



Food and Agriculture
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World Organisation
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8TH ANNUAL MEETING OF THE PPR GLOBAL RESEARCH AND EXPERTISE NETWORK (PPR-GREN)

25 – 27 NOVEMBER 2025 QINGDAO, CHINA



中华人民共和国农业农村部

Ministry of Agriculture and Rural Affairs of the People's Republic of China



中国动物卫生与流行病学中心
China Animal Health and Epidemiology Center

A GF-TADS initiative for
PPR control



GF-TADS
GLOBAL FRAMEWORK FOR THE
PROGRESSIVE CONTROL OF
TRANSBOUNDARY ANIMAL DISEASES



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Costs and Benefits of Global Peste Petits Ruminants (PPR) Eradication

Jonathan Rushton*,

Gemma Chaters, Anne Meyer, Govindaraj Guarrappa Naidu, Wudu Jemberu Temesgen,
Nick Lyons, Theo Knight Jones, Ben Huntington, Lian Thomas, Mieghan Bruce

*Professor of Economics of Animal Health

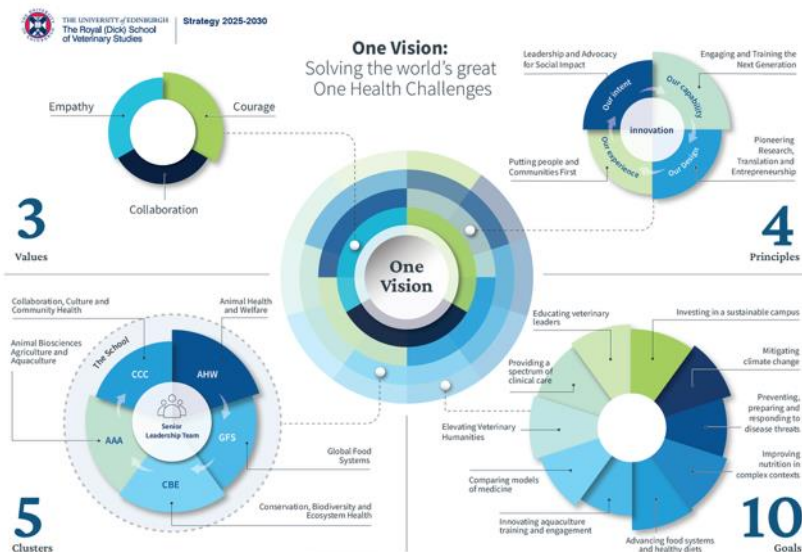
Director of the Global Burden of Animal Diseases programme

jrushton@ed.ac.uk

*PPR Global Research and Expertise Network – Annual Meeting
Qingdao, Shandong Province, China – 25th to 27th November 2025*

Royal Dick School of Veterinary Studies

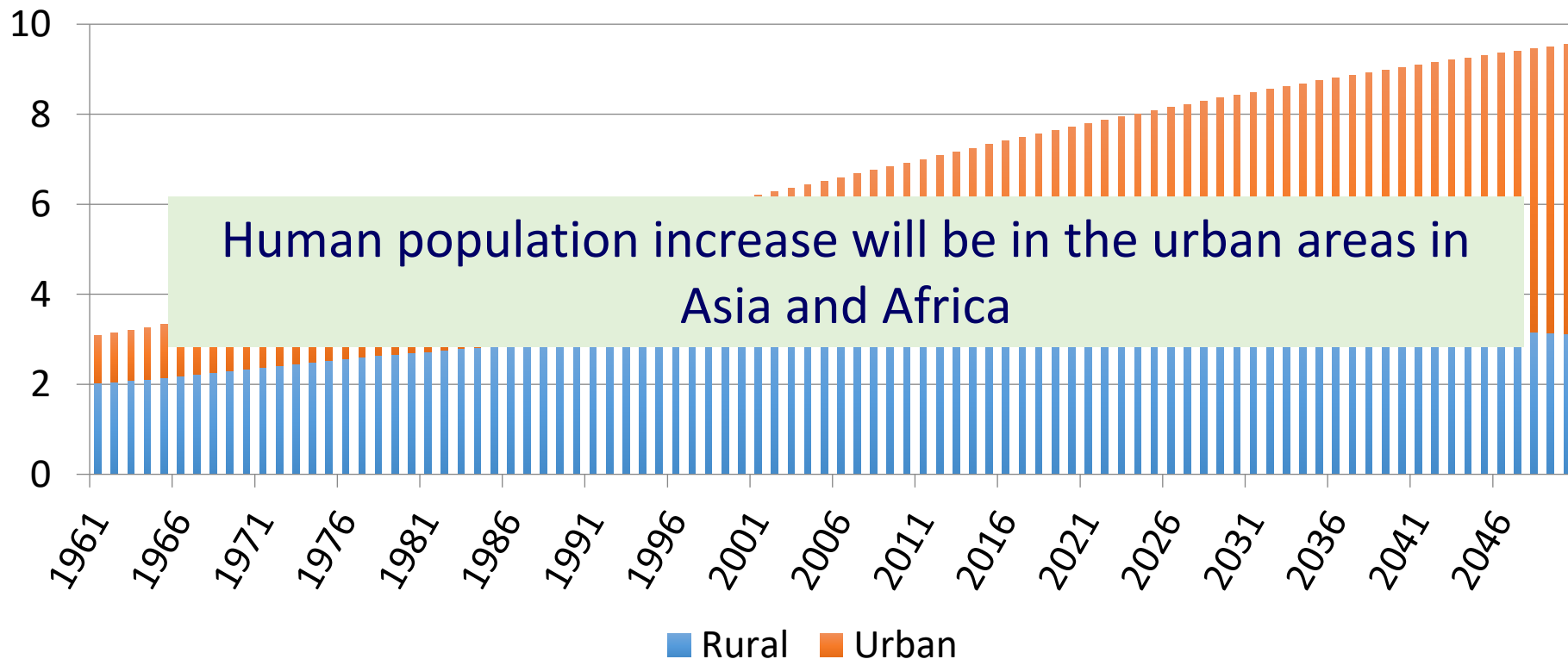
- Vision
 - **“Solving the world’s greatest One Health challenges”**
- Delivered through high quality science and based on values of:
 - Empathy
 - Courage
 - Collaboration



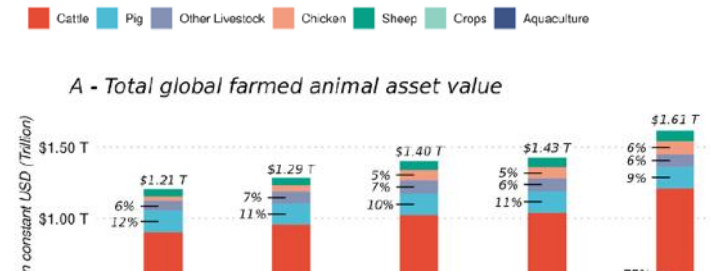
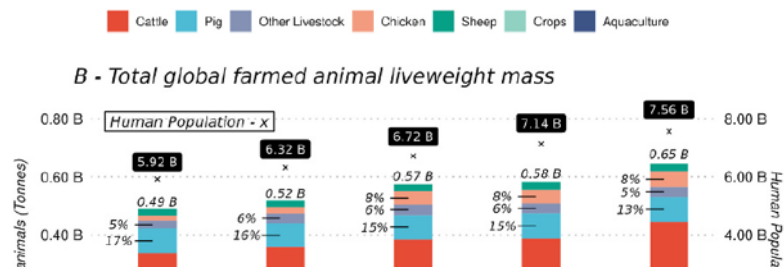
The Gleaners
By Jean Francois Millet in 1857



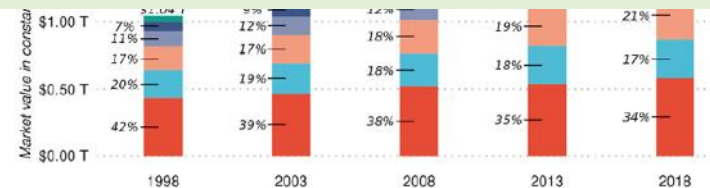
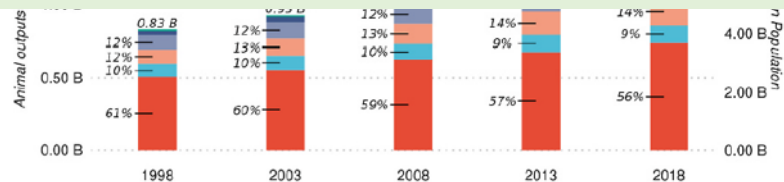
Global population – rural and urban estimates 1961 to 2050 (FAOSTAT, 2015)

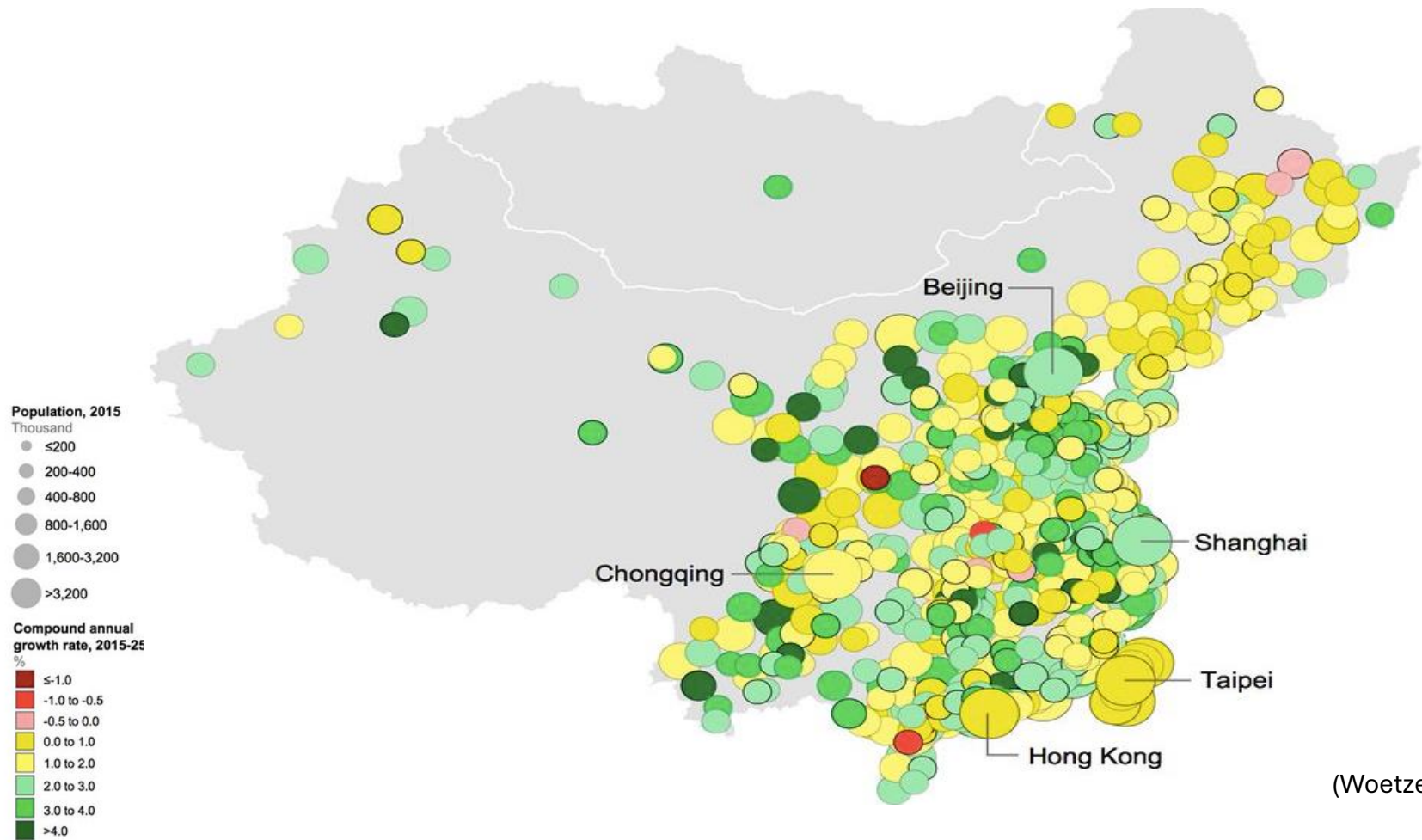


Global livestock biomass (Schrobbach et al, 2023)

