World Organisation for Animal Health
Founded as OIE

UNIVERSITY OF LIVERPOOL

Global Burden of Animal Diseases (GBADs)
- *Vision to implementation*

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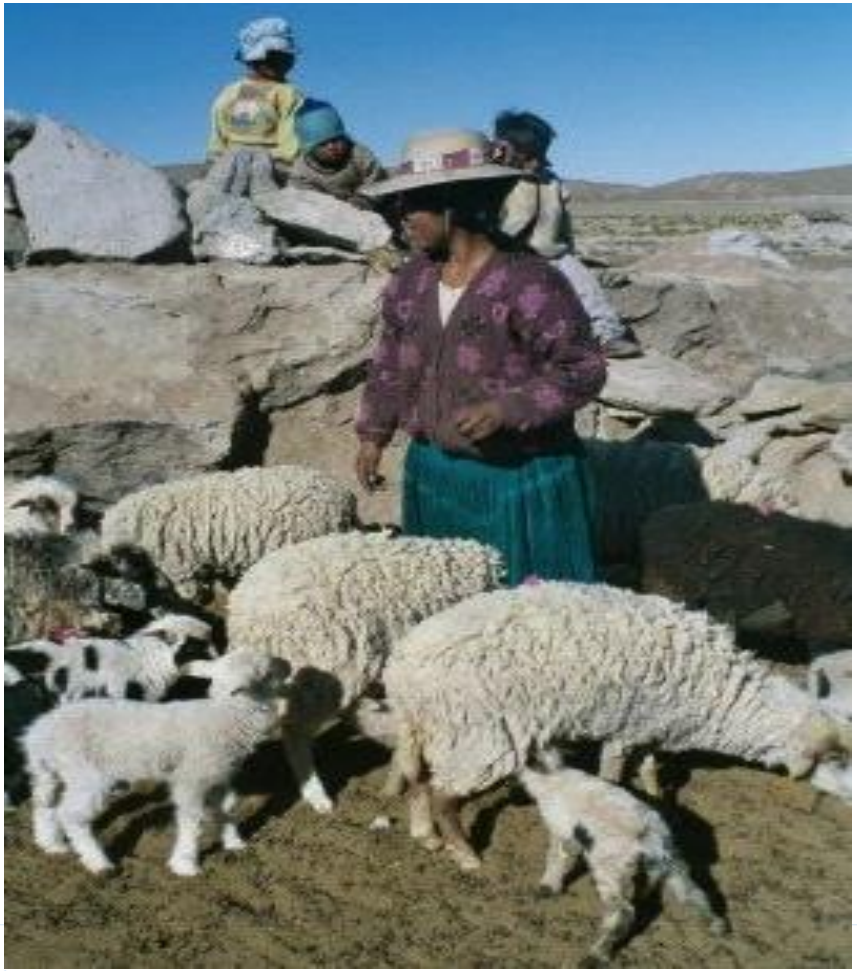
Special Seminar
Roslin Institute, University of Edinburgh
29th April 2024

https://animalhealthmetrics.org

GBADs

Juanita Peréz - A woman livestock keeper living on the ***margins***












These are people who depend on livestock and aquatic animals
They are people living on the ***margins of society***

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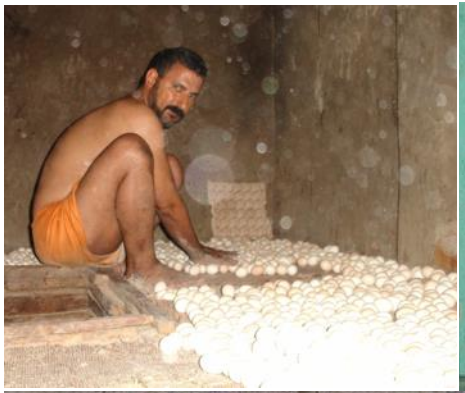
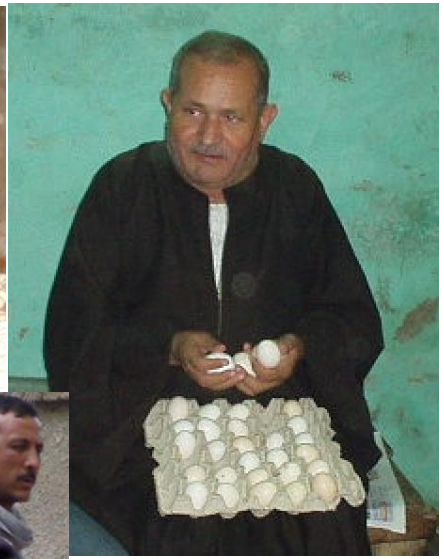
Poorly defined targeting of the animal health resources for poor disadvantaged livestock keepers

- Lack of data and information for the public and private sector to build business cases to address the last mile of delivery
- It is suspected that expenditure versus production loss is stark in many livestock systems
- Hundreds of millions of poor livestock owners are poorly served with veterinary services



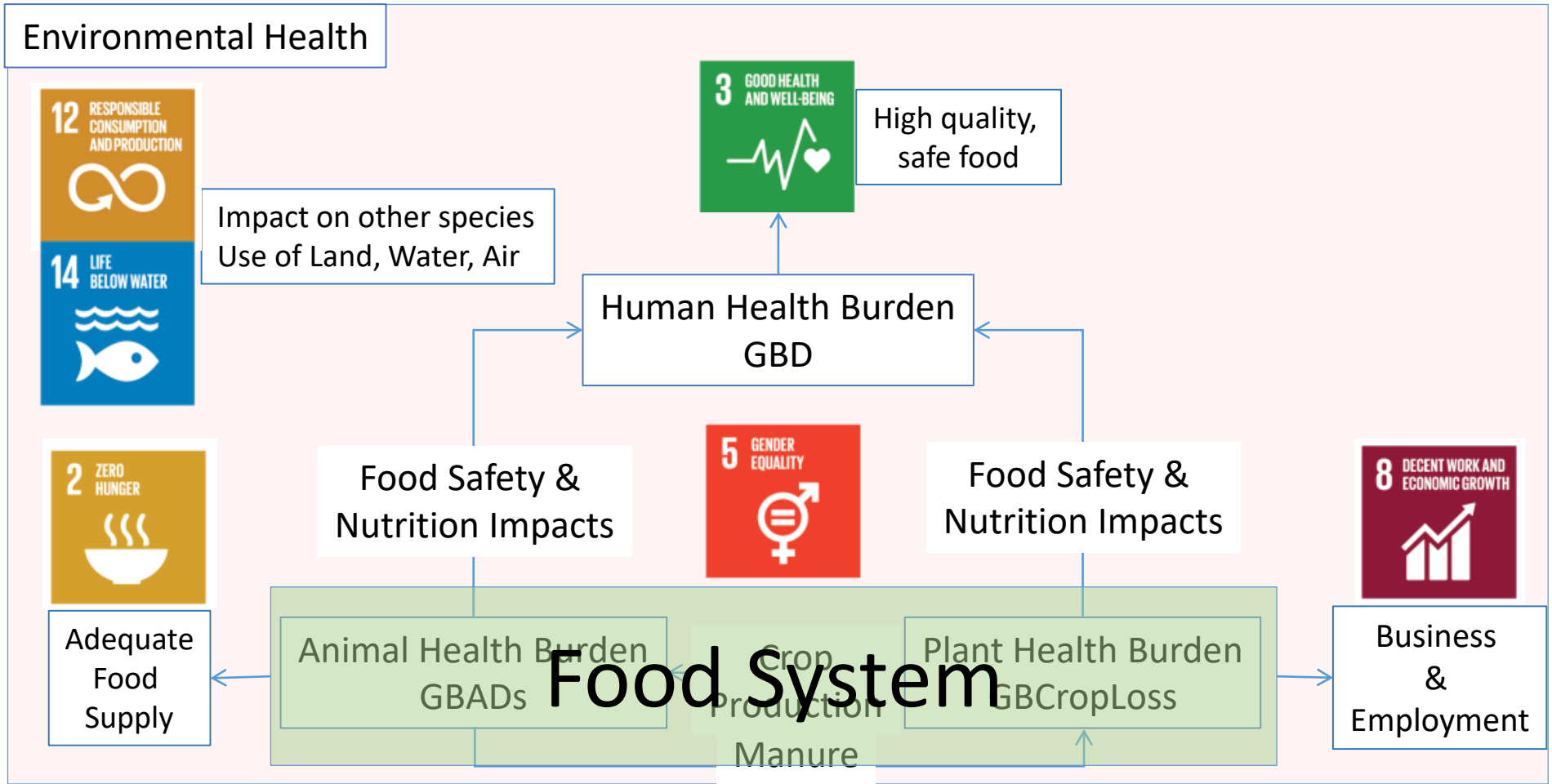


Difficult funding environment for animal health

- Lack of data and information to build business cases
- World Bank teams struggle with analyses
- Evidence the global programmes for FMD and PPR are still not adequately funded at global or national levels

Little or no information on the success (or failure) of animal health policy areas

- No time series data on livestock production, productivity and trade that isolate animal health inputs and outputs
- Public strategy and policy development people are dissatisfied with current datasets available
- Recent attempts at a cost benefit analysis of rinderpest eradication failed to generate enough data to do justice to the success of this programme


Environmental Health
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
14 LIFE BELOW WATER
Impact on other species
Use of Land, Water, Air
3 GOOD HEALTH AND WELL-BEING
High quality, safe food
Human Health Burden
GBD
2 ZERO HUNGER
Food Safety & Nutrition Impacts
5 GENDER EQUALITY
Food Safety & Nutrition Impacts
8 DECENT WORK AND ECONOMIC GROWTH
Adequate Food Supply
Animal Health Burden
GBADs
Crop Production
Manure
Plant Health Burden
GBCropLoss
Business & Employment
Food System

Definitions

- **Global** – we will make estimates at a world level built on information from member states and private sector stakeholders
- **Burden** – our estimates will be based on the economic and social impacts of diseases
- **Animal** – we cover terrestrial and aquatic species that are kept for food, wool, manure, power, social capital
- **Diseases** – our estimates cover infectious, non-infectious and external causes (injury, accidents, predation)

Global Burden of Animal Diseases - GBADs

What motivates the GBADs programme?

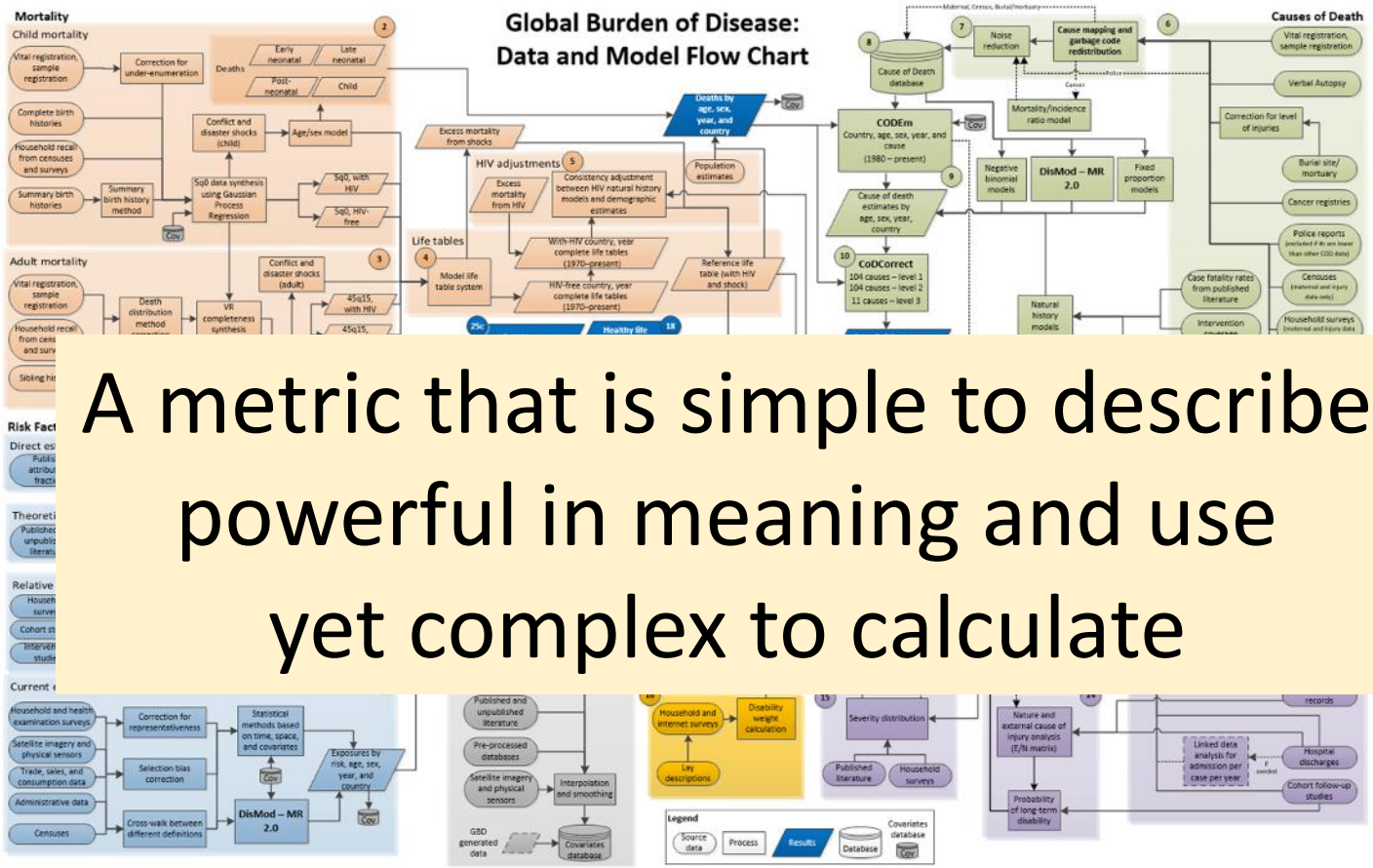
Our livestock keepers, consumers and the environment need:

