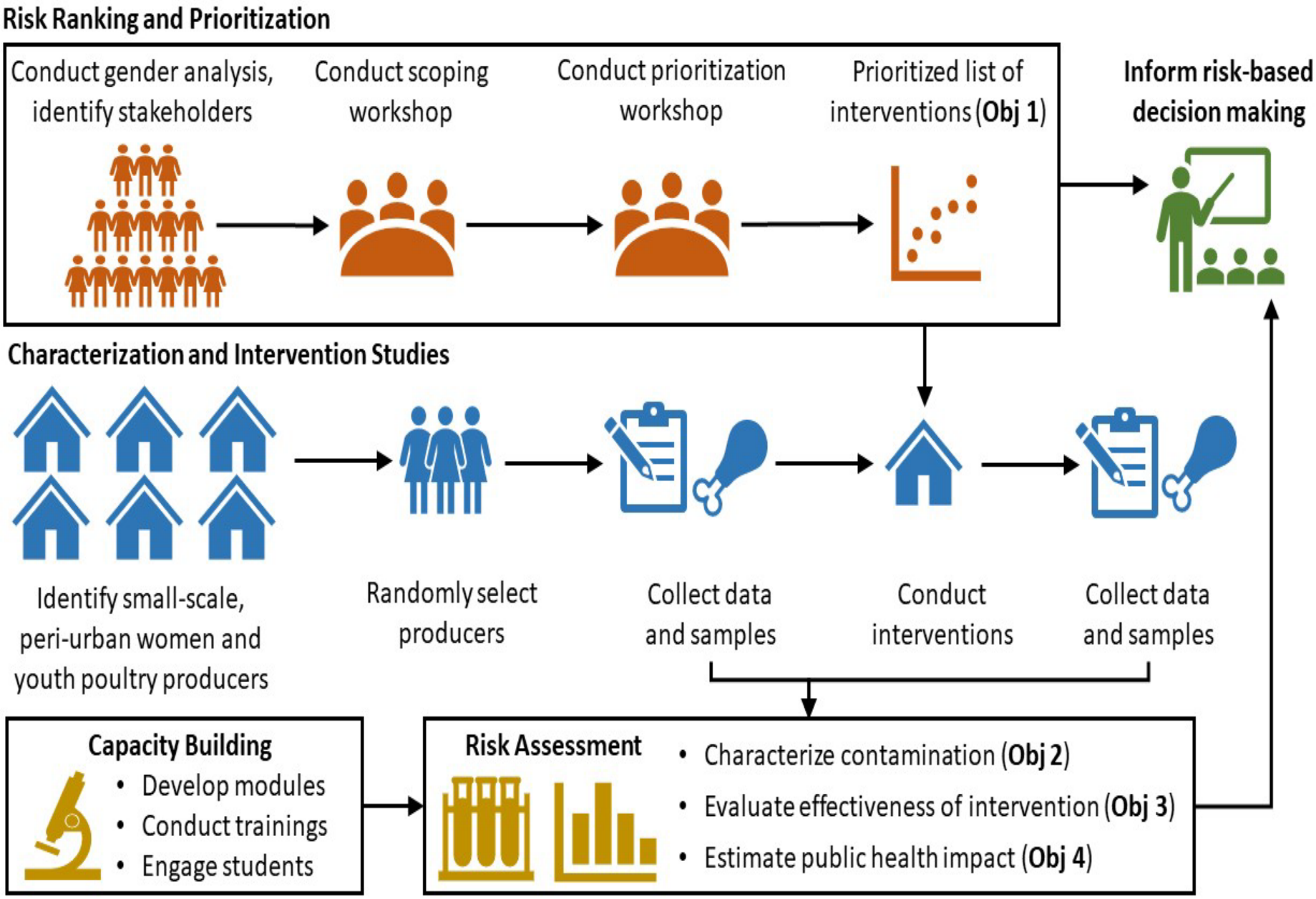
Poultry in Kenya

- Important dietary component for poor and middle-class Kenyan households
- Significant source of income for women and youth
- Traditional processing often occurs in informal settings and rarely includes pathogen mitigation strategies
- Focus on *Salmonella enterica* and *Campylobacter* spp. in poultry value chains managed by women and youth farmers in peri-urban areas of Kenya

Objectives

1) Identify, in collaboration with stakeholders, food safety priorities for poultry value chains in Kenya using a risk-informed approach.
2) Characterize *Salmonella enterica* and *Campylobacter* spp. in poultry value chains managed by women and youth farmers in peri-urban areas of Kenya.
3) Develop and evaluate the efficacy of culturally and gender appropriate, practical, and scalable intervention strategies for mitigating risk of *Salmonella enterica* and *Campylobacter* in poultry that effectively account for gendered roles in poultry production.
4) Estimate the public health impact and evaluate the benefits and costs from selected intervention strategies to inform public and private decision-making.

Project Overview



Project Team

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  - Arie Havelaar
- **Kenya Medical Research Institute**
  - Robert Onsare
  - Sam Kariuki
- **University of Nairobi**
  - Catherine Kunyanga

Questions?

**“As for the future,
your task is not to foresee it,
but to enable it.”**

- Antoine de Saint-Exupery
French Writer, 1900-1944

Thank You!

Kowalcyk.1@osu.edu

- Guiseppe Arcimboldo

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Food Safety and One Health: Approaches to Reducing Foodborne Pathogens and Zoonotic Diseases

Panel Discussion

Martin Wiedmann
Framing Food Safety and Zoonotic Disease

Thumbi Mwangi
Research-Driven Approaches to One Health

Barbara Kowalcyk
Food Safety Research and Zoonotic Disease

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Thank You!

Please join us for our next webinar on food safety and nutrition in February 2021.

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