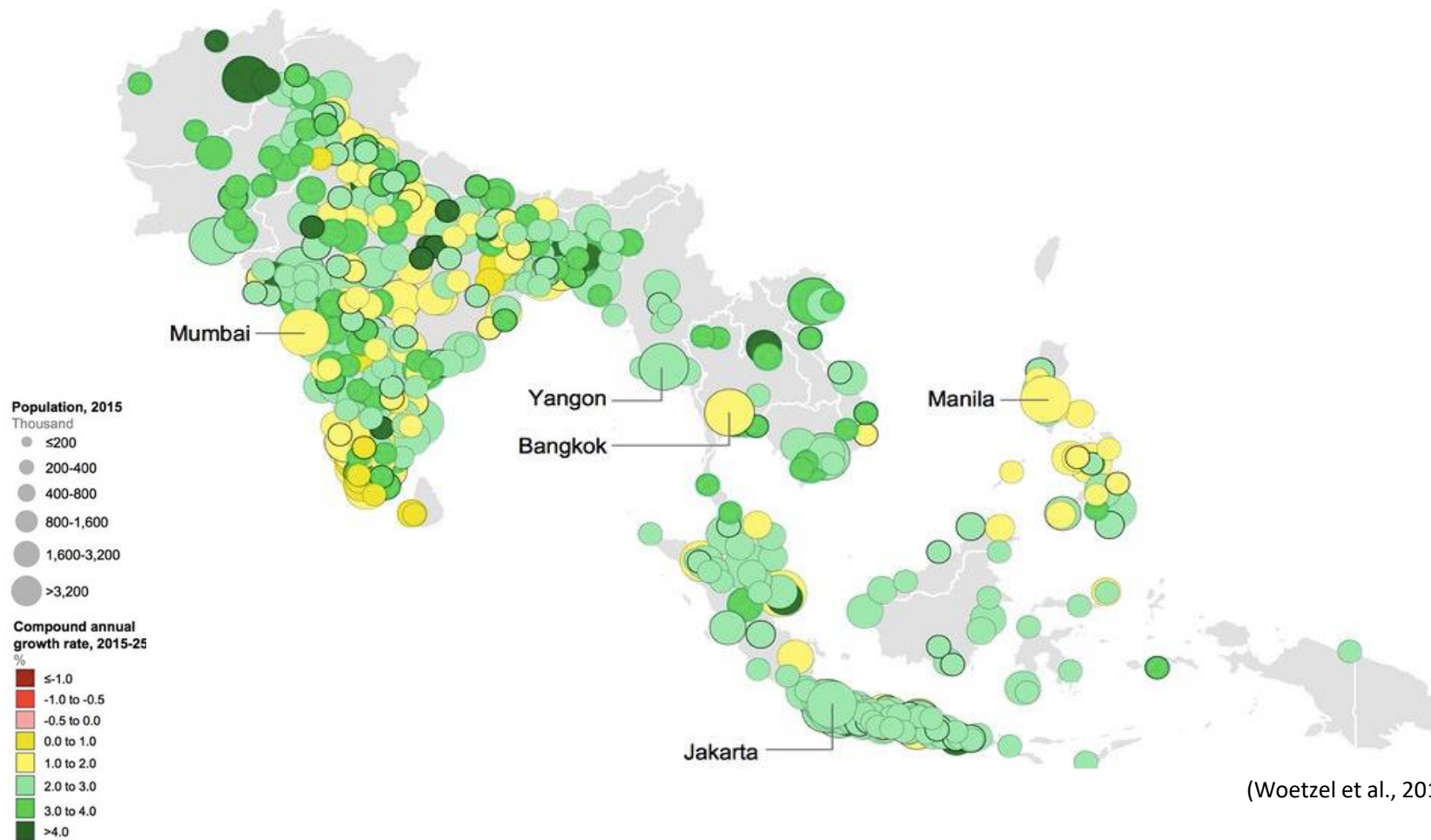


0.6 billion tonnes of livestock and farmed aquatic species
US\$1.6 trillion invested in these animals
US\$ 1.7 trillion in meat, milk and eggs

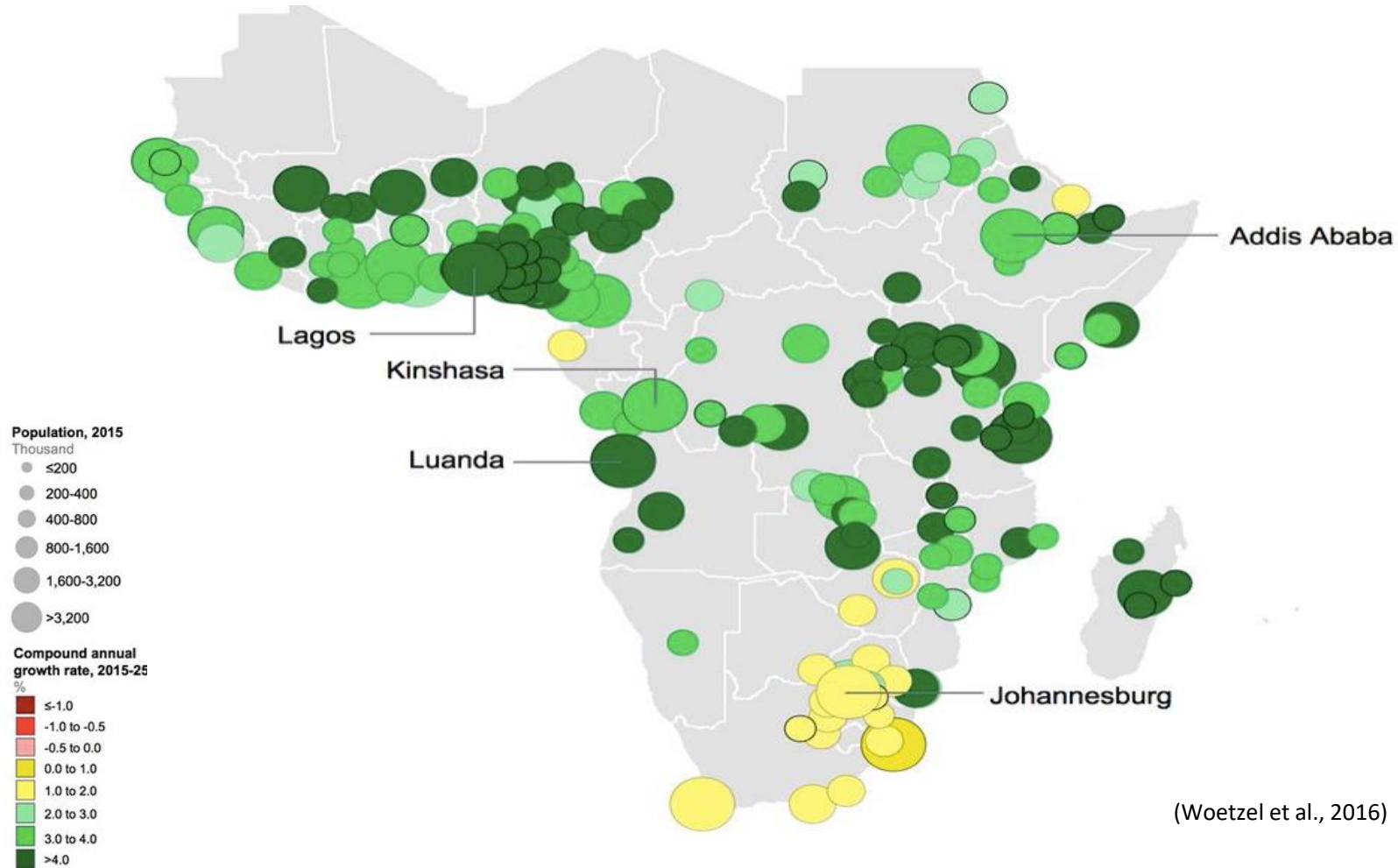




(Woetzel et al., 2016)



(Woetzel et al., 2016)



(Woetzel et al., 2016)

Synopsis

- Introduction
 - PPR and its control
- Reminder of economics
 - Elements of disease burden
 - Economic equilibrium of control
- What is known about economics of PPR and its control
- Reflections
 - Where are we in the control of PPR?
 - What can economics and social science do to support PPR GEP?