- **Investment plans** which ensure there are adequate animal health systems
- **Allocation of resources** to problems that most affect their health and wellbeing
- **Evaluation** of animal health investments to ensure they are delivering on societal outcomes

Vision

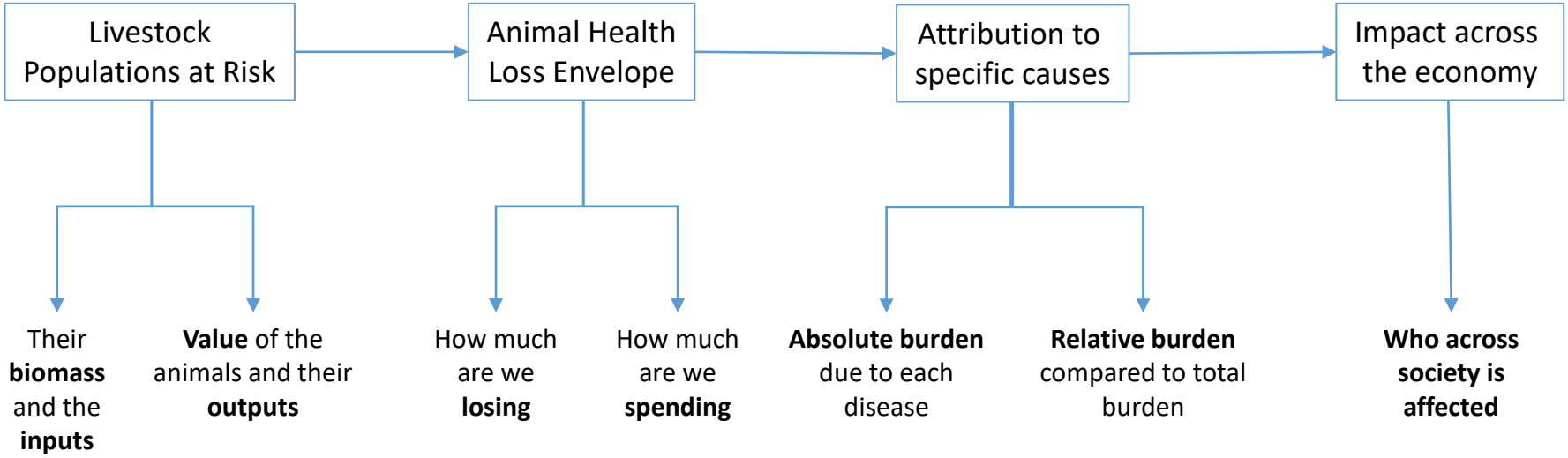
- **Vision:** For GBADs to be a world leader on livestock data and analysis for the economics of animal health built on data science and epidemiology
- **How:**
  - Tested and accepted methods of burden estimation
  - Publication of dataflow and methods
  - Publication and endorsement of global, regional and national burden estimations
  - Operational excellence in delivery of an expanded programme
  - Growing number of people and organisations using our approach
- **Value:** better investment, allocation and evaluation of animal health systems

GBADs – framework development and country case study implementation



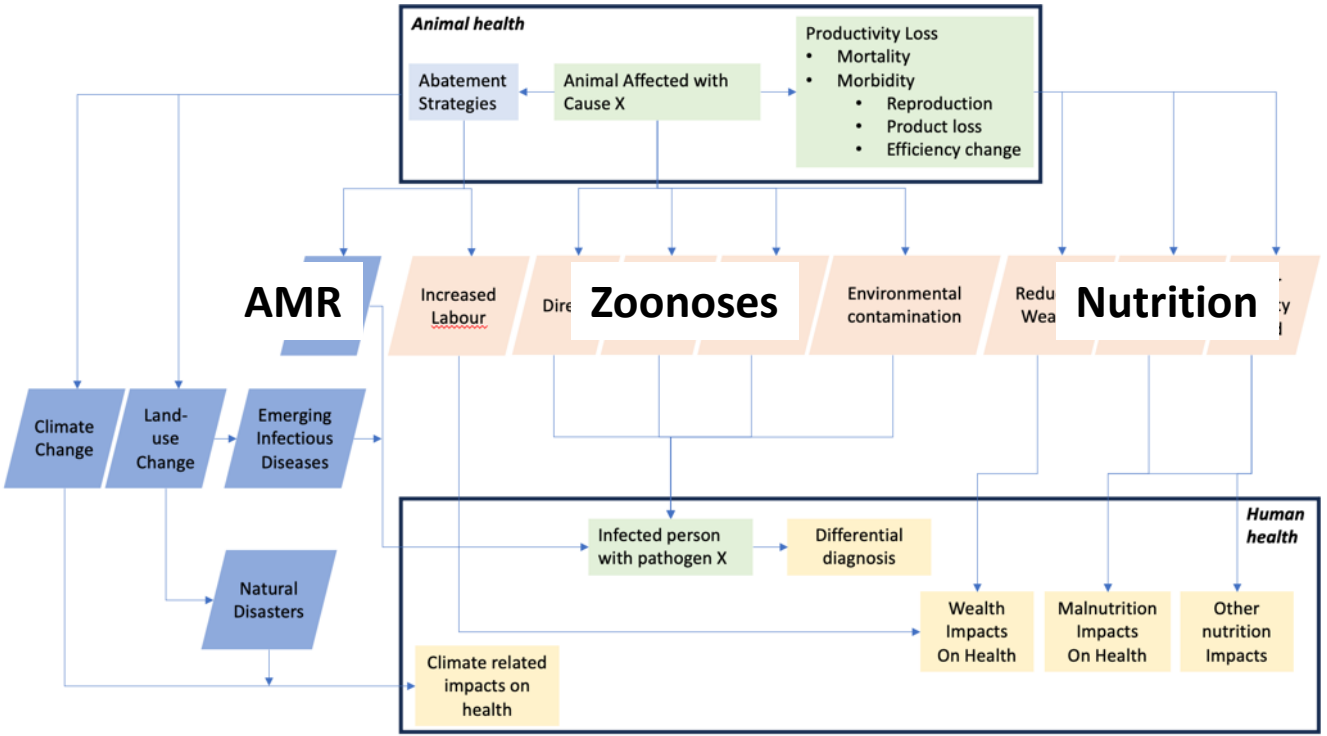
A metric that is simple to describe
powerful in meaning and use
yet complex to calculate

GBADs - Analytical structure to provide clarity on data and analysis



Rushton et al 2021

Framework to capture interactions between human and animal health



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Courtesy of David Pigott, Brecht Devleesschauwer

Global and national burden estimations

Number of animals

$$N$$

Biomass

$$N \times W = Biomass$$

$$W \ - weight\ per\ head$$

Asset Value

$$N \times W \times P = Asset\ Value$$

P —*price per unit of weight*

Economic Value (EV) - Asset plus Output Value

$$(N \times W \times P) + (O \times P) = EV$$

O $-total\ weight\ of\ output$

Mortality loss

$$(N \times Mr) \times W \times P = Mortality\ loss$$

Mr $-$ *proportion of mortality loss*

Morbidity loss

$$(O \times El) \times P = Morbidity\ Loss$$

El – *yield gap proportion*

P – *price per unit of livestock product*

Expenditure

$$EV \times C = Expenditure$$

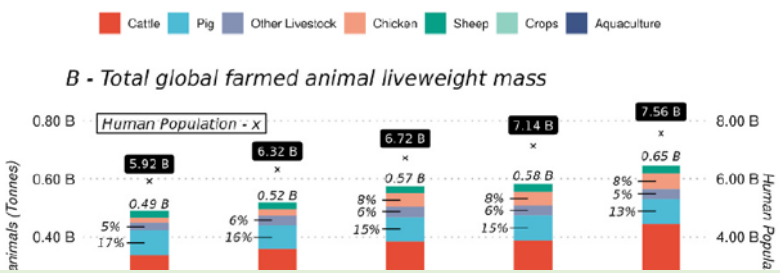
C $-proportion\ of\ EV$

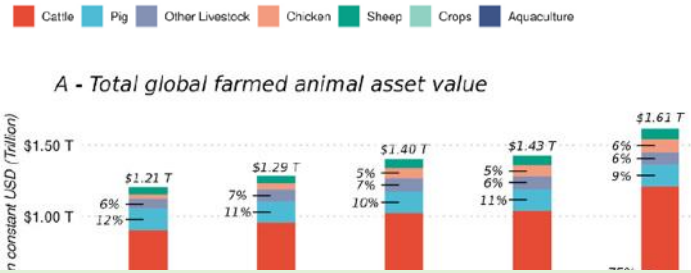
Animal Health Loss Envelope

$$(N \times W \times P \times Mr) + (O \times P \times El) + (EV \times C) = AHLE$$

- $(N \times W \times P \times Mr)$: Change in Assets
- $(O \times P \times El)$: Change in Revenue
- $(EV \times C)$: Change in Expenditure

Global livestock biomass (Schrobback et al, 2023)

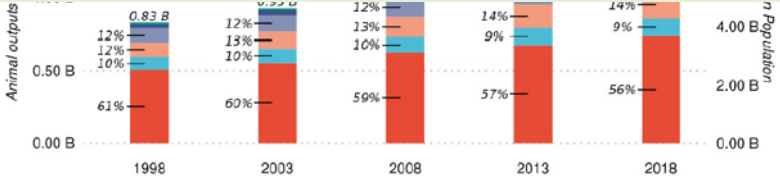


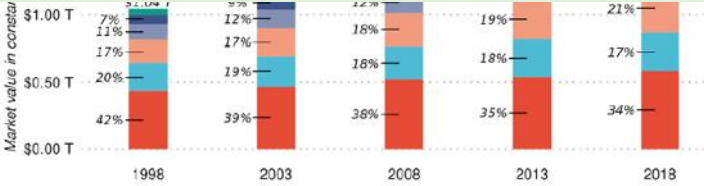


0.6 billion tonnes of livestock and farmed aquatic species

US$1.6 trillion invested in these animals

US$ 1.7 trillion in meat, milk and eggs





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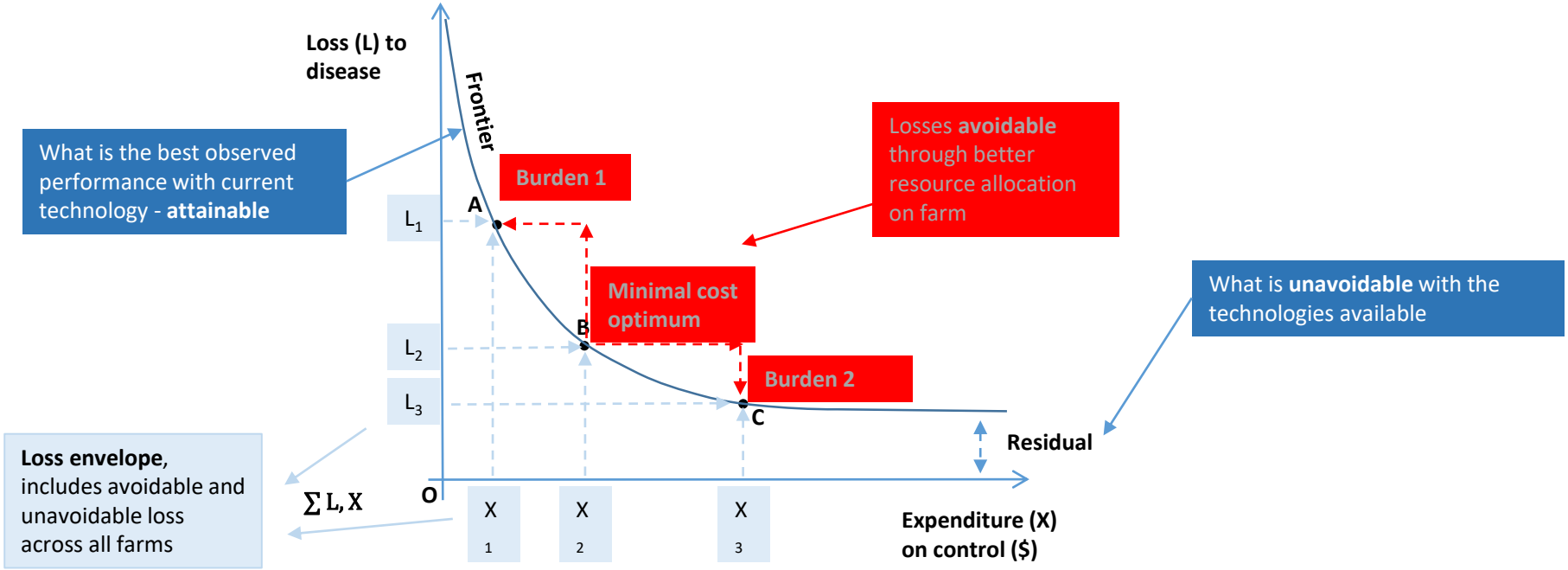
GBADs

Relative and absolute losses to disease - Animal health loss envelope



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Courtesy of Will Gilbert

GBADs

Avoidable and unavoidable losses

- Total burden (AHLE) can be divided between **avoidable** and **unavoidable** losses
- Avoidable losses indicate technical and allocation issues within the system
  - **Spending the wrong amount, on the wrong things**
  - **Unequal access across the population**
- Unavoidable losses indicate lack of technical options for producers
  - **The interventions needed don’t exist, or are not accessible to the population**

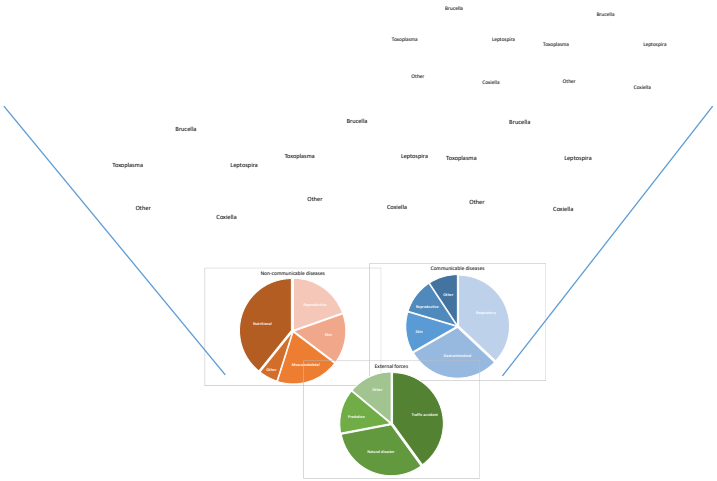
Attribution

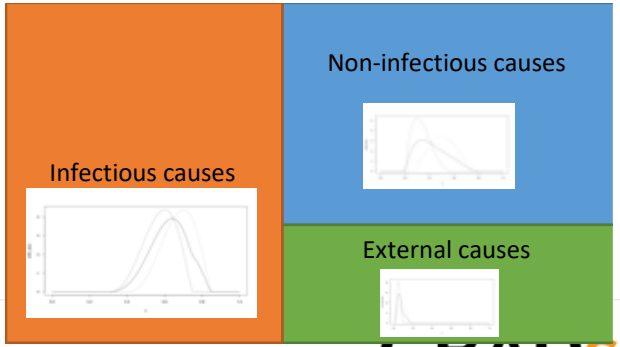
- To attribute the AHLE by a type of disease or health problem you need data on presence of the problem and its impact on mortality and morbidity
- Our public surveillance systems are established to focus on transboundary animal diseases in livestock with normally an indicator of present or absent – not a level
  - There are systems in the private sector where diseases and health problems are monitored yet these data are private
- The research and hence the literature on the impact of a disease issue is variable

Attributing AHLE to specific causes

Cause-specific models

Level I – IV





Courtesy of Mieghan Bruce and her team

https://animalhealthmetrics.org

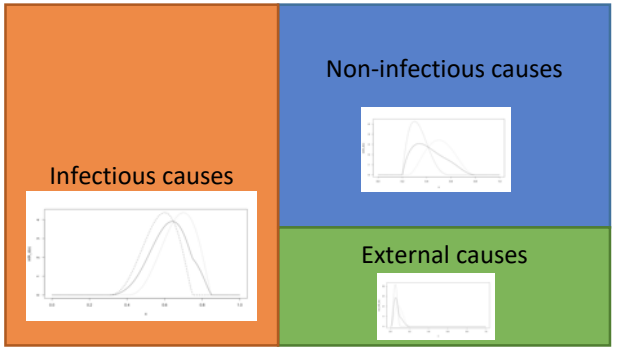
GBADs

All-cause

Level I

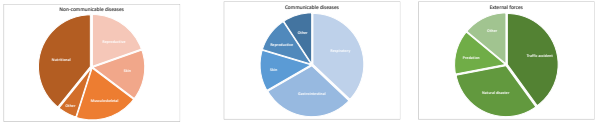
Broad group

ATTRIBUTION



Level II

Aggregate group



Level III

Cause-specific

ATTRIBUTION

Level IV

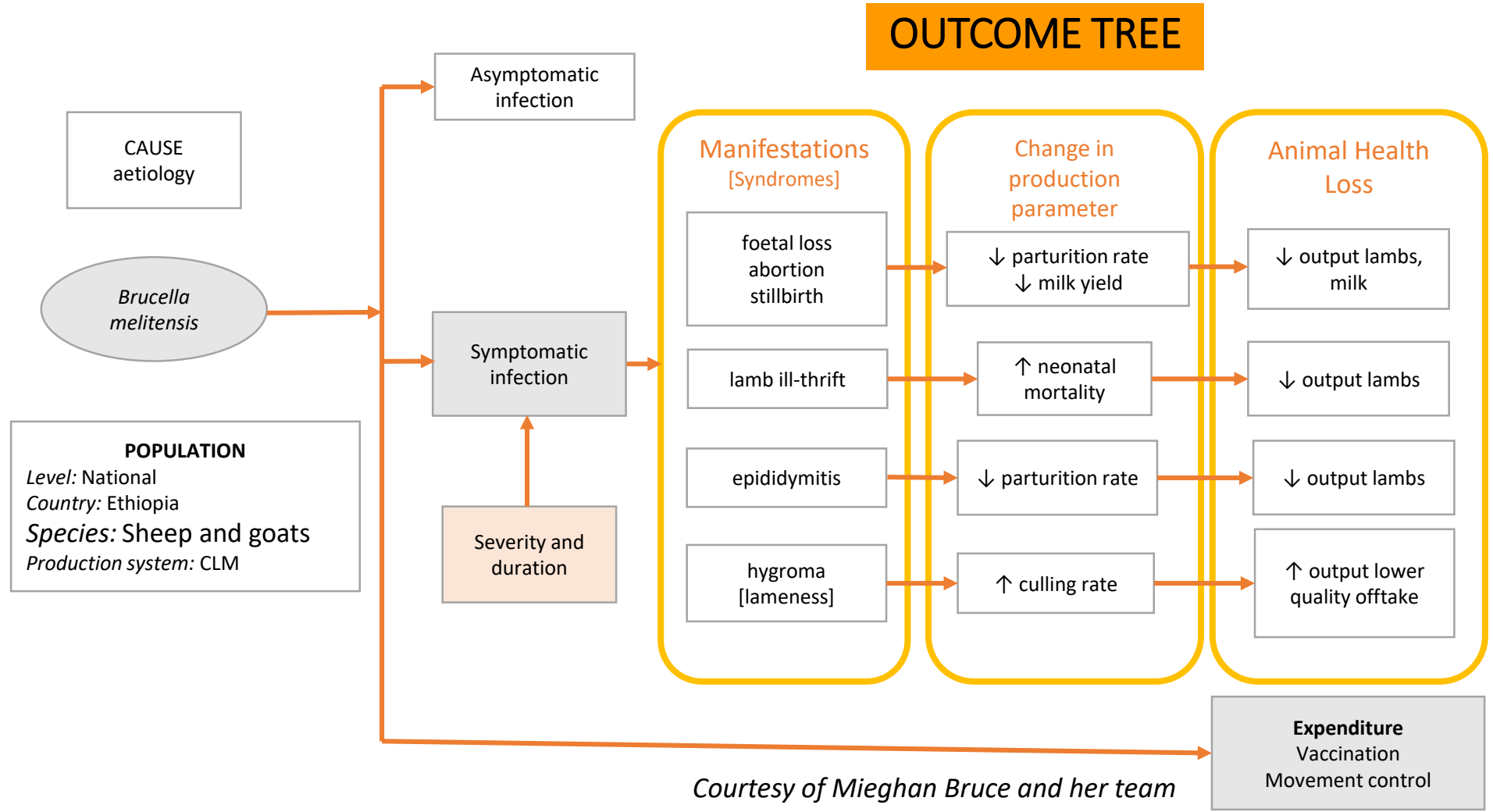
Disease variations

https://animalhealthmetrics.org

Courtesy of Mieghan Bruce and her team

GBADs

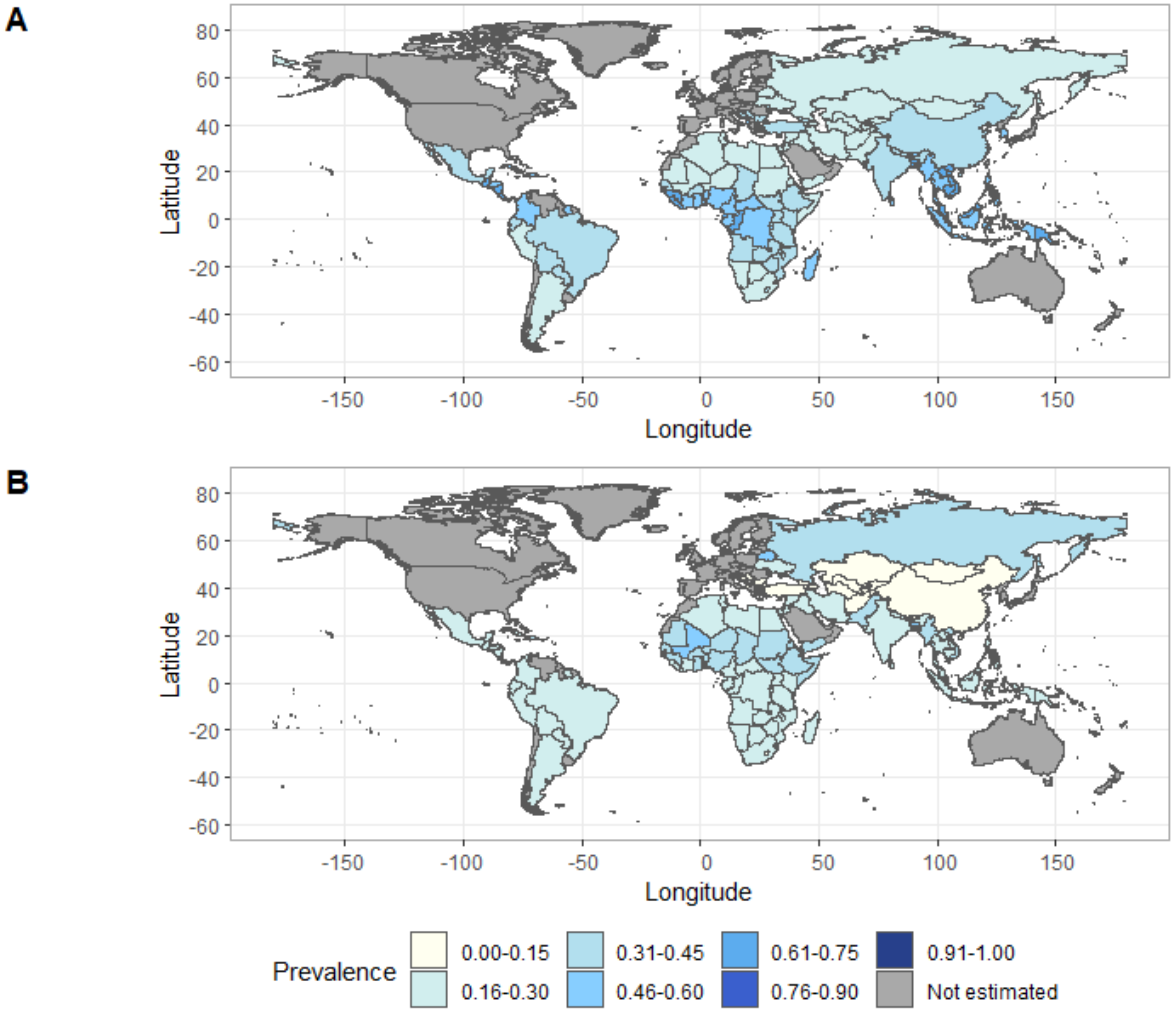
OUTCOME TREE



Courtesy of Mieghan Bruce and her team

Data collation: backyard poultry systems in low- and middle-income countries

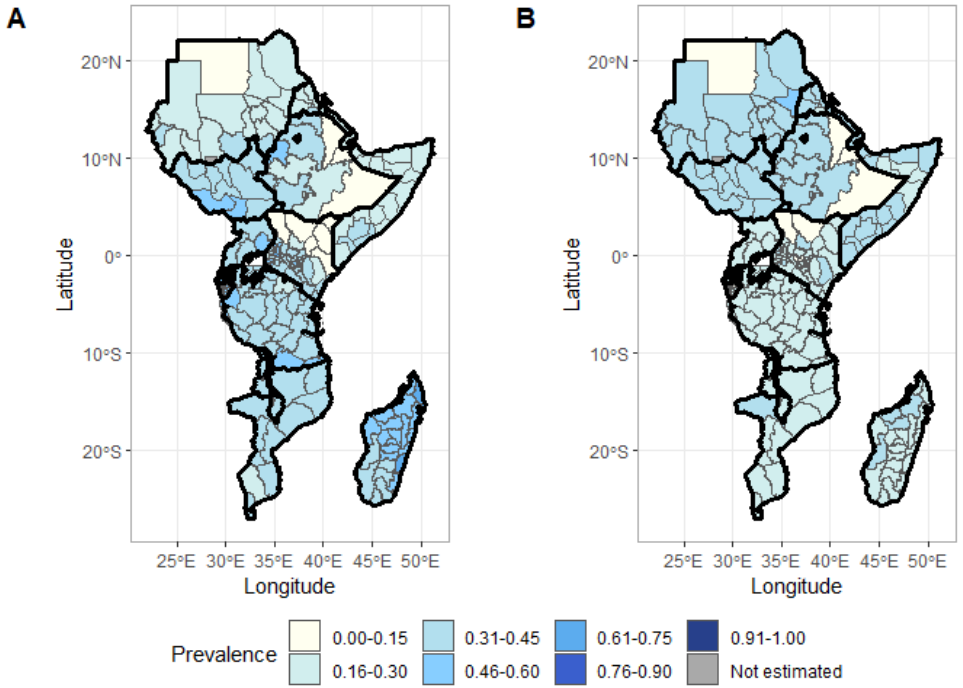
- Backyard poultry production is the most widespread form of poultry keeping in the world, being an important component of small farmers' livelihoods and a tool for poverty alleviation
- Systematic review for prevalence and incidence estimates of important diseases in backyard chickens
- Use imputation models based on meta-regression analysis to estimate disease prevalences in all LMICs
- Estimate disease burdens - attributing losses of each disease into the AHLE
- Bottom-up approach using co-morbidity model



Predicted prevalence of coccidiosis (A) and ascaridiosis (B) in low and middle-income countries

Once completed for all major diseases, burden estimates will be made based on outcome trees and measures of disease impact

Courtesy of Violetta Moñoz Gomez and Paul Torgerson



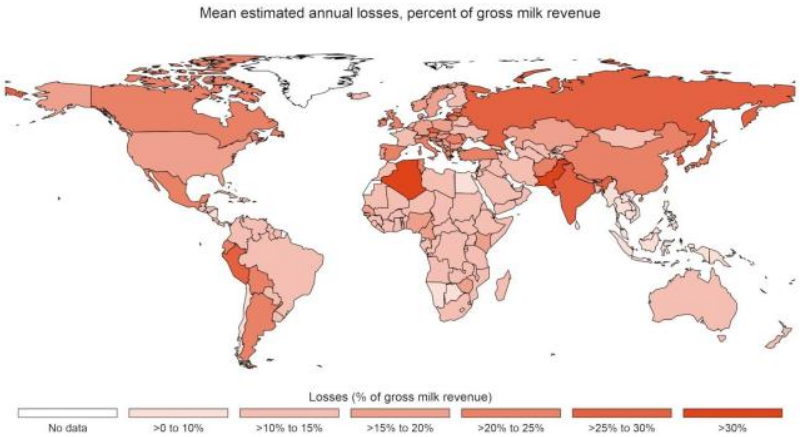
For greater granularity, predictions at sub national level.