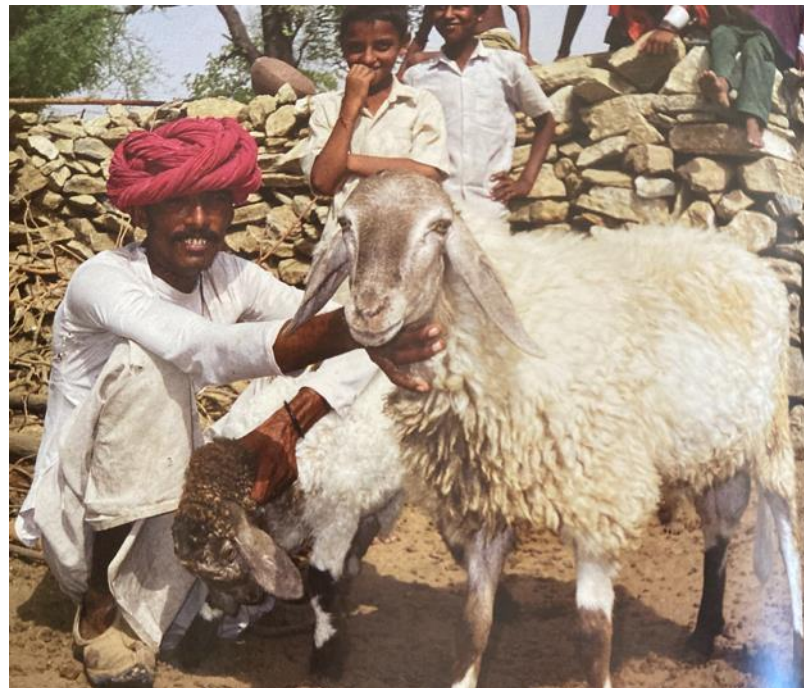


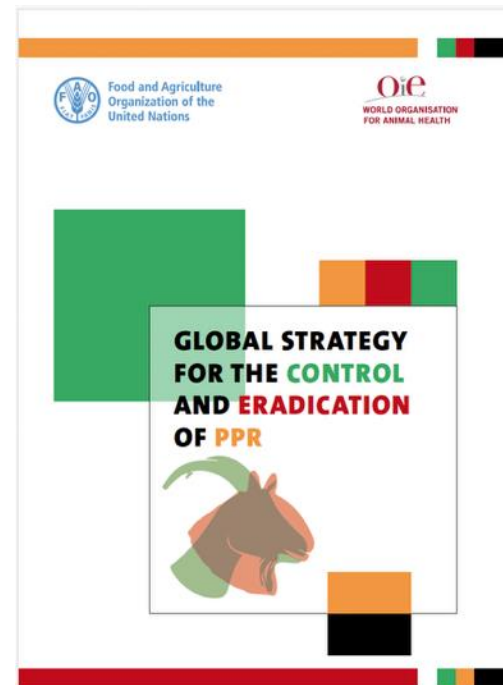
Photo Ellen Geerlings

Important take aways

- A cost benefit analysis **is not equal** to an economic assessment
- A positive cost benefit analysis **does not mean** an optimal solution
- Cost mobilisation **does not equal** efficiency of resource use
 - Often US\$10,000 dollars goes much further than US\$ 1 million
- Good implementation needs **constant cost analyses** and **regular cost effectiveness analyses**
- Good CEA need you to decide on **outcome metrics** and the level of **improvement on that metric per dollar invested**

Context

- Global PPR eradication strategy was developed over ten years ago – (FAO-OIE, 2015)
- What has changed since then?
- Are we closer to the goal of eradication?
- What have been the costs over the last 10 years?



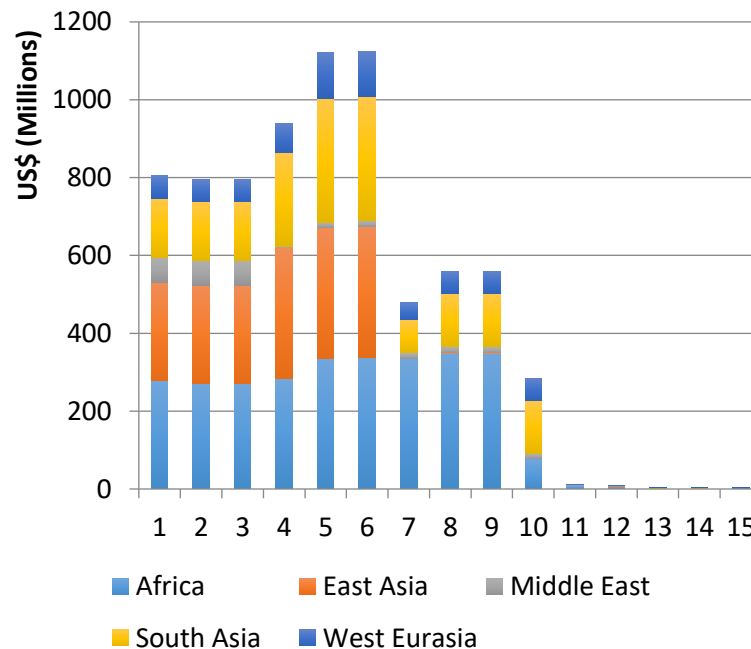
The strategy – core activities

- Regional and global level **coordination**
- An **ex-ante assessment** of the PPR situation in the country
- **Surveillance** to follow the disease and to monitor the vaccination efficacy
- **Vaccination** to manage PPR



The estimated costs of the strategy (Rushton, Lyons, Sucena Afonso, 2012)

- Total programme costs in undiscounted US\$ were estimated to be between US\$ 7.6 - 9.1 billion over a 15 year period
- These were costs for **99 countries**
- The activities were for a population of **1.8 billion sheep and goats**
- These animals provided products for **5.4 billion people**



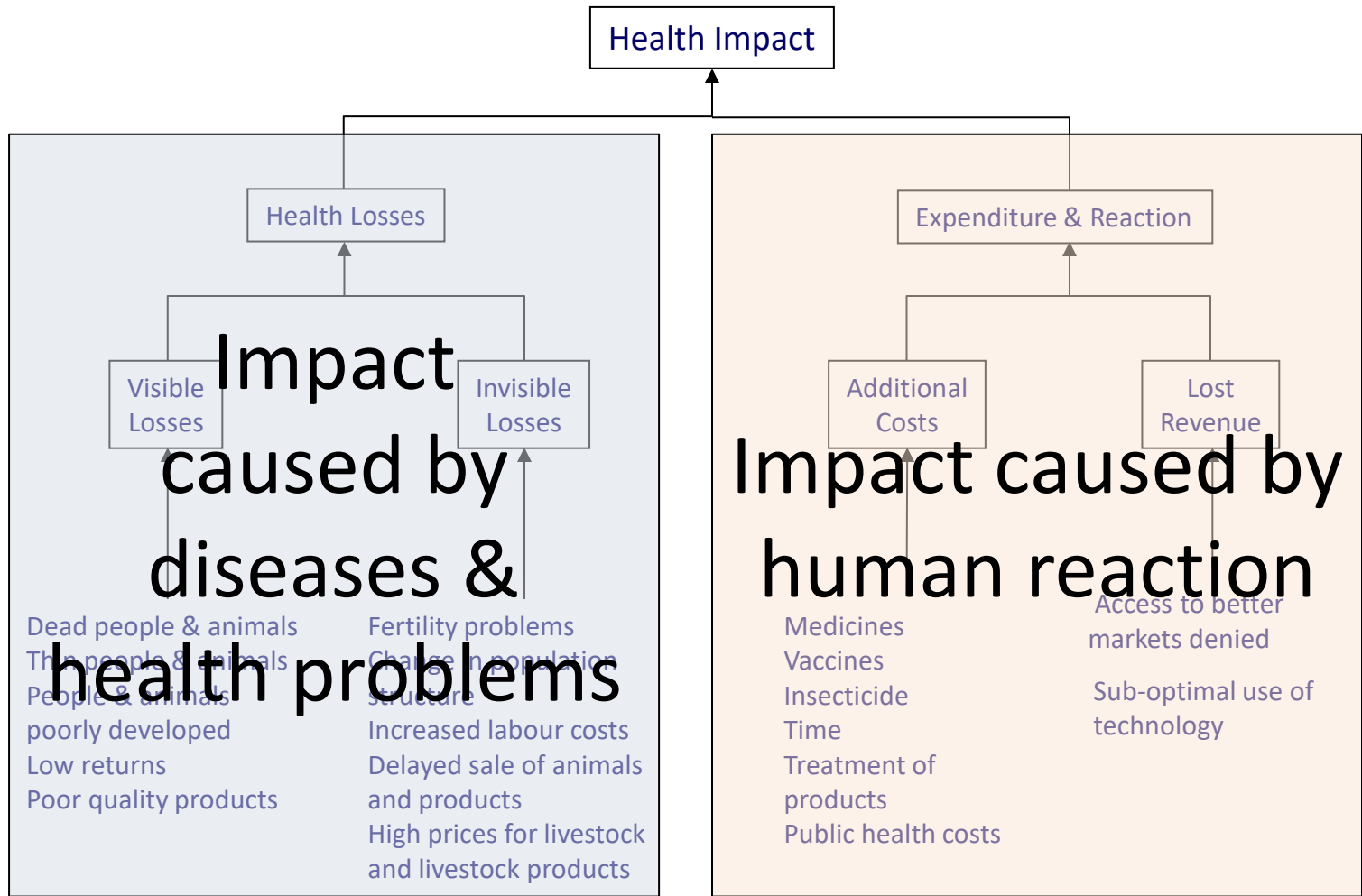
Context

- PPR programme has been running for ten years
- During this period there have been advances
- Yet what do we know about the costs and benefits of the PPR control?
- And how should this be assessed?



Courtesy Di Mayberry

Economics of disease burden & control



There will be winners and losers

Table 17 The impact of HPAI across the chain of the poultry industry and the general economy.

Part of the Industry	Heavy losers	Losers	Neutral	Winners
Supply Industry	Feed industry	Day old chick suppliers (assuming demand will be high after an outbreak has ended)		Veterinary profession Vaccine producers
Production	Producers with high investments in fixed capital and loans (sectors 1 and 2 and possibly 3) More important in Thailand, Indonesia and Viet Nam	Producers who lost poultry either through HPAI or flock eradication (all sectors)	Producers who were not directly affected by HPAI (all sectors, but particularly sectors 1 and 2) (assumes that the lack of a market is after compensated for by higher prices an outbreak)	Beef, pig, sheep and goat producers
Marketing	Sole traders of poultry in areas badly affected by HPAI	Sole traders in areas not directly affected by HPAI	General traders of livestock	Traders of other livestock
Processing	Export orientated poultry abattoirs (sector 1 and specific to Thailand)	National supply poultry abattoirs	General abattoirs	Other livestock abattoirs
Consumers	Urban poor	Rural poor in areas affected by HPAI	Rural poor in areas not affected by HPAI Urban medium and rich who can afford other protein sources	
General	People who have died and their families. Workers in poultry export industry (sector 1 and specific to Thailand)	Workers in national poultry industry processing Tourism industry (more specific to Thailand and Bali, Indonesia)		Workers in other livestock processing industries

Rushton, J., Viscarra, R.E., Guerne Bleiche, E. and Mcleod, A. (2005) *Impact of avian influenza outbreaks in the poultry sectors of five South East Asian countries (Cambodia, Indonesia, Lao PDR, Thailand, Viet Nam) outbreak costs, responses and potential long term control*. World Journal Poultry Science. 61 (3) pp 491-514

Who is affected by PPR?

The animals

- Animals (domestic and wild) suffer when they have PPR and some suffer more than others
- PPR control also mean the animals suffer through movement restrictions, culling, vaccination
- Probably a net gain on welfare with control measures as the animals do not experience disease



Photo Ellen Geerlings

Producers

- Producers are impacted by the disease in their animals in terms of loss of production, change in fertility, sometimes death
- Yet the biggest impacts will be around trade through local, national or international bans
- And they will be asked in many countries to contribute in-cash and in-kind to control and prevention measures



Value chain businesses

- PPR affects livestock and livestock product movements
- There will be restrictions on trade
- This can limit market access to the markets with the best prices for products
- PPR will limit investment in livestock value chains which in turn affect the finance and service companies that support livestock businesses



Consumers

- The biggest losers from PPR are consumers, but which consumers depends on the trading patterns
- Outbreaks that stop exports reduce prices to home consumers, increase prices to consumers in importing countries
- Consumer impacts need information on trade and movement



Researcher, Vets..... and a few economists and social scientists

- PPR creates interesting research on the biology, epidemiology, economics and social sciences
- Researchers provide services to the livestock sector and the food systems and they gain from PPR
- Some vets and their businesses are dependent on PPR



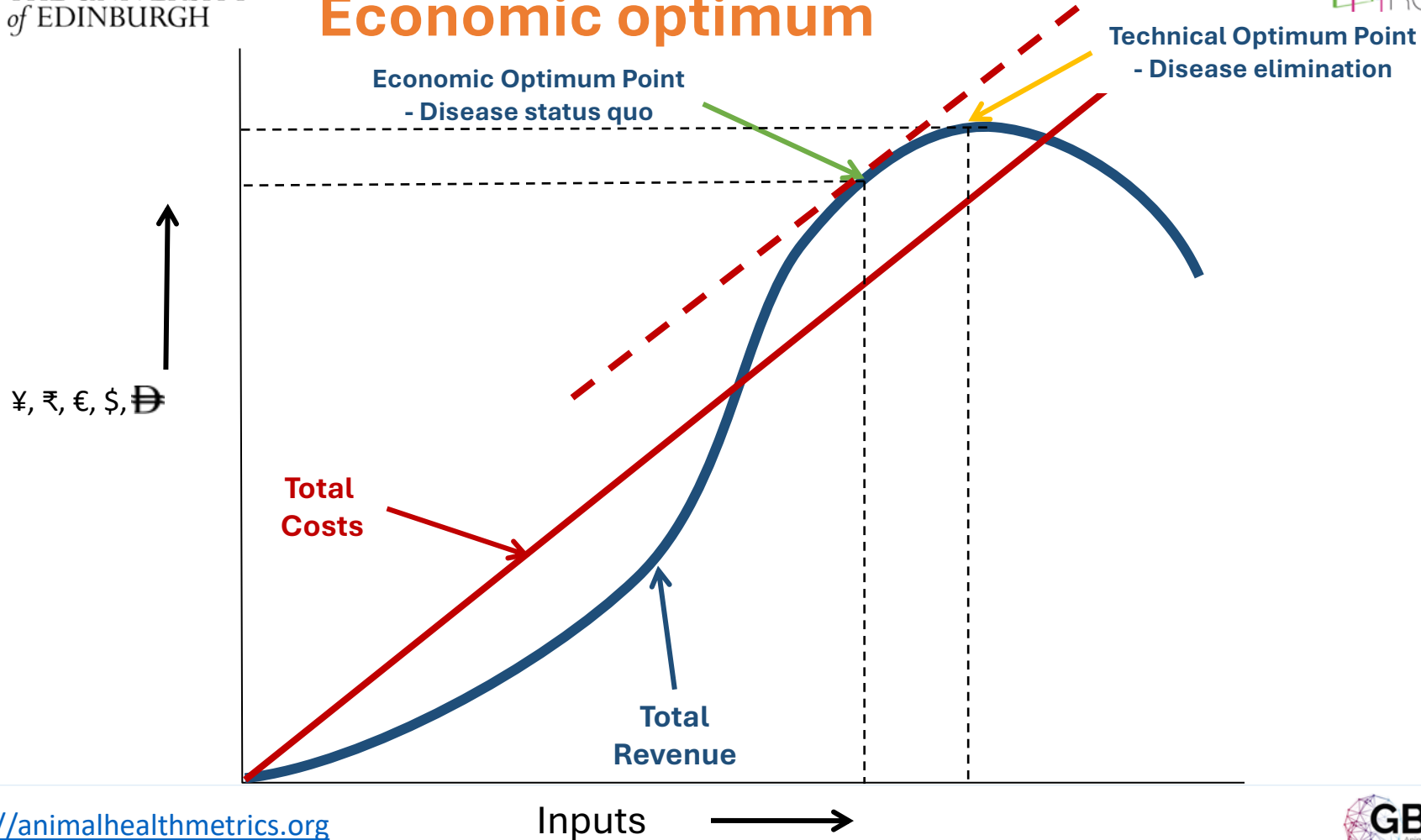
People we forget

- People who keep animals that are not affected by PPR
- People who live in areas that do not have PPR
- These people are not considered when making decisions on PPR over other animal health issues
- **They receive little or no animal health support**

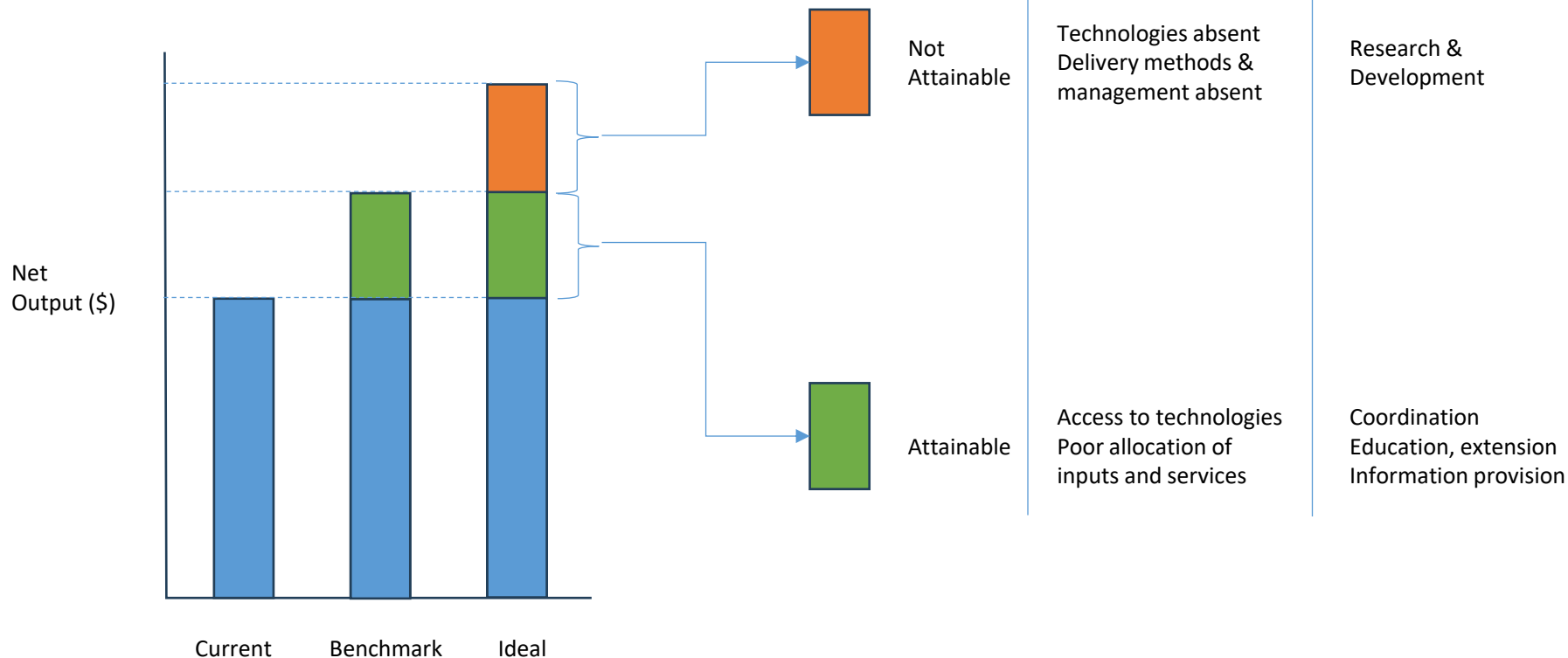


And the economic rational.....

Economic optimum



GBADs gap analysis



A question?

- When eradicating a disease the last part is often the hardest
 - particularly if technologies are poor
 - biological, epidemiological, economic, social sciences
- It requires an effort (money, time, dedication) that does not initially give a good return
 - Time and money spent is less than is given back
- **Are at we at this point with PPR?**



What is known about PPR economics?

Estimated cost of PPR eradication (Jones et al, 2016)

Table 1. Summary of programme budget by cost category and programme phase (US\$ million).

Budget Category	Phase 1 (Years 1–3)	Phase 2 (Years 4–8)	Phase 3 (Years 9–12)	Post-eradication (Years 13–15)	Total
Global Coordination	7.5	14.1	12.9	3.5	38.0
Regional Coordination	9.4	17.6	16.1	4.3	47.5
National coordination	40.3	129.7	94.3	-	264.3
Animal health institutions	4.9	18.7	11.8	-	35.4
Epidemiology and surveillance	149.7	663.5	471.9	-	1,286.5
Diagnostic Laboratories	44.8	44.0	35.3	-	124.1
Vaccination	166.8	806.5	36.9	-	1,010.2
Training and research	62.9	35.2	6.5	1.3	105.9
Socio-economics	26.0	27.0	34.9	14.7	102.5
Contingency and emergency response capacity	13.0	27.3	21.1	5.0	66.4
Total Programme Cost	525.2	1,783.7	741.7	28.7	3,080.7

doi:10.1371/journal.pone.0149982.t001

Estimated benefits from successful eradication (Jones et al, 2016)

Table 2. Discounted benefits and costs of PPR eradication under different scenarios (US\$ million).