For example: Predicted prevalence of coccidiosis (A) and ascaridiosis (B) in Eastern Africa

Courtesy of Violetta Moñoz Gomez and Paul Torgerson

Attribution of the global burden of animal diseases

- Comorbidity model to attribute animal disease burdens
- Model builds up from observed output then adds in estimated losses based on the incidence and impact of major diseases in a production system
- Developed on UK dairy system*, but rolled out to global estimates

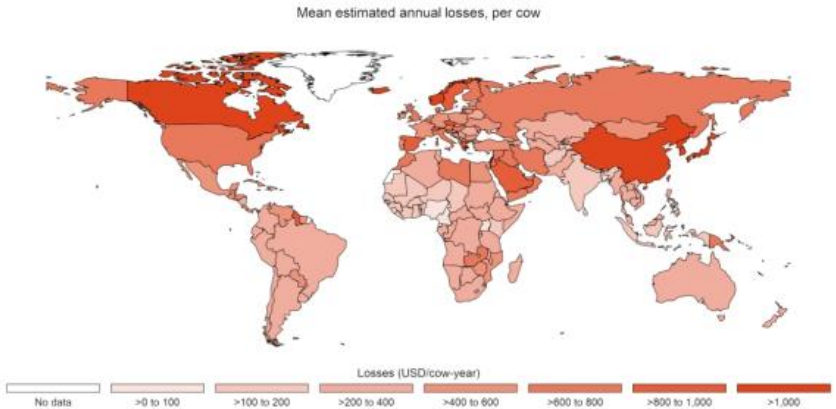


Rasmussen et al 2024.Global losses due to dairy cattle diseases: A comorbidity-adjusted economic analysis. Journal of dairy Science (in review)

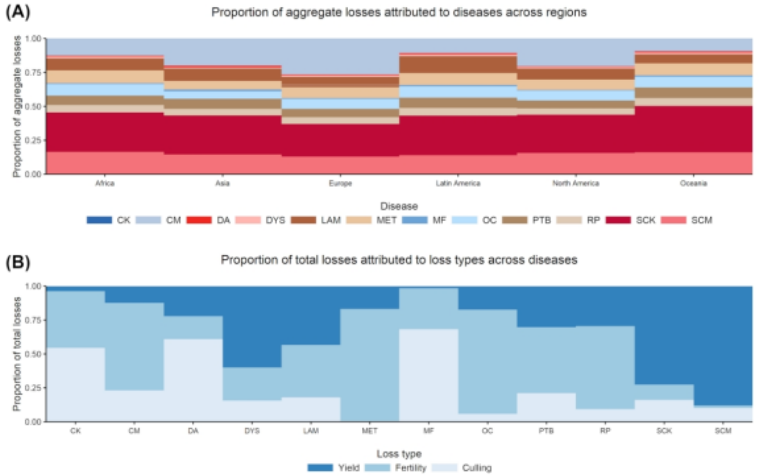
*Rasmussen, P., Shaw, A.P., Munoz, V., Bruce, M. and Torgerson, P.R., 2022. Estimating the burden of multiple endemic diseases and health conditions using Bayes' Theorem: A conditional probability model applied to UK dairy cattle. Preventive veterinary medicine, 203, p.105617.

Disease attribution

Loss per cow



Loss by disease and type of loss



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Farm versus global burden estimations

- In general the literature is dominated by estimations of the burden of diseases that are financial estimations of the impact at farm-level
- Economists will challenge these as the removal of these impacts will change the supply of livestock products and shift the equilibrium points across the economy
- The scale of these changes at an economy level depends on the importance of the livestock sector relative to other parts of the economy
- Using economy models – either partial or general equilibrium models – allows us to look at where the benefits to society occur and GDP changes

Economy and trade implications

- Global modeling to reflect the impact and distortions diseases and their control have on the private and social good to countries and regions
- Global modeling will provide
  - Impacts on country level GDP, economic efficiency, prices, etc.
  - Impacts on domestic and international trade patterns
  - Impacts on the redistribution of wealth to consumers and firms
  - Information on how to more efficiently and equitably invest
  - Guidance on policy impacts
- Estimation
  - Partial Equilibrium Modeling (supply chain)
  - General Equilibrium Modeling (e.g., GTAP)

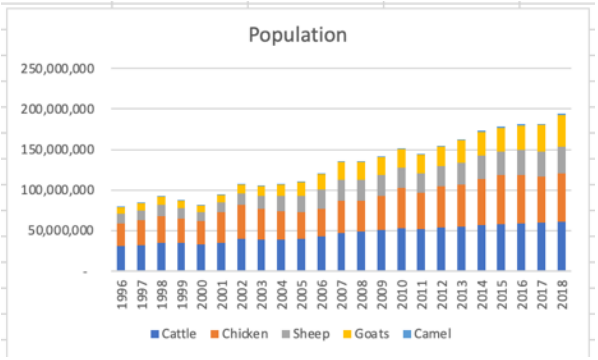
Results from Ethiopia – courtesy of Professor Wudu Temesgen, ILRI and Dr Gashaw Benyene, Ministry of Agriculture, Ethiopia

Results from Ethiopian case study

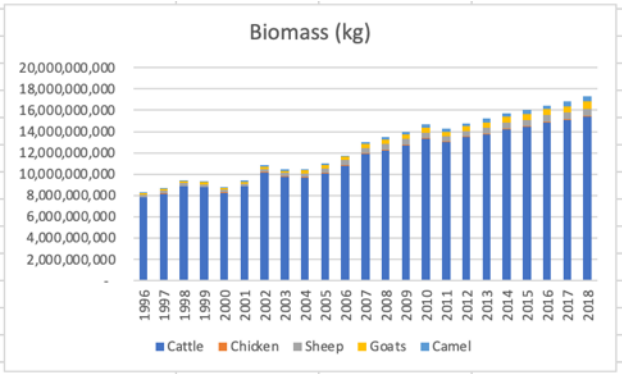
- Results on
  - population, biomass and economic value
  - Animal health loss envelope
  - Attribution
  - Wider economic impact
- Presented in
  - stakeholder workshops held in Addis Ababa in November 2022, May 2023 & April 2024
  - WOAH general session in Paris May 2023 where over 70 people attended
- Reception to the work is positive

Ethiopian livestock population to biomass and value (from the GBADs webpage)

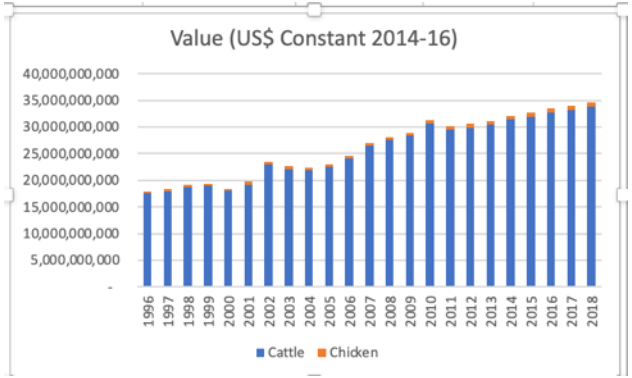
Population (head)



Biomass (kg)



Value of animals ($)



Weights → Prices

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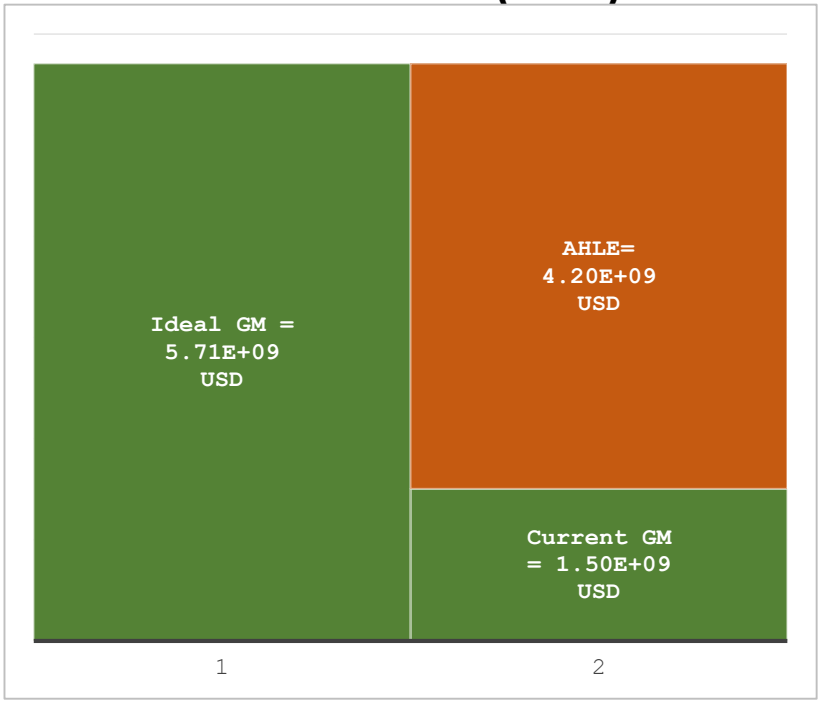
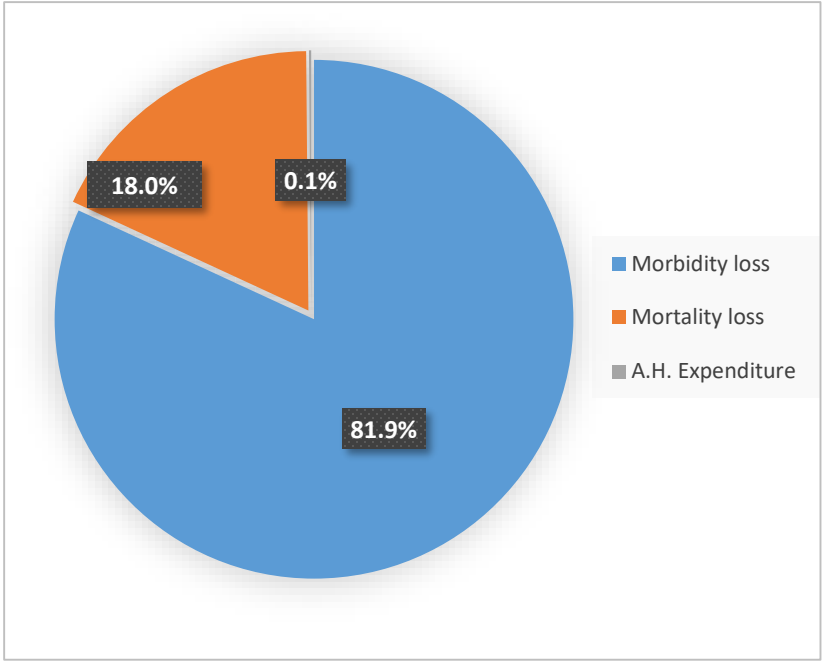
Animal health loss envelope (AHLE)

Small ruminants AHLE (2021)



Components of small ruminants AHLE



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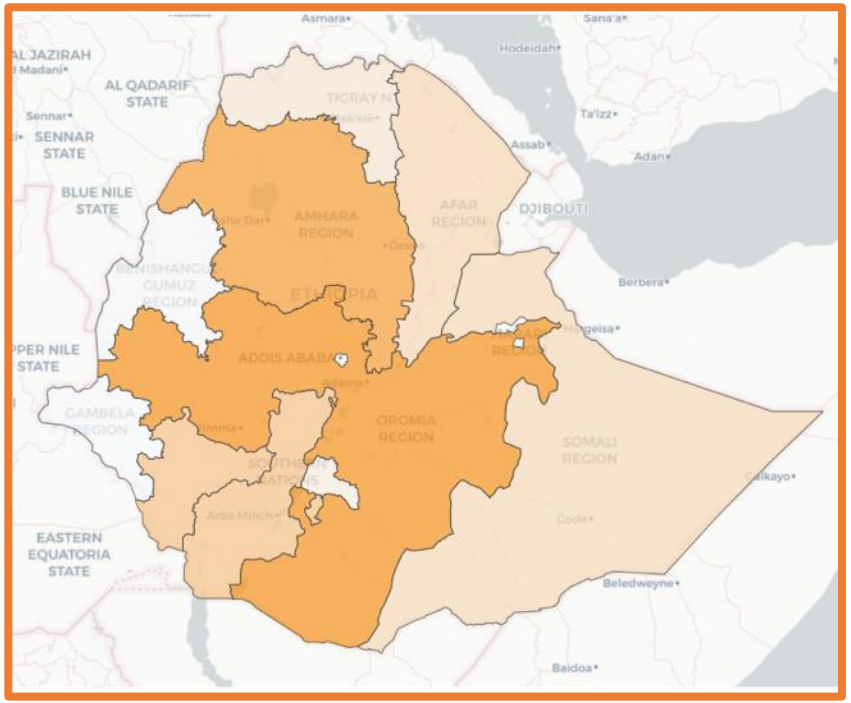
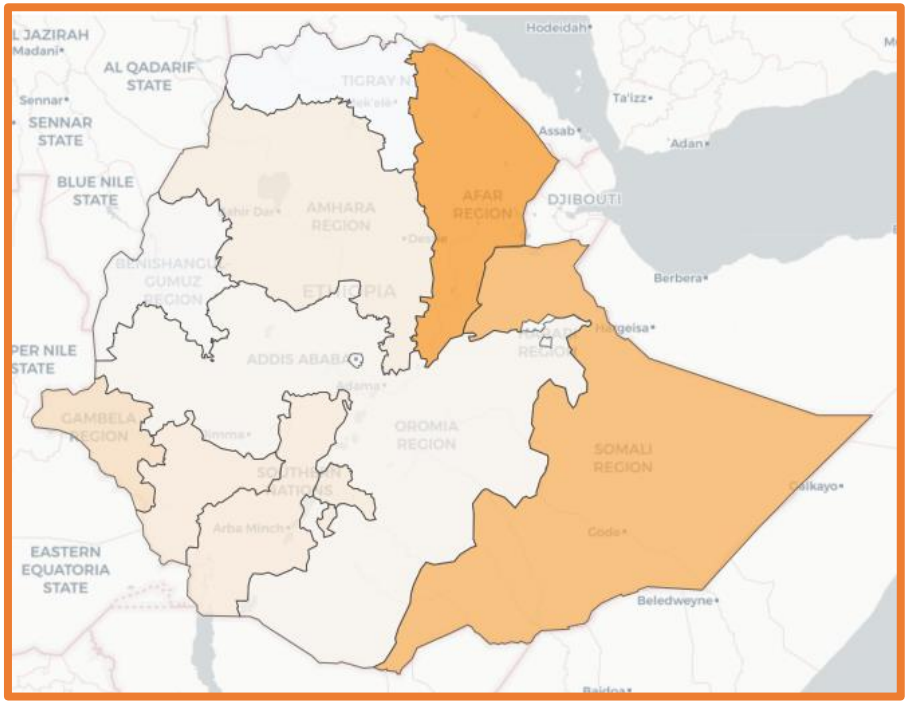
Courtesy of Wudu Temesgen