Item	Low mortality scenario (1.4%)	Most likely scenario (2.6%)	High mortality scenario (4.7%)
Programme costs (discounted @5%)	2,264	2,264	2,264
Benefits (discounted @5%)	41,905	76,490	135,887
Discounted benefits, mortality	12,451	23,123	41,799
Discounted benefits, avoided vaccination losses	2,034	2,034	2,034
Discounted benefits, own sector effects	10,210	18,961	34,275
Discounted benefits, linkage effects on output	17,431	32,372	58,519
Net benefit	39,641	74,226	139,591
Benefit Cost Ratio (BCR)	18.51	33.78	60.02
BCR, mortality effects only	5.50	10.21	18.46
BCR, mortality and vaccination	6.40	11.11	19.36
Internal Rate of Return (IRR)	104%	199%	219%

doi:10.1371/journal.pone.0149982.t002

Reliance on an ex ante cost benefit analysis

- Jones et al (2016) calculated a benefit cost ratio of 33
 - Every dollar invested would return 33
- Their analysis was based on a strategy that did not follow the global strategy
- Their strategy has also not been followed by countries



Vaccination



Photo Ellen Geerlings

Vaccination in West Africa (Tago et al, 2017)

- A vaccine cost model was developed and applied to Senegalese data
- The overall costs of vaccination were estimated to vary between US\$0.18 to 0.54 per dose delivery
- The model was very sensitive to the number of vaccines delivered per team and the type of production system



Reality of vaccination costs (Lyons et al, 2019)

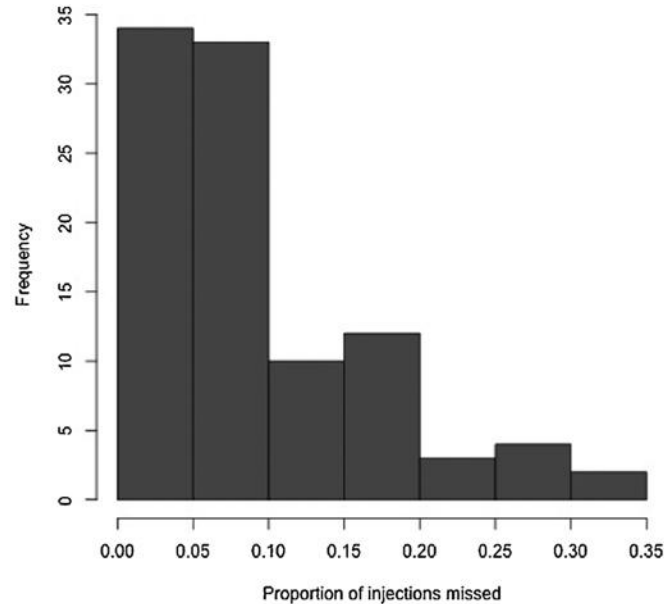


Fig. 3. Frequency distribution of the mean proportion of PPR vaccinations missed from data collected at four different sites in Ethiopia.

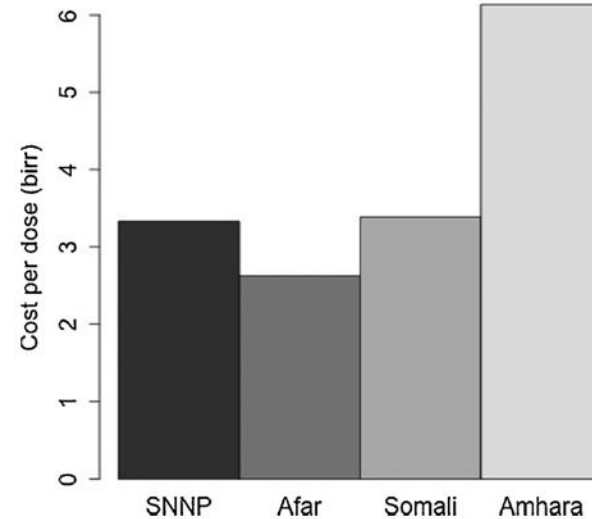


Fig. 4. Total mean costs for each animal vaccinated for PPR in four regions of Ethiopia incorporating the cost of vaccine and delivery accounting for wastage through missed doses and discarded partially used bottles in each area (all costs in Ethiopian birr, ETB).

Reality of vaccination coverage 2015-18 (Zhao et al, 2020)

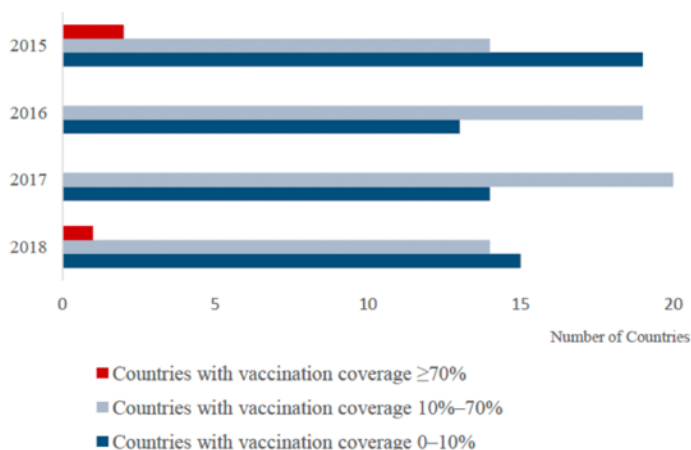


Figure 1. The number of countries with different vaccination coverage percentages for which data were available. Vaccination coverage is estimated by dividing the number of vaccine doses used (derived from WAHIS) by the number of goats and sheep in the country (derived from FAOSTAT).

<https://doi.org/10.3390/v13010059>



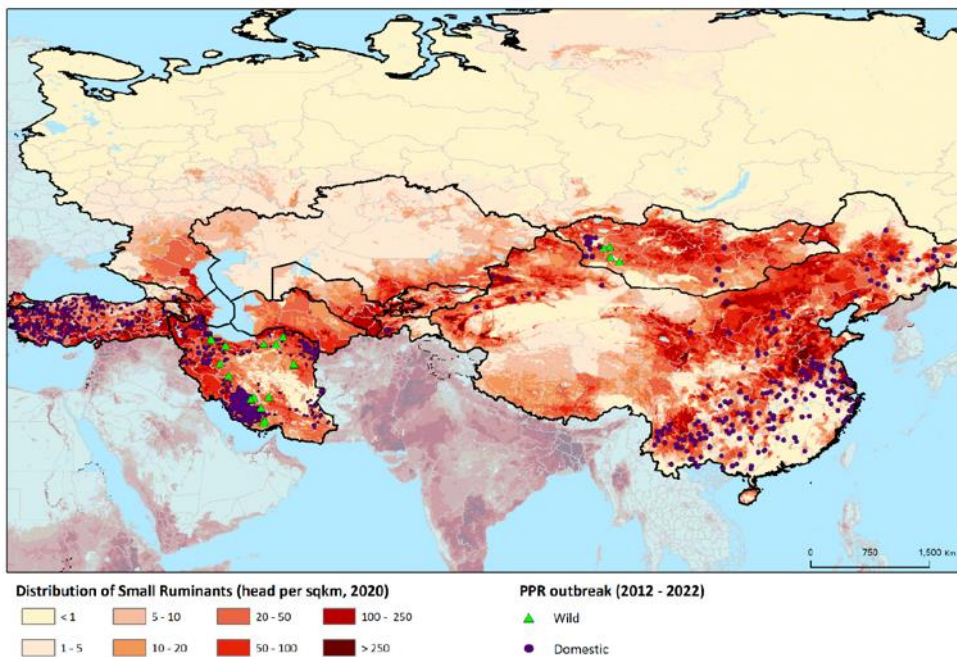
Is this the reality of outbreaks 2015-19 (Zhao et al, 2020)?

- The total number of PPR outbreaks worldwide has decreased significantly in recent years, but the infection scope of PPRV, both geographical and host range, is still wide
- Remarkably, more than 48% of all outbreaks between 2015 and 2019 have occurred in 5 countries, highlighting the urgent need for these countries to strengthen prevention and control
- Twenty-one countries, which have had no new cases for five consecutive years, can prepare their documentation for OIE validation of their PPR free status

Table 2. Peste des petits ruminants (PPR) outbreaks reported to the World Organization for Animal Health (OIE) from 2015 to 2019 for nine different sub-regions.

Sub-Regions	No. of Outbreaks	Proportion of Total Reported Outbreaks Globally
Southern Africa	171	1.3%
Central Africa	199	1.6%
Western Africa	1912	15.0%
Eastern Africa	485	3.8%
Northern Africa	394	3.1%
Middle East	7710	60.4%
West Eurasia	405	3.2%
South Asia	1386	10.9%
East Asia	58	0.5%
Countries not included in the Nine sub-regions	37	0.3%

Distribution of small ruminant population and reported PPR outbreaks 2012-22 (Legnardi et al, 2022)



Source: UN 2022 modified with GLWA unpublished data, EMPRES-i data, EU Animal Diseases Information System (ADIS) data, from Veterinary Organization (VVO) data

PPR status (Legnardi et al, 2022)

Disease reporting

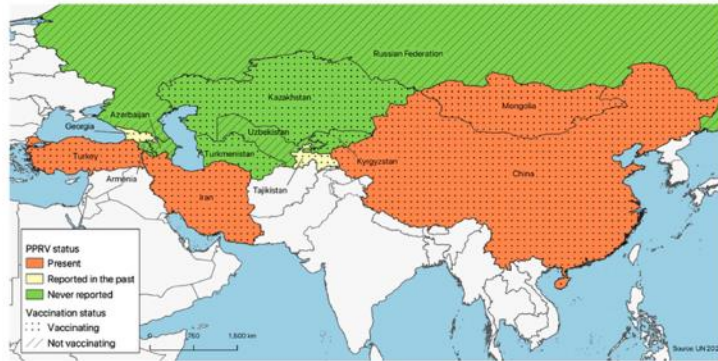


Figure 2. Map of the region under consideration showing each country's PPR epidemiological and current vaccination status, retrieved respectively from OIE WAHIS and from Roadmap meetings. See main text for further details.

Pathway status

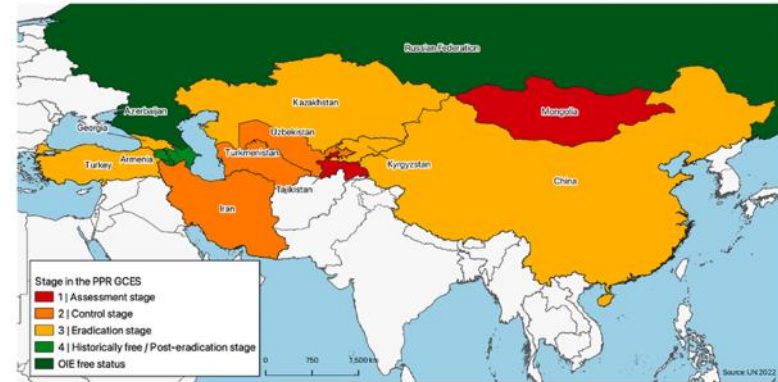


Figure 3. Map of the region detailing each country's self-reported stage within the stepwise approach of the PPR GCES, updated in October 2021, except for Mongolia (last update in 2017) and Tajikistan (last update in 2019).

Reality of PPR budgets 2017-2020 Central and East Asia (Legnardi et al, 2022)

- In the countries reporting expenditure for PPR there was total spend of approximately US\$40 million per year
- Most of this was spent (80%) in two countries – China and Turkey

Table 2. Reported national budgets for activities related to PPR in 2017–2020. Figures originally given in local currency are provided in USD (according to the exchange rate on 1st January of the respective year). Unless other donors are specified in the footnotes, all funds came from government sources. N/A indicates not reported.

Country	2017	2018	2019	2020
Armenia	USD 2 million	USD 2.7 million	USD 2.9 million ¹	USD 3 million ¹
Azerbaijan	N/A	N/A	N/A	N/A
China	USD 23 million	USD 24.6 million	USD 23.2 million	USD 23 million
Georgia	USD 2.7 million	USD 2.8 million	USD 3 million	USD 3.2 million
Iran (Islamic Republic of)	N/A	N/A	N/A	N/A
Kazakhstan	USD 32,674	USD 25,001	USD 82,189	USD 375,613
Kyrgyzstan	USD 1.8 million	USD 2.9 million	USD 2.7 million	USD 2.7 million
Mongolia	N/A	N/A	N/A	N/A
Russian Federation	N/A	N/A	N/A	N/A
Tajikistan	N/A	N/A	N/A	N/A
Turkey	USD 14.2 million	USD 15.8 million	USD 8.6 million	USD 8.5 million
Turkmenistan	USD 1243	USD 1240	USD 1238	USD 857
Uzbekistan	USD 18,000	USD 18,500	USD 18,500	USD 20,000

¹ Including donations equal to USD 120,000 from the USA Defense Threat Reduction Agency (DTRA).

<https://doi.org/10.3390/ani12162030>

Summary (Legnardi et al 2022)

- West Eurasia, Central and Eastern Asia present some challenges
 - For example PPR outbreaks in susceptible wild ruminants
- A coordinated approach is needed that focuses on both eliminating PPR from infected areas and preventing the spread of the disease to new territories
- PPR freedom in West Eurasia is achievable



PPR losses in Ethiopia (Jemberu et al, 2022)

- The flock losses during PPR outbreaks were ETB 319 (USD 13.4) per sheep and ETB 306 (USD 12.9) per goat.
- Mortality accounted for more than 70% of the total losses in both sheep and goat flocks.
- Vaccination costs for PPR were estimated at ETB 3 per correctly vaccinated animal.
- Based on the estimated animal-level direct economic losses and vaccination cost, it can be conjectured that vaccination will pay if a district PPR outbreak occurs more than once every 13 years.

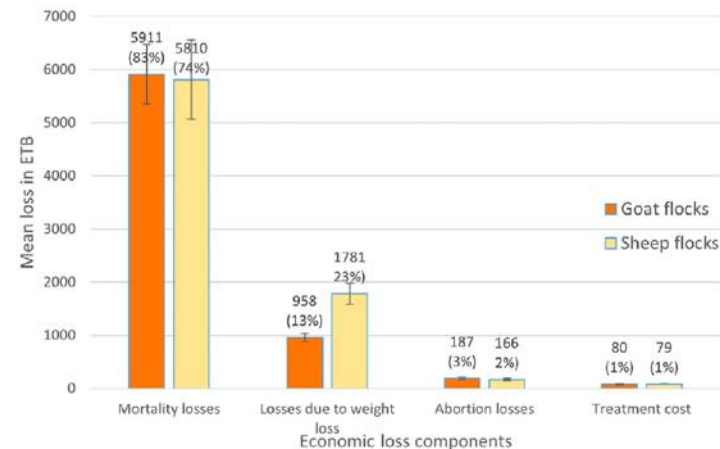


FIGURE 2 The components of mean economic losses per affected flock due to PPR with standard error bars

DOI: 10.1111/tbed.14544

PPR losses in India (Govindaraj et al, 2016)

Table 6: *Mortality and morbidity losses in goat and sheep for various levels annual incidence of PPR in India (INR millions)*

Type of loss	Annual Incidence levels		
	5%	10%	15%
1. Mortality loss	6007.3(74.6)	12014.5(74.6)	18021.8(74.6)
2. Morbidity loss			
I. Weight loss			
a. Direct losses due to reduction in body weight	404.5(5.0)	809.0(5.0)	1213.5(5.0)
b. Live weight loss due to increased inter-lambing period	952.9(11.8)	1905.8(11.8)	2858.8(11.8)
c. Live weight loss due to increased abortion	42.5(0.5)	84.9(0.5)	127.4(0.5)
II. Milk loss	32.9(0.4)	65.9(0.4)	98.8(0.4)
III. Other associated loss			
a. Cost of high feeding and rearing inputs	367.7(4.6)	735.4(4.6)	1103.1(4.6)
b. Miscellaneous loss	250.2(3.1)	500.5(3.1)	750.7(3.1)
3. Total Loss	8058.0(100)	16116.1(100)	24174.1(100)

Govindaraj, G., V., Balamurugan, H., Rahman. 2016. Estimation of economic loss of PPR in sheep and goats in India: An annual incidence based analysis. *British Journal of Virology*, 3(3s): 77-85.

PPR in Karnataka, India (Govindaraj et al, 2023)

- Karnataka state, India has implemented the PPR 'mass vaccination' strategy since 2010–11, resulting in a significant reduction in the number of outbreaks
- **The disease incidence in the state declined significantly and benefits of vaccination outweighed the cost many-fold.**
- However, Karnataka continues to report outbreaks every year hence a new mass vaccination programme was planned to eliminate the PPRv
- The majority of the veterinarians concurred with the PPR control activities and there was acceptance by farmers

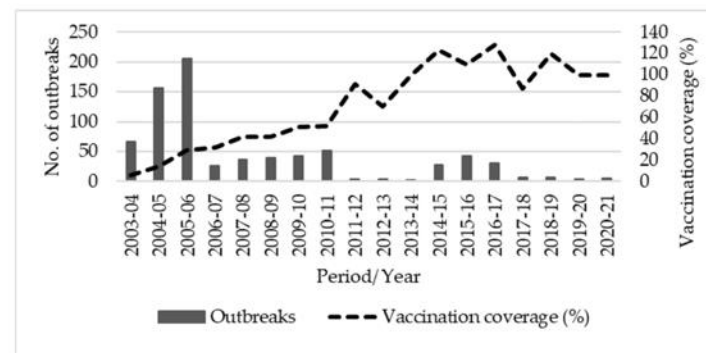
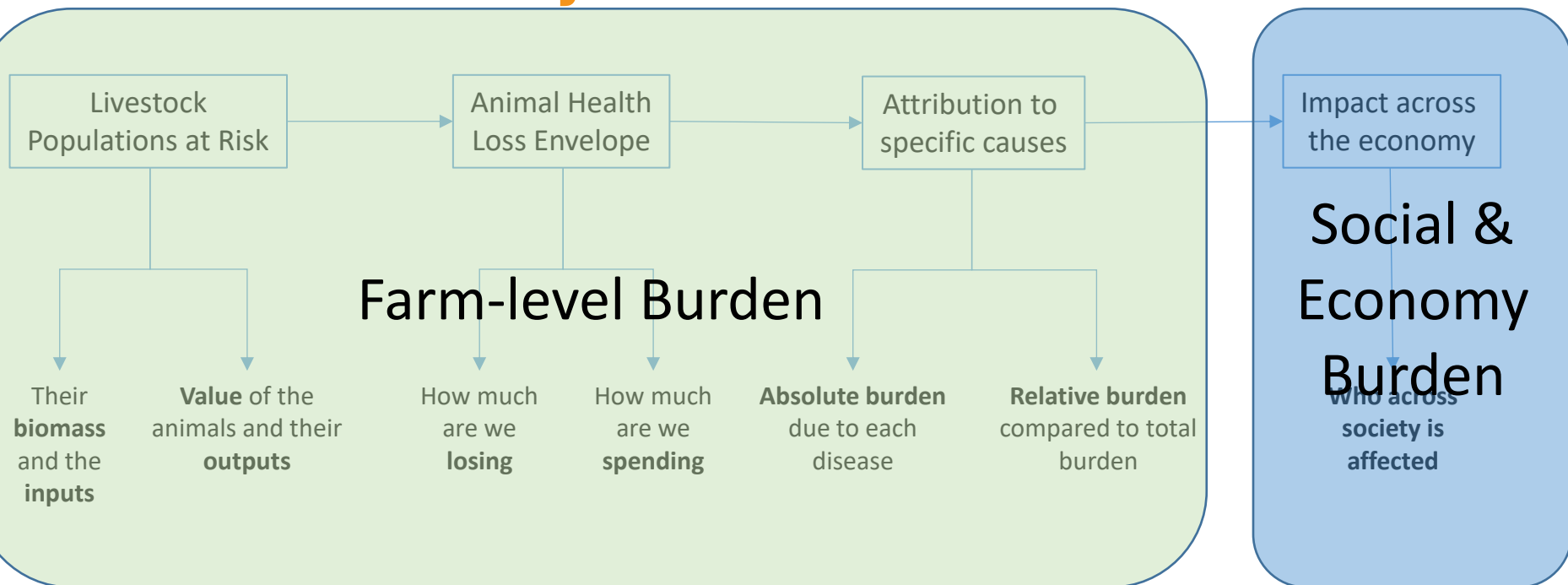


Figure 2. Reported PPR outbreaks and vaccination coverage in Karnataka between 2003–2004 and 2020–2021.

<https://doi.org/10.3390/ani13050778>

Need for a systematic approach to PPR burden and economic assessment of PPR control

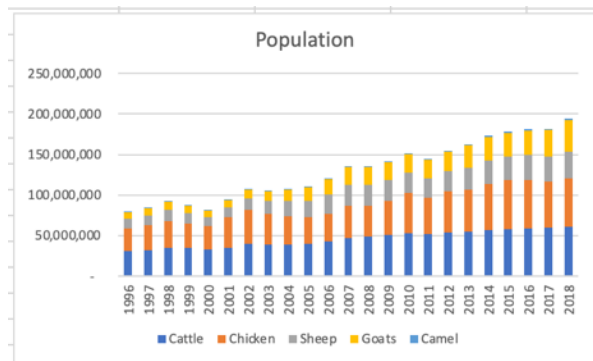
GBADs - Analytical structure to provide clarity on data and analysis



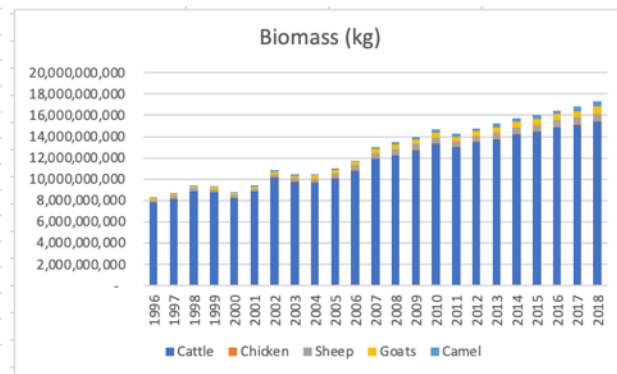
Rushton et al 2021

Understanding the context biomass and value (from the **GBADs** webpage)