Subnational Cattle AHLE by regional states (2021)

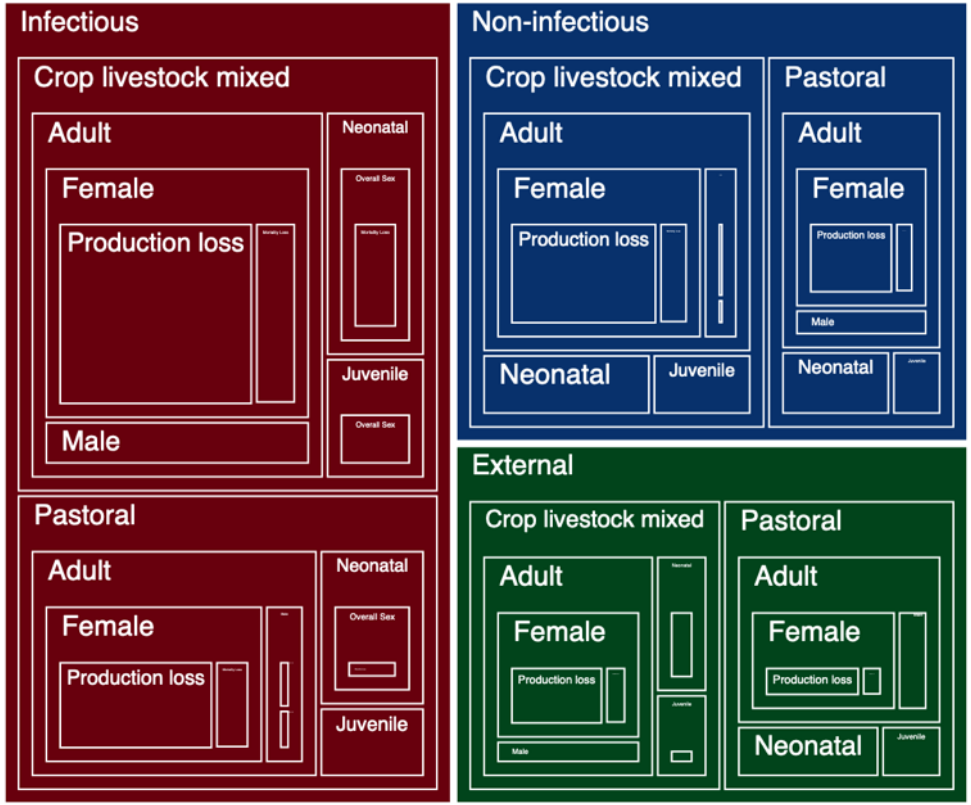
Total AHLE by regional states



AHLE per kg of biomass by regional states



Attribution at high level causes (Level 1), e.g., of Small Ruminants



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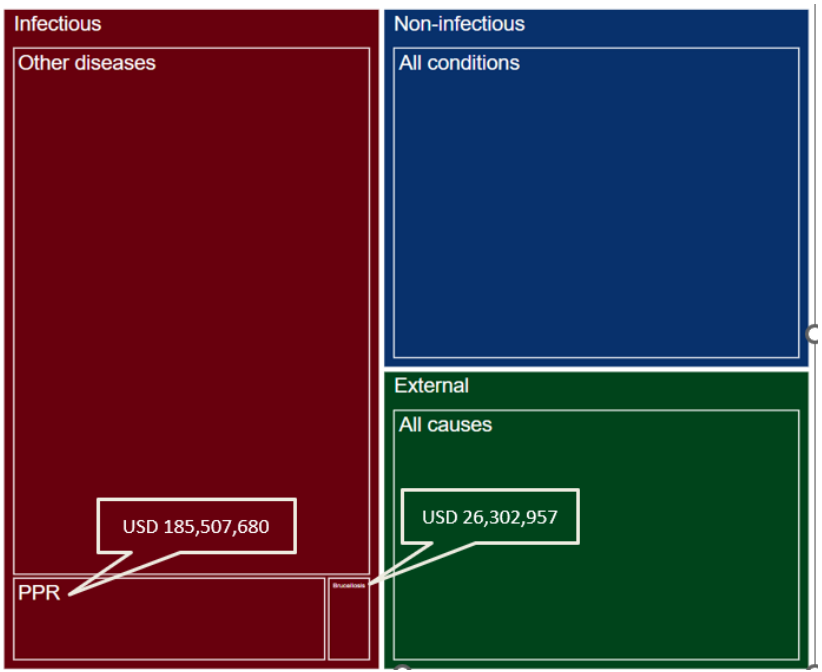
Attribution at specific cause/disease level

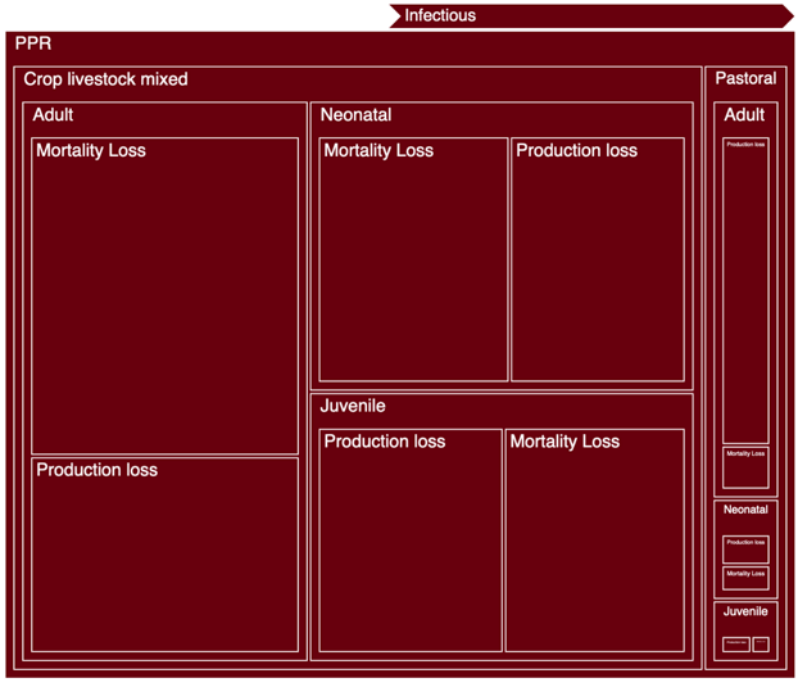
- PPR and brucellosis impacts were estimated based on literature review and expert elicitation
- These diseases are relatively small proportion of the estimated total loss yet cause significant farm level financial impact
  - PPR – US$ 185.5 million
  - Brucellosis – US$ 26.3 million

The proportional burden of disease in small ruminants

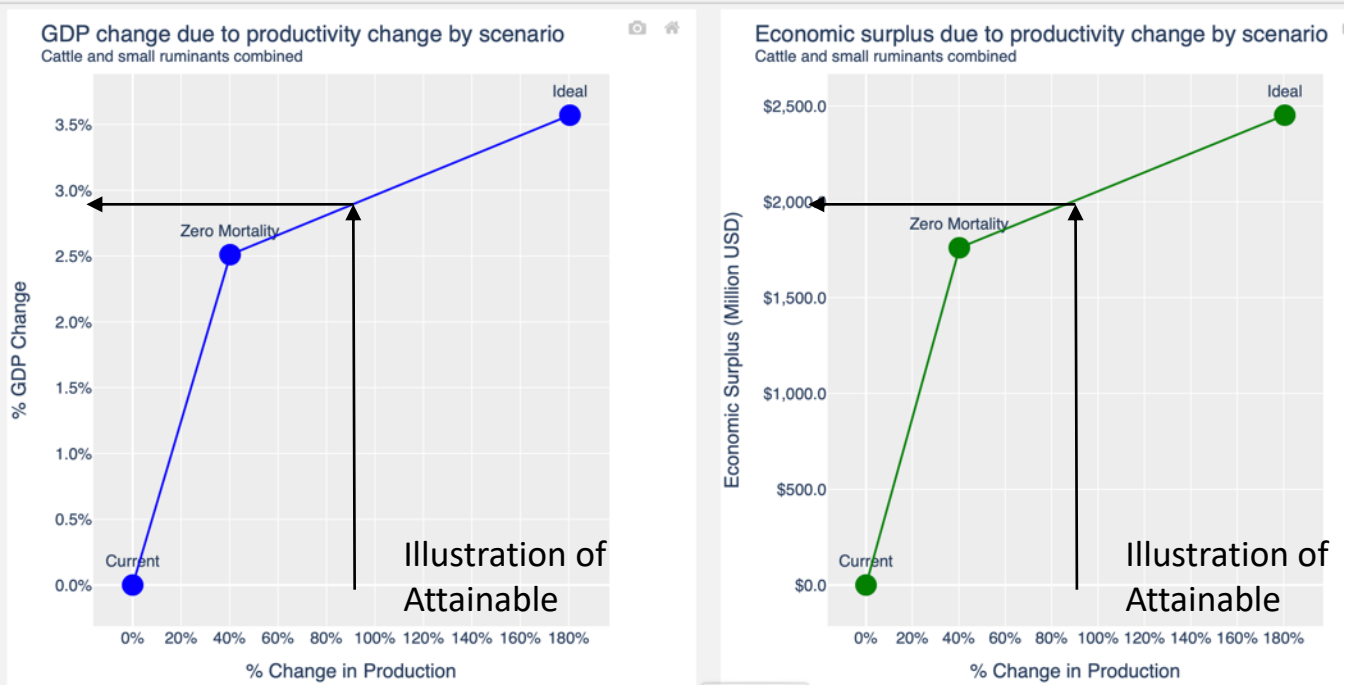


Attribution of PPR impacts by production system and age group

- Through literature review and imputation of these data it is possible to attribute the PPR impacts in small ruminants to production system and age groups
- Information provided is intended to help target interventions such vaccination and movement controls



Dashboards that provide information on economy and market shifts



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Courtesy of Tom Marsh, Golam Shakil, Dustin Pendell

GBADs


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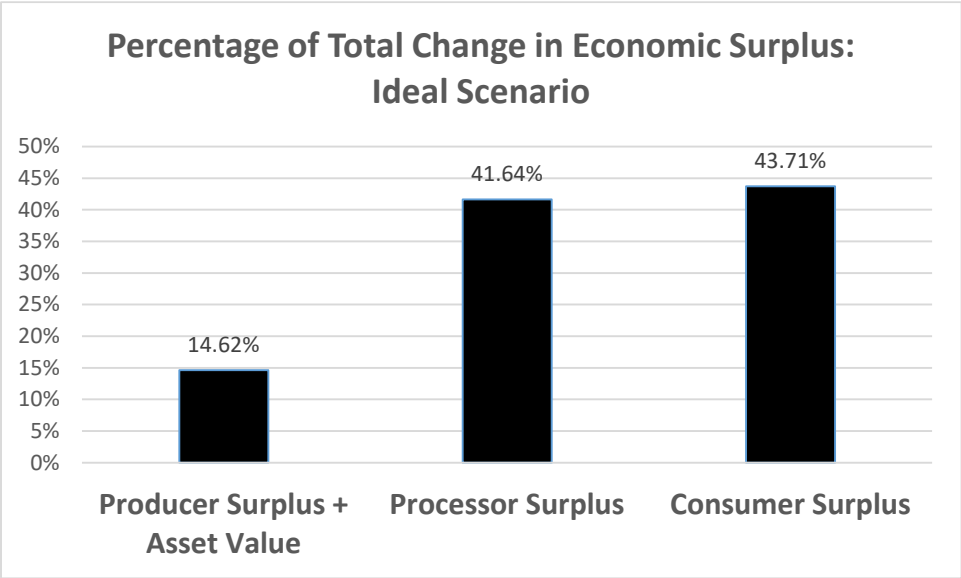
Sadia
Frozen
CHICKEN
Sadia

Animal health services impact consumers

- Animal health burdens affect consumers and value chain actors more than producers
- A shift in animal health burdens will generate benefits across society and in particular urban consumers