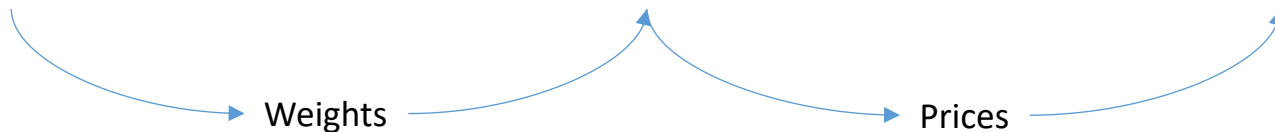
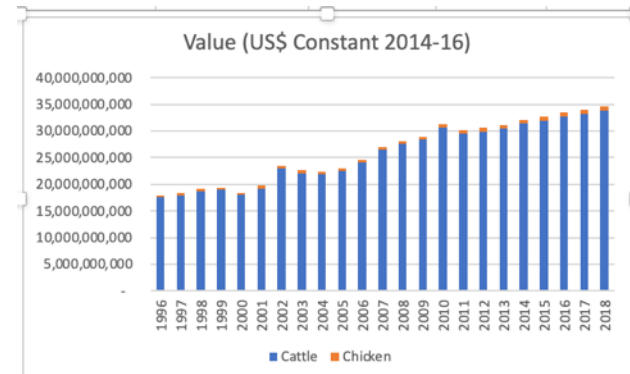
Population (head)



Biomass (kg)



Value of animals (\$)

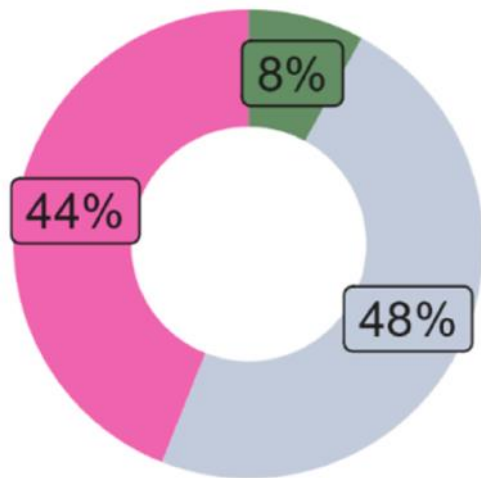


Weights

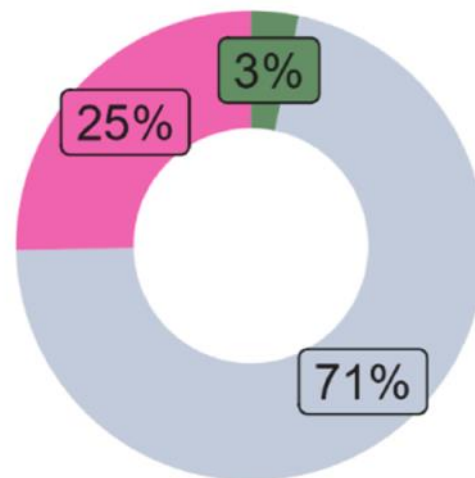
Prices

Senegal estimated losses in mixed crop livestock systems in sheep and goats (Meyer et al, 2025)

Goats



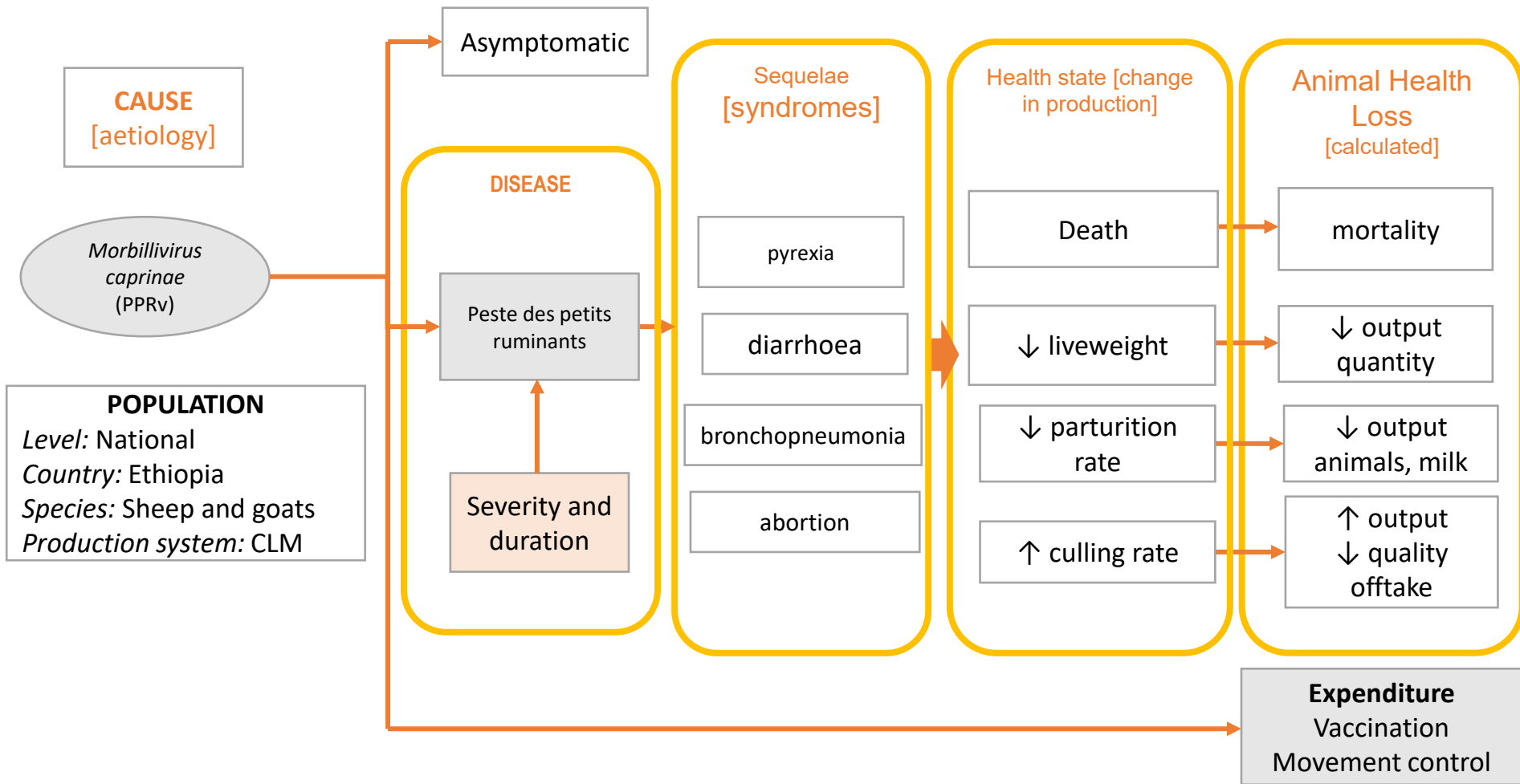
Sheep



Component

- Animal health expenditure
- Mortality losses
- Production losses

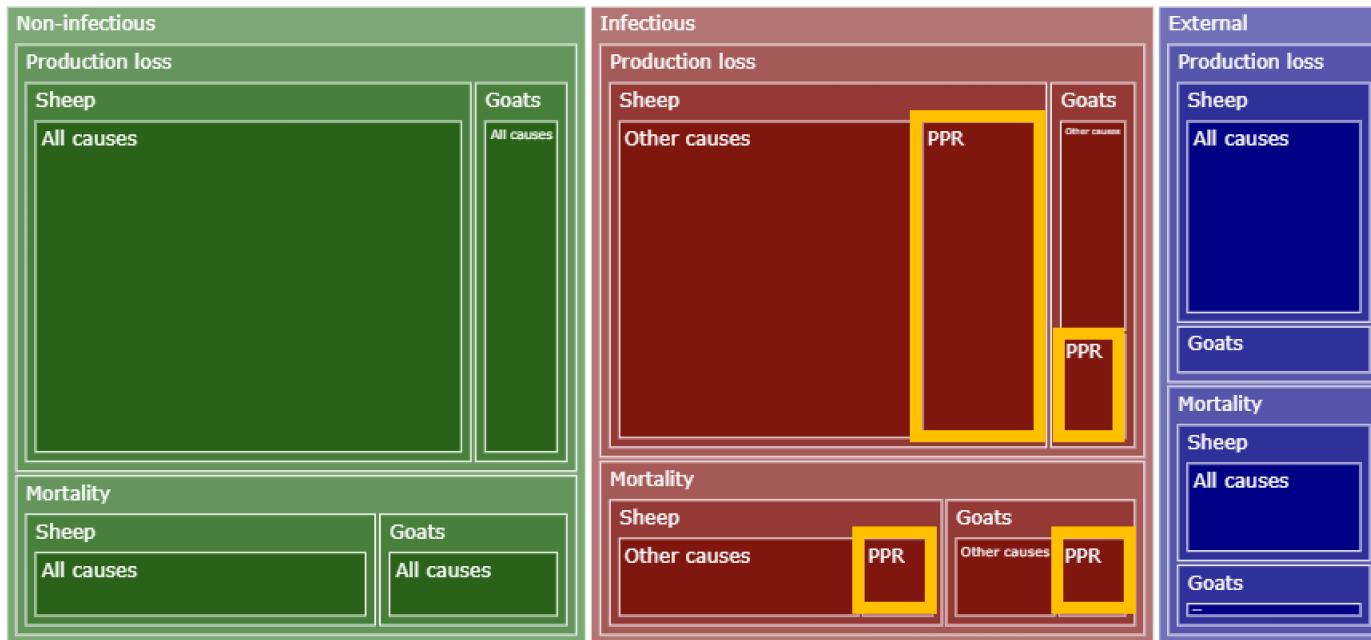
IDRC · CRDI



Disaggregation of disease burden

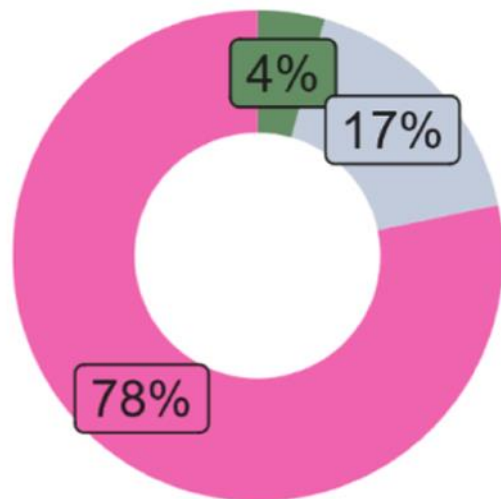
- PPR in context: small ruminants in Senegalese mixed crop livestock production

AHLE

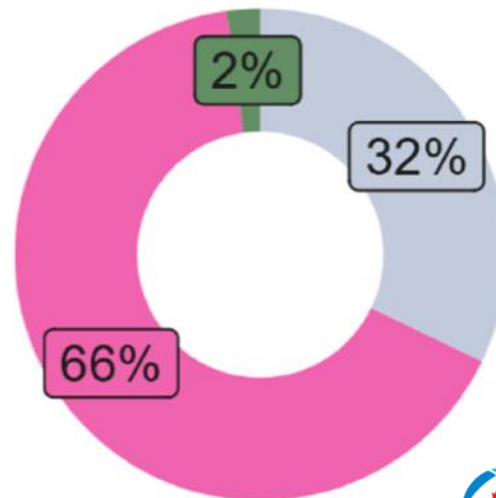


Senegal PPR attribution in mixed crop livestock systems in sheep and goats (Meyer et al, 2025)

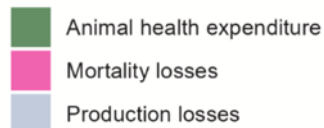
Goats



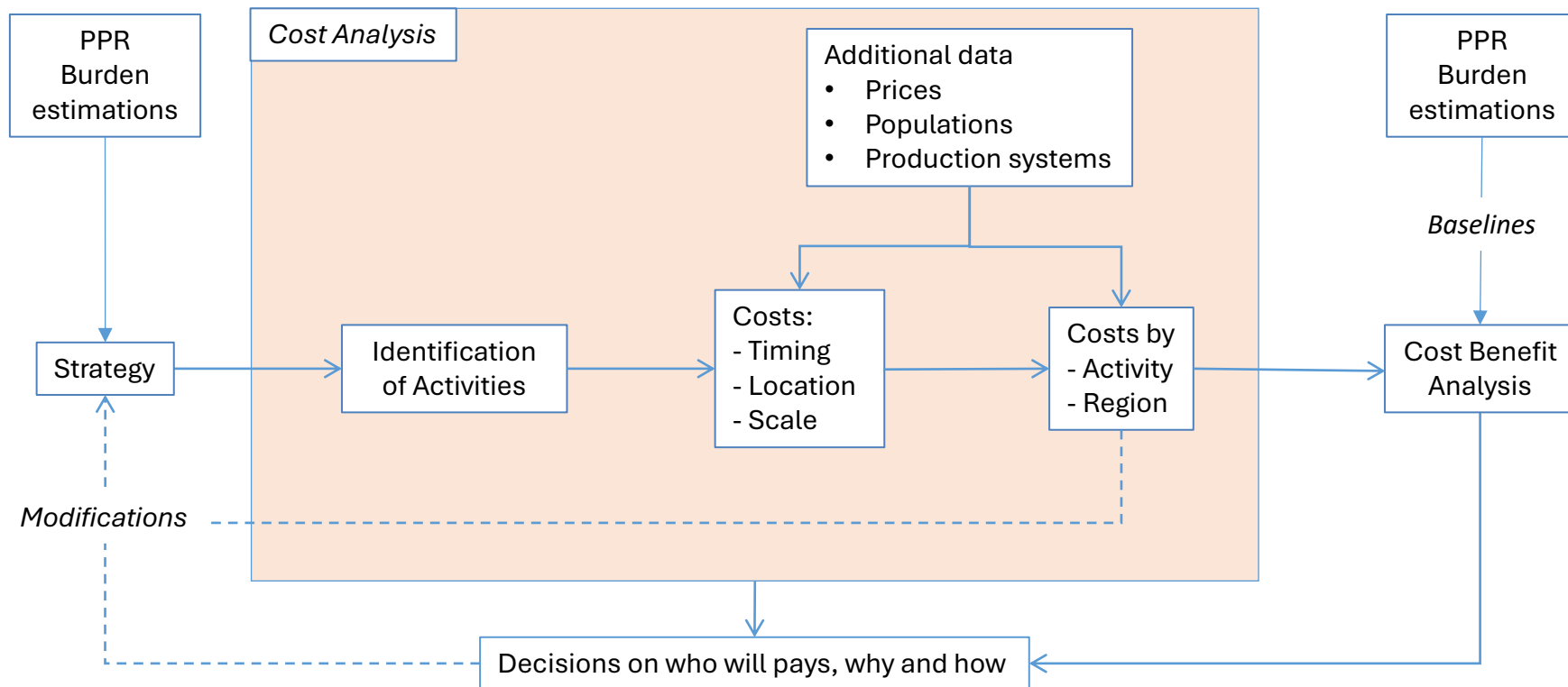
Sheep



Component



Systematic approach to cost benefit analyses





Reflections

Where are we with PPR?

Background

- Investment has been lower than estimated for the global strategy or the Jones et al (2016) plan
- Yet the vaccination carried out appears to have dampened down PPR outbreak reports with good returns (Govindaraj et al, 2023) - **success**
- However, virus continues to circulate and cause problems (Govindaraj et al, 2023)
- Over reliance on an ex-ante cost benefit analysis that is over 10 years old and does not relate to how countries have invested in PPR control

Questions

- Should we be satisfied with a status quo for PPR?
- Have we reached a point of transition with the current strategy?
- Do we need an alternative approaches if PPR virus elimination is to be achieved?
- What are the economic and social impacts of PPR and its control?

What would the alternatives look like?

- The Jones et al (2016) plan was based on strategic use of vaccine through investment in surveillance, epidemiology
- A similar proposal was made by Cameron (2019)
- The Cameron strategy is similar to the later stages of the rinderpest eradication programme

Strategies for the Global Eradication of Peste des Petits Ruminants: An Argument for the Use of Guerrilla Rather Than Trench Warfare

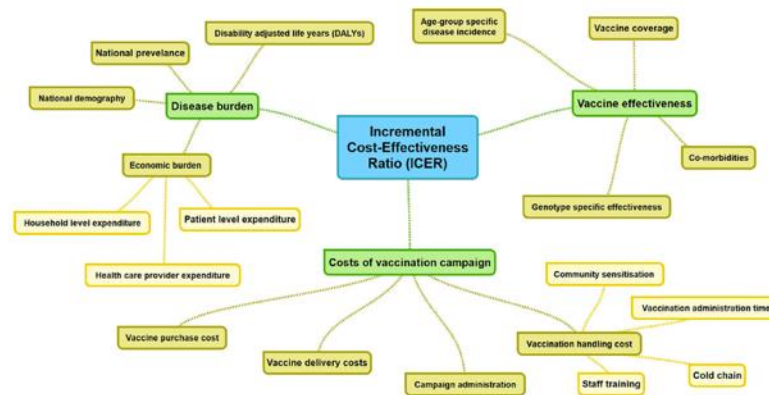
Angus R. Cameron*

Ausvet Europe, Lyon, France

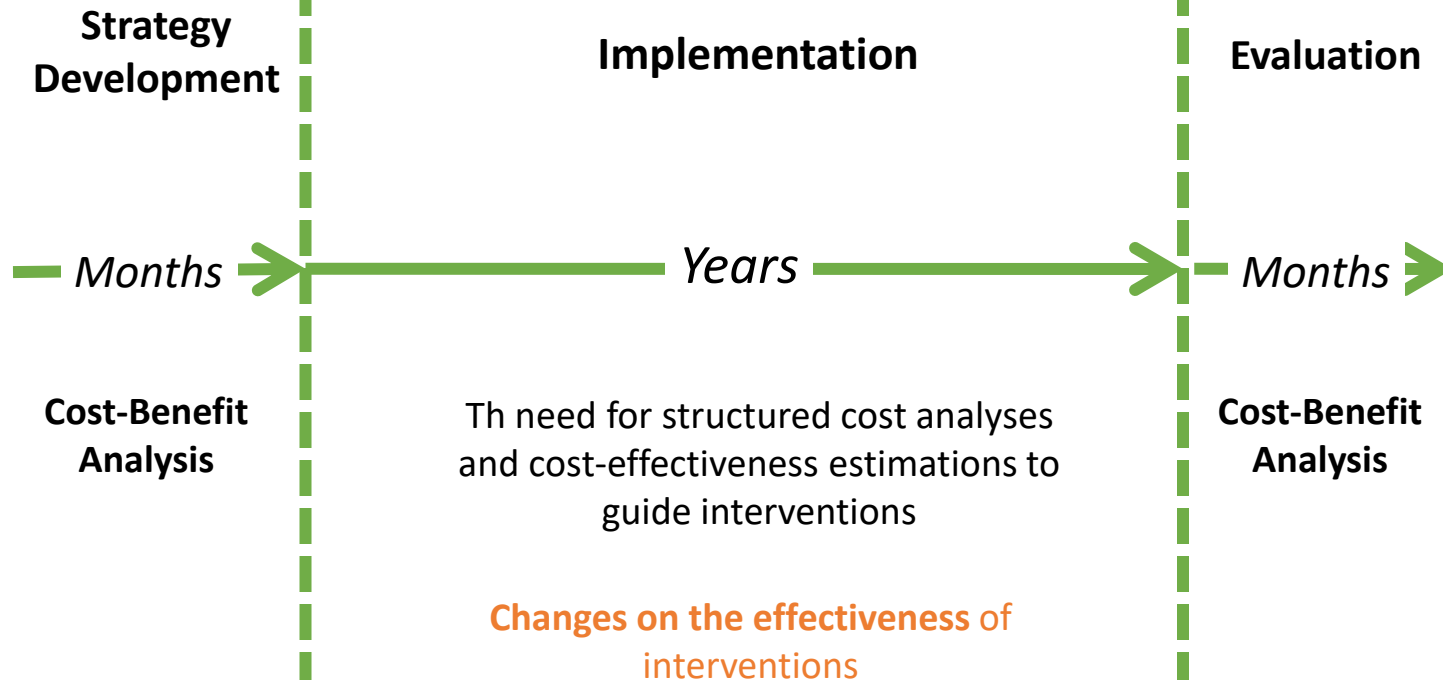
doi: 10.3389/fvets.2019.00331

The need to include the best economics and social science

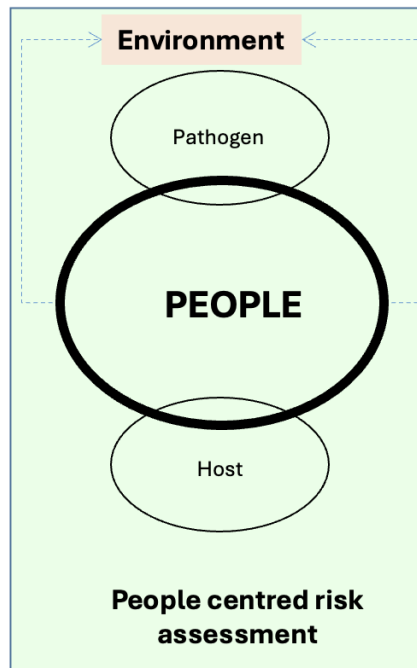
- Costs of key components need to be collected
- Their effectiveness needs to be measured
- Cost effectiveness analysis need to be a corner stone of implementation
- They will provide information for monitoring and evaluation



Thomas et al, 2019 doi: 10.1016/j.vaccine.2018.10.044. Epub 2018 Oct 16. PMID: 30340883 .



People centred approach to health



Photos Ellen Geerlings

Key investments