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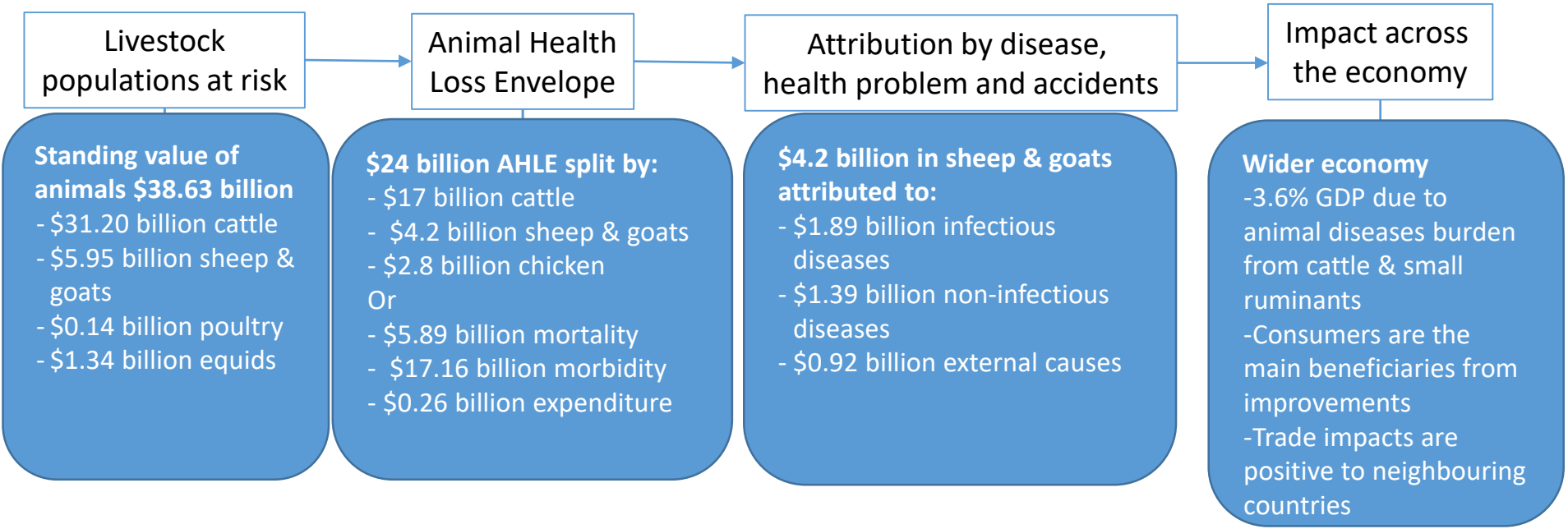
Courtesy of Tom Marsh, Golam Shakil, Dustin Pendell

GBADs

GBADs summary estimates for Ethiopia



https://animalhealthmetrics.org

Courtesy of Wudu Temesgen & GBADs collaborators

GBADs

GBADs work on working equids in Ethiopia

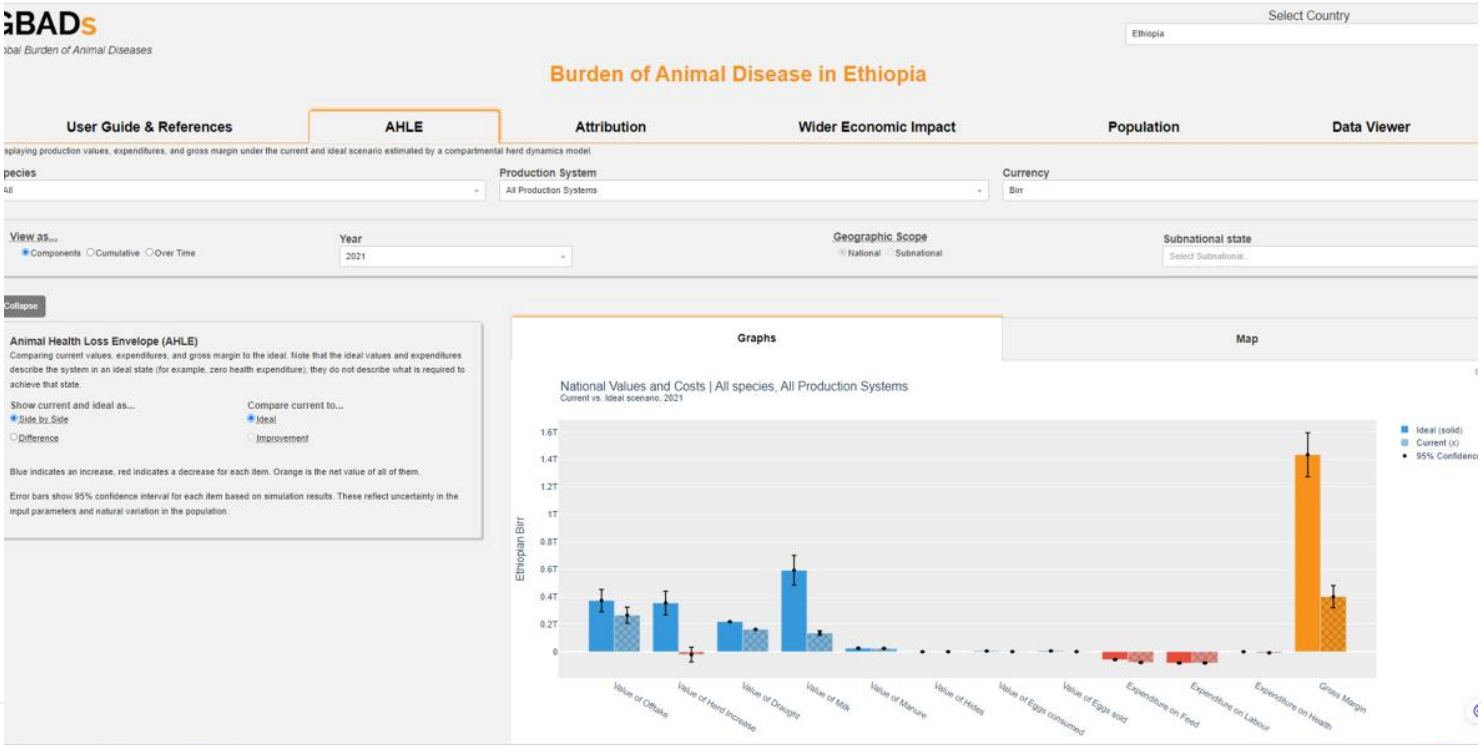
- An ongoing analysis shows the seldom recognized importance of donkeys in Ethiopia's diverse production systems
- Donkeys provide essential economic services, helping marginalized households with limited resources to significantly enhance their well-being and financial circumstances
  - Contributes up to 26% of annual income for owners

Courtesy of Girma Asteraye et al

Capacity building of stakeholders on the economics of animal health

- Support to develop a cadre of people in the application of economics of animal health through:
  - Two rounds of training on the economics of animal health including **GBADs** approach to assessing animal disease burdens
  - Coaching of core group from Ministry of Agriculture in the use of economics to animal health

GBADs Ethiopia case study dashboard



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Courtesy of Wudu Temesgen & GBADs collaborators

GBADs

GBADs

Decision making within the Ministry of Agriculture - use of GBADs outputs now and in the future

Decision / Question	Information Desired	Dashboard components
How much is the disease burden and how much should we invest or allocate to animal health system? ⇒ Develop a national control program ⇒ Design policy and strategy	➢ the overall annual disease burden ➢ How disease impact changes over time ➢ the impact of all and specific diseases on the national and agriculture GDP	AHLE Wider eco-impact
What is the optimal allocation of investments to diseases, based on their relative impact?	➢ the relative impact of each disease by region ➢ the relative costs and efficacy of treatment for those diseases	Attributed AHLE
Which region should we focus on for intervention?	➢ the impact of disease burden in each region	Subnational AHLE (map)
For which cause do we need to design intervention and allocate more funds?	➢ the burden for each cause ➢ How the impact of each cause changs over time	Attributed AHLE

Courtesy of Gashaw Benyene et al

Impacts from the work

- Advocacy for livestock policies with the use of the economic impact estimations
- PPR project has used **GBADs** PPR work and has not repeated it
- Ease of access to data from the livestock facilitating analysis of policies and interventions

World Organisation for Animal Health
Founded in 1924

Animal Diseases | Avian Influenza | 91st General Session | SEARCH

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Inicio » Articles » **GBADs programme: empowering decision-making on livestock health through comprehensive data in Ethiopia**

Article

GBADs programme: empowering decision-making on livestock health through comprehensive data in Ethiopia

https://animalhealthmetrics.org

GBADs

Results from other regions

Courtesy of:

- CSIRO/BRIN/Griffith - Indonesia,
- Anne Meyer, DSV, ISRA – Senegal
- Emma-Jane Murray and Conor MacLoon (UCD), David Graham (AHI) and Eoin Ryan (Irish Government) – Republic of Ireland

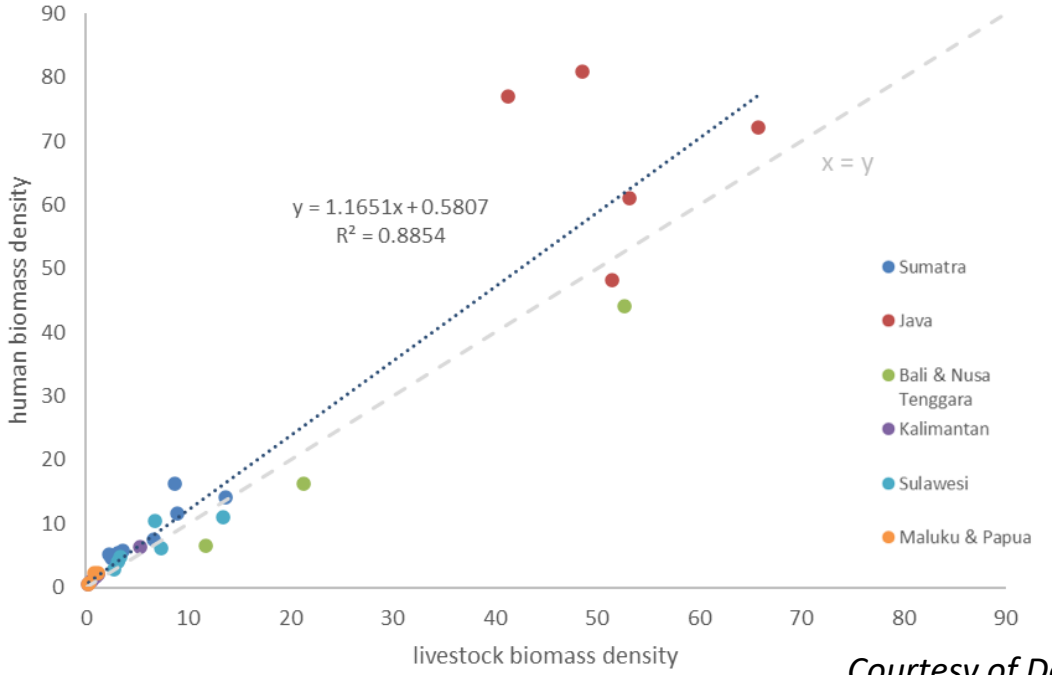
Utility of GBADs in Indonesia

- There are multiple potential end users & pathways to impact
- There is a need for accurate & timely information to support decision making
  - Interviewees perceive **GBADs** to be credible & relevant
  - Strong interest in all **GBADs** products (not just disease burden)
  - Information needs to be locally relevant
- The use of **GBADs** information as a tool for lobbying was consistently highlighted across different levels of decision making

Courtesy of Dom Smith, Di Mayberry, Yin Li, Harimurti et al

Indonesian biomass density 2021

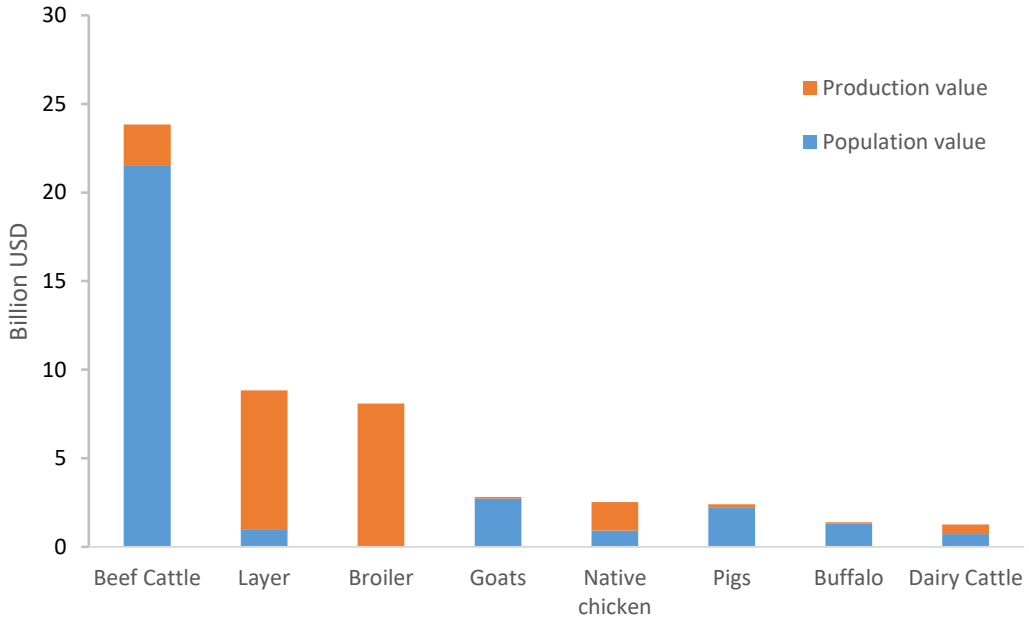
Tonnes liveweight / km^2



- Strong positive correlation between human & livestock biomass density
- Implications for resource use, zoonotic disease transmission

Courtesy of Dom Smith, Di Mayberry, Yin Li, Harimurti et al

Species differences in how livestock are valued



- Poultry are valued for their products; meat & eggs
- Cattle, small ruminants & pigs have larger population (asset) value

Courtesy of Dom Smith, Di Mayberry, Yin Li, Harimurti et al

Total livestock value in 2021 (USD)

Asset + production value

Courtesy of Dom Smith, Di Mayberry, Yin Li, Harimurti et al

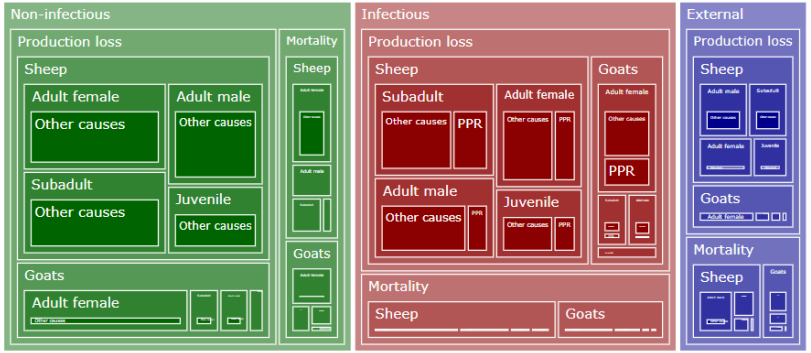
Livestock value as a portion of GRP in 2021 (%)

Asset + production value

Courtesy of Dom Smith, Di Mayberry, Yin Li, Harimurti et al

Senegal - High-level attribution of mortality and production losses (expert-based)

- Similar methods were applied in the Senegal case study as for Ethiopia
- Lessons were learned on best practice
- This generated the overall loss (AHLE) and allowed high level attribution by cause



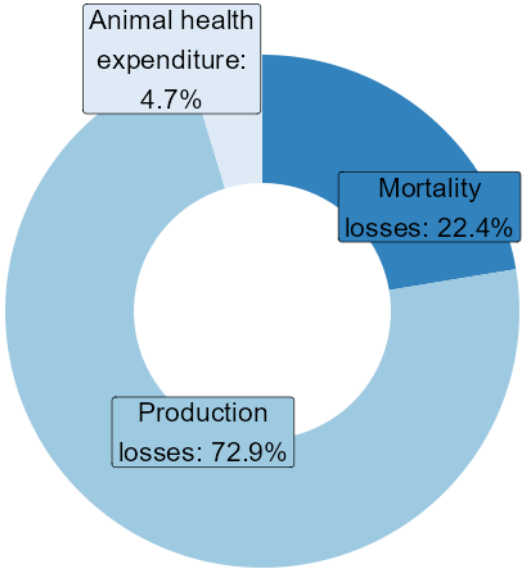
IDRC · CRDI

Courtesy of Anne Meyer, DSV, ISRA

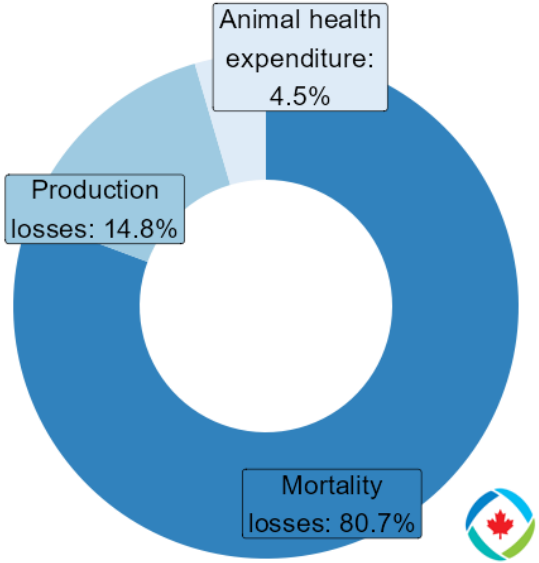
Senegal estimated losses in mixed crop livestock systems in sheep and goats in 2022

Courtesy of Anne Meyer, DSV, ISRA

All Cause



PPR



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GBADs

Republic of Ireland

- Cattle case study funded by the Republic of Ireland government
- A further pig study is planned
- Cattle systems analysis is linked to government data sets with discussions on how **GBADs** methods can be embedded in government analytical structures

*The research to estimate the biomass of Irish cattle by production type, and the associated changes over time, will be **highly relevant to ongoing policy discussions** about the Irish cattle herd and environmental issues. Issues such as whether policies supportive of a reduction cattle numbers are needed in order to reduce methane emissions, and the impacts across the cattle sector of a reduction in stocking density in some dairy farms due to changes in the nitrates derogation limits in 2024, are a focus of considerable public and stakeholder interest and debate in Ireland. The results of this research will provide an **evidence base to inform such discussions** by robustly estimating the cattle biomass across types of farming systems in Ireland, as well as changes in biomass over time. This work will also provide an example for other countries facing similar discussions and debates relating to biomass, production and environmental issues.*

Reaction from Dr Eoin Ryan, Head of Animal Welfare Division, Department of Agriculture Food and the Marine on the biomass work

Courtesy of Emma-Jane Murray, Conor Macloon UCD, David Graham, AHI, Eoin Ryan, Irish Government

Other general support and interest

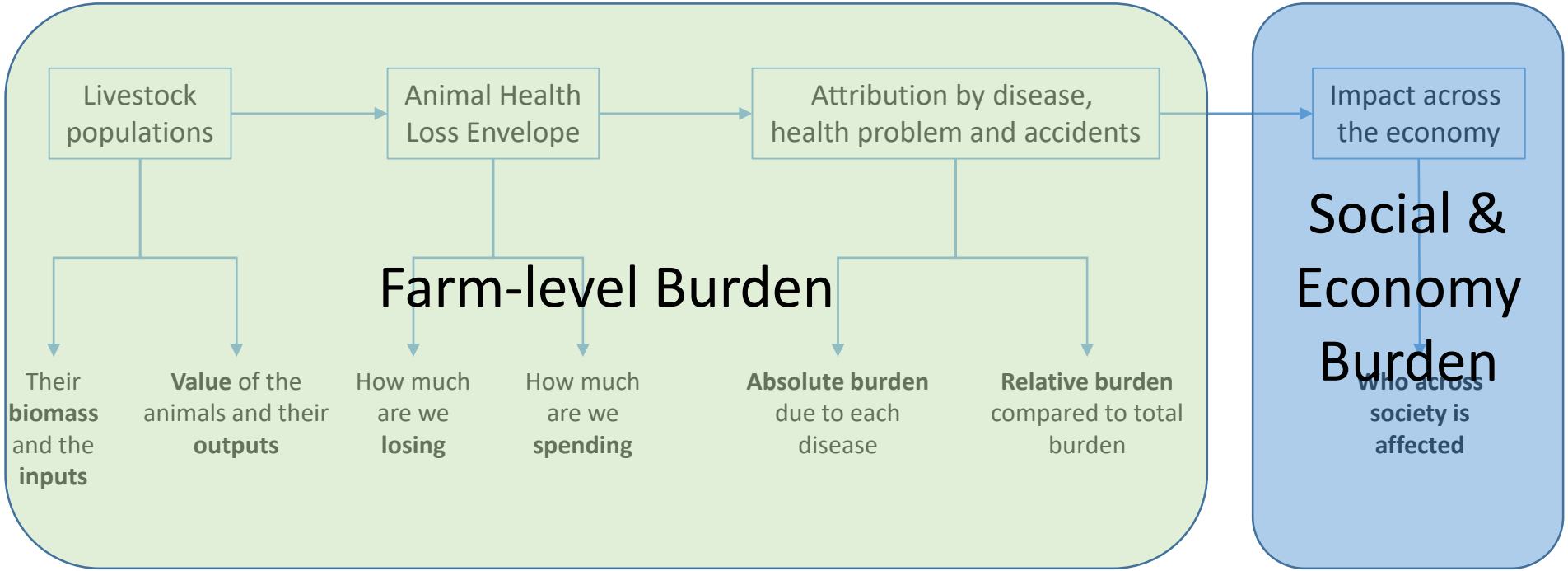
- EU H2020 funded DECIDE project with burden estimations of endemic diseases in Europe
- EU Animal health and welfare partnership has funded a European burden of disease study
- EFSA call on the burden of zoonoses and Livestock Innovation (USAID) tender refer to **GBADs** methods
- Two established WOAH Collaborating Centres for Economics of Animal Health – Europe and the Americas
- Brooke fund a study in Ethiopia and would like to extend this for a further two years
- CAHEC China intend to add **GBADs** into their two year workplan
- NIVEDI, India are developing a proposal for two Indian states
- Australia biomass estimates will be used in environment work
- ILRI have included **GBADs** methods in a new project on RESTORE (restoration of livestock services in Ethiopia) – EU funded

GBADs – initial findings and the future

Key findings to date

- **Methods are workable and can be rolled out**
  - Ongoing investment to improve access to data and informtion
- **Livestock populations continue to increase**
  - With implications to the environment, public health and the economy
- **Low levels of animal health expenditure in small scale producers compared to technologies available & production losses experienced**
  - Access is a problem to millions of poor producers
- **Animal health burdens have largest impacts on consumers, value chain actors and then producers**
  - There are public good implications in the provision of animal health services

GBADs - Analytical structure



Rushton et al 2021

GBADs phase III

- Global estimations
- Country case studies
  - Guides developed leading to intervention identification and also standardized approaches (**normative**) procedure
- Knowledge Engine
- Capacity development in development and application of the economics of animal health

Global Estimations

- Focus on:
  - Mortality
  - Morbidity
  - Expenditure
  - Attribution by major diseases

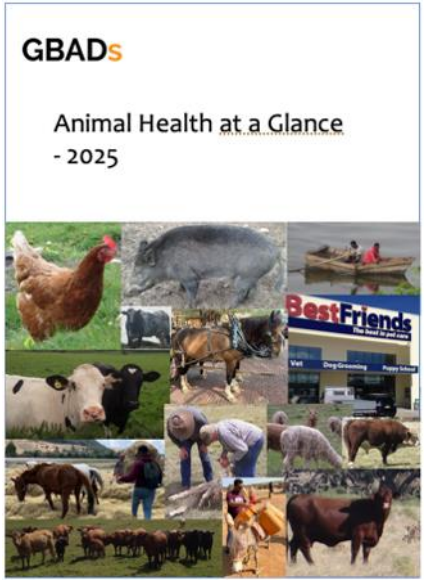
$$(N \times W \times P \times Mr) + (O \times P \times El) + (EV \times C) = AHLE$$

Change in Assets

Change in Revenue

Change in Expenditure

Reports every two years



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GBADs

Country case studies

- Rollout of country case studies based on the experiences from Ethiopia, Senegal, Indonesia, Republic of Ireland
- Customized according to in-country user-needs
- Co-produced dashboards, reports
- Links to improve global estimations

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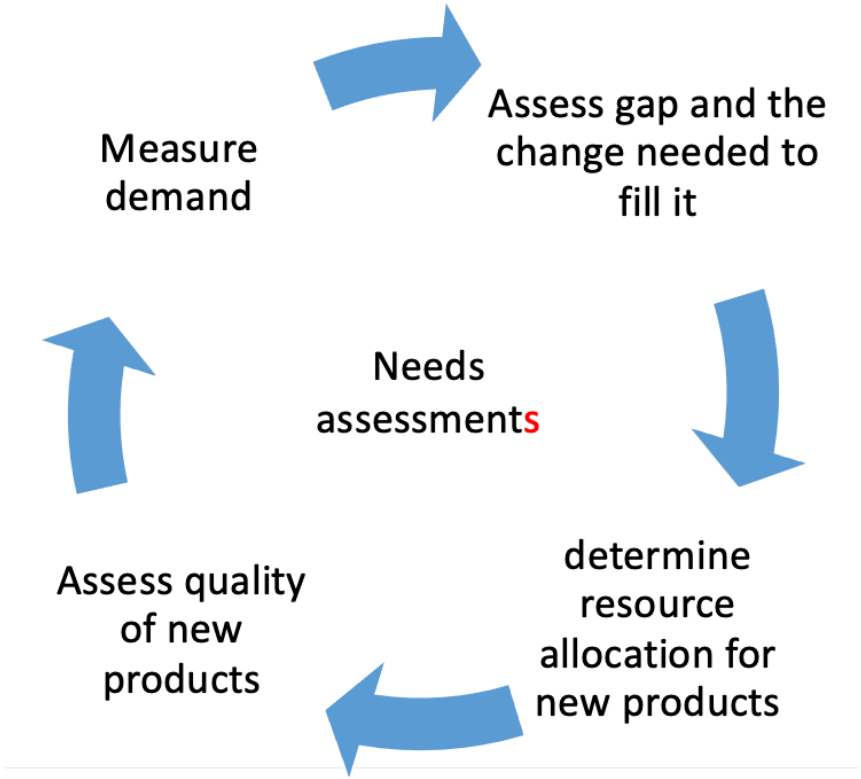
GBADs

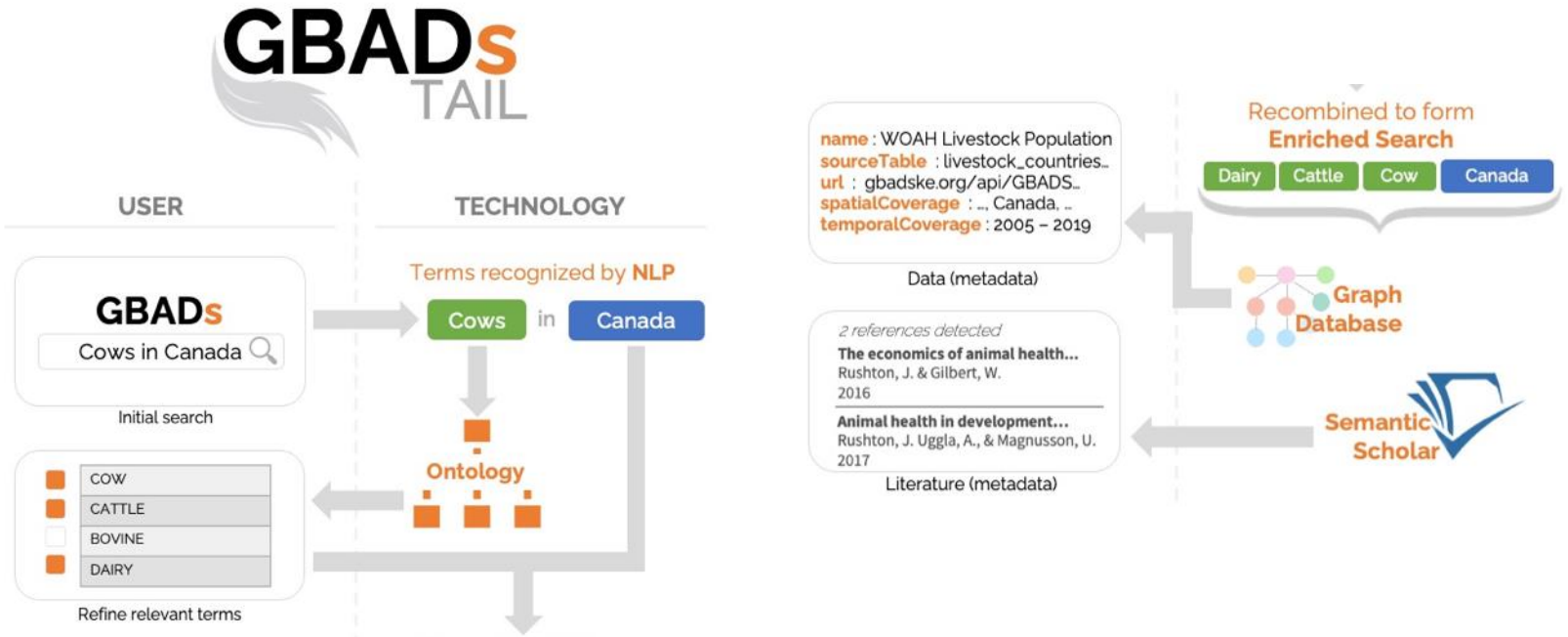
Strengthening the GBADs utility

- Matrix evaluation
- Survey of users and potential users
- Modifications of offerings
  - Dashboards
  - Data analytics
  - Guides
  - Courses



GBADs

GBADs knowledge engine refinement



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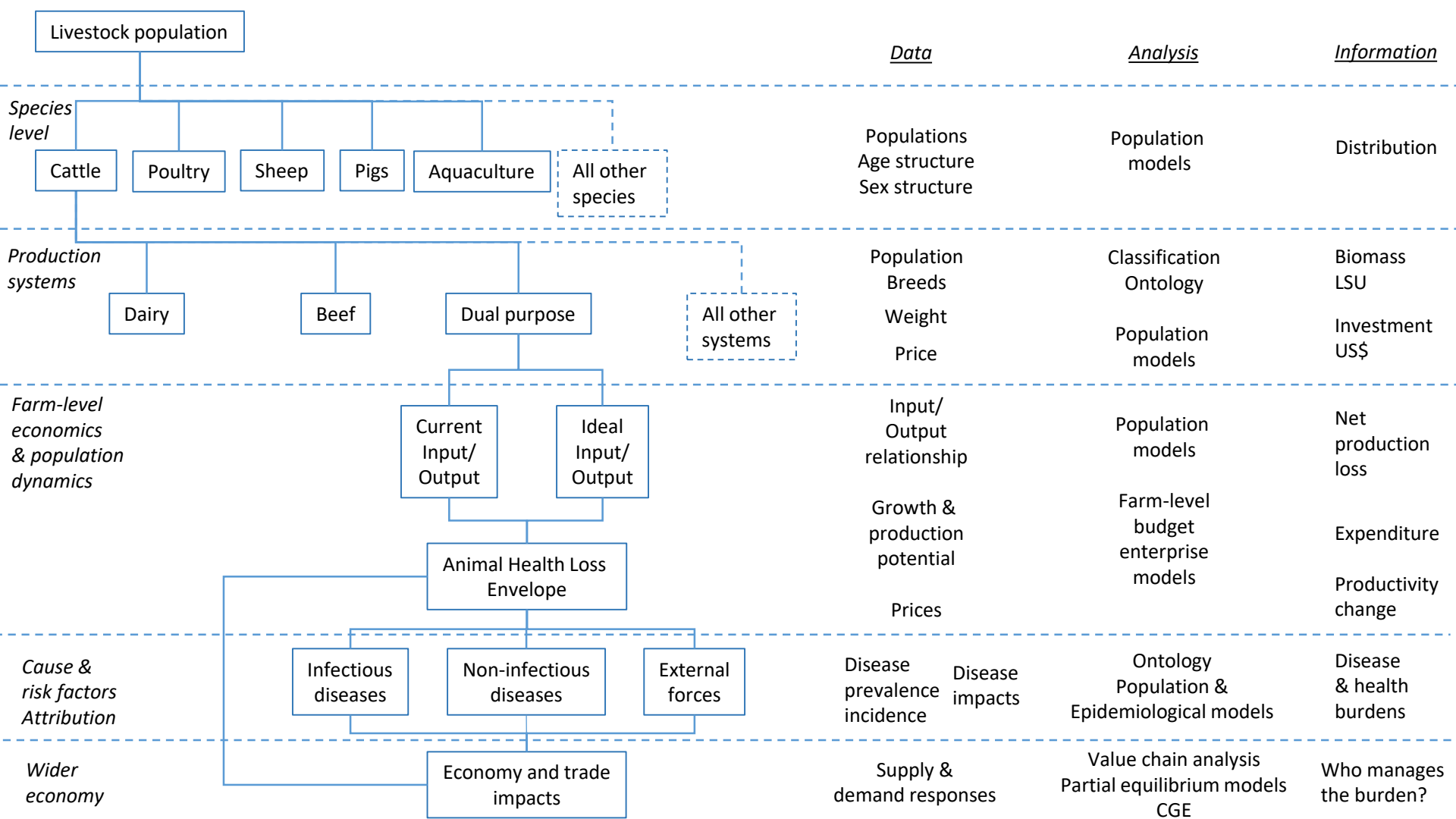

Livestock population
Data
Analysis
Information
Species level
Cattle
Poultry
Sheep
Pigs
Aquaculture
All other species
Populations
Age structure
Sex structure
Population models
Distribution
Production systems
Dairy
Beef
Dual purpose
All other systems
Population
Breeds
Weight
Price
Classification
Ontology
Population models
Biomass
LSU
Investment
US$
Farm-level economics & population dynamics
Current Input/ Output
Ideal Input/ Output
Animal Health Loss Envelope
Input/ Output relationship
Growth & production potential
Prices
Population models
Farm-level budget enterprise models
Net production loss
Expenditure
Productivity change
Cause & risk factors Attribution
Infectious diseases
Non-infectious diseases
External forces
Disease prevalence incidence
Disease impacts
Ontology
Population & Epidemiological models
Disease & health burdens
Wider economy
Economy and trade impacts
Supply & demand responses
Value chain analysis
Partial equilibrium models
CGE
Who manages the burden?

GBADs datasets

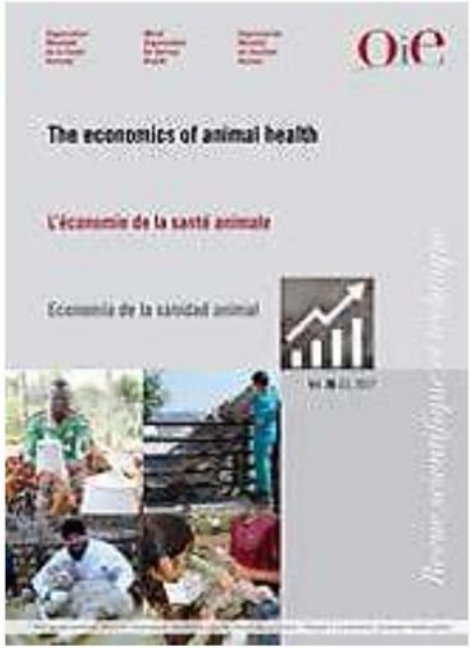
GBADs datasets	Exist	General user	Other specific user	GBADs utility
Populations at risk		CVO, Private companies, Ministries of Agriculture and Finance		Establishing a denominator for comparisons
Numbers (head count)	Yes			
Biomass (kg liveweight)	No		Environmental assessments	
Economic value (US$)	No			
Animal health loss envelope		CVO and Ministries of Agriculture, Health and Finance		Assessing the balance between health inputs and averted losses to indicate areas of weak investment
Production loss				
Mortality	No			
Morbidity	No			
Expenditure				
Farm level	No		AMU/AMR programmes	
Public investment	No			
Attribution of burden		CVO, private companies		Identify weaknesses in disease management and potential intervention areas
Infectious diseases	No			
TADs	Some		Eradication programmes	
Non-infectious diseases	No			
External causes	No		Welfare programmes	
Economy and social impacts		Ministries of Agriculture and Finance; Development agencies; Foundations		Understand the balance of burden across society and impacts on the environment
GDP changes	No			
Economic surplus	No			
Producer surplus	No			
Value chain actor surplus	No			
Consumer surplus	No			

Capacity development

- Integration of the capacity development with epidemiology and surveillance
- Focus on adding value to these data through economic and social analysis

GBADs guides with a special edition of WOAH Rev Tech Sci

- Phase II will generate five guides on estimations of:
  - Biomass
  - Economic value
  - Animal health loss envelope
  - Attribution by cause
  - Wider economic impacts
- There will also be a special edition of Rev Tech Sci that looks at policy implications



Case Study Countries

Continue to develop and support a **community of practice**

Key
Ongoing
Being initiated

https://animalhealthmetrics.org

GBADs

GBADs – the legacy of estimating burdens

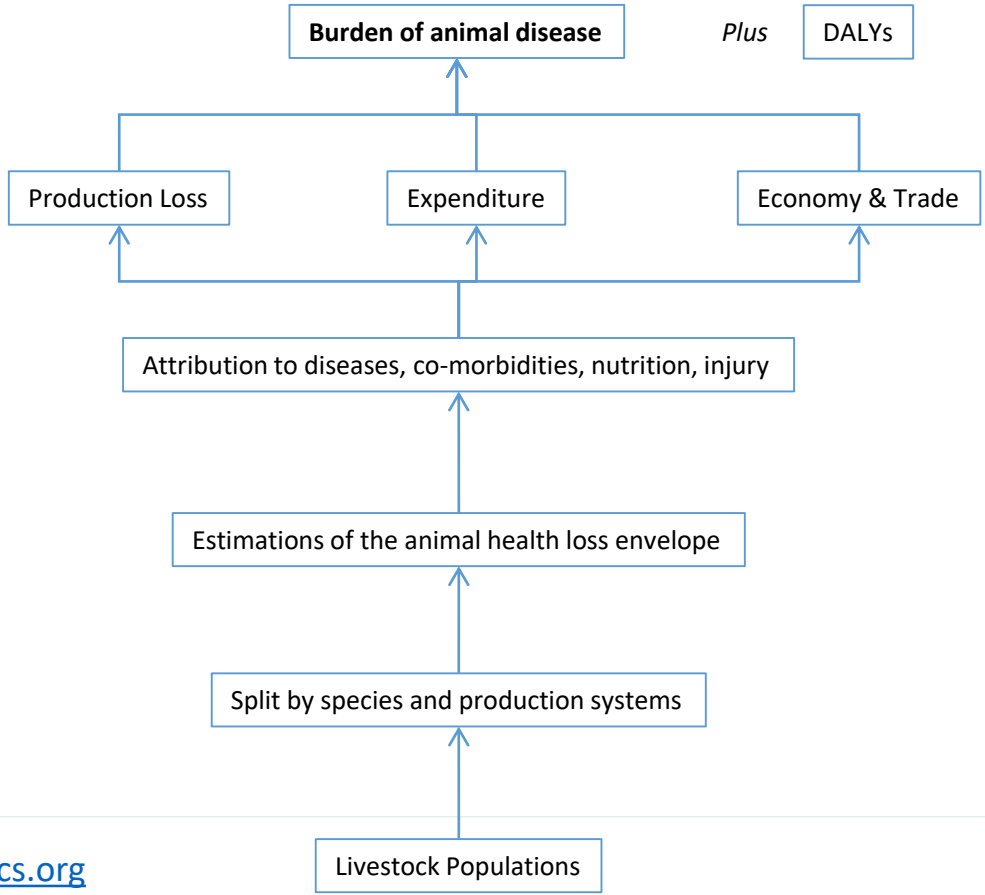
Methods & Capacity

Institutionalisation of **GBADs** methods

Tools for Prioritisation and policy needs

Educational materials

Codes of best Practice



Information

Impacts that can be compared between countries and food systems

Health losses by disease and by people affected

Distribution of livestock losses by species, systems, geographies

Distribution of livestock by biomass, capital value

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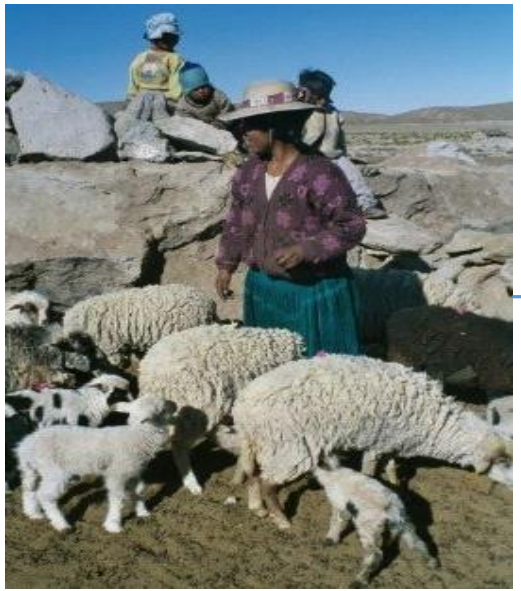
GBADs

People on the margins



Nutrition

Genetics

Parasites


Building capacity
Developing teams

Acknowledgment: GBADs funders and collaborators

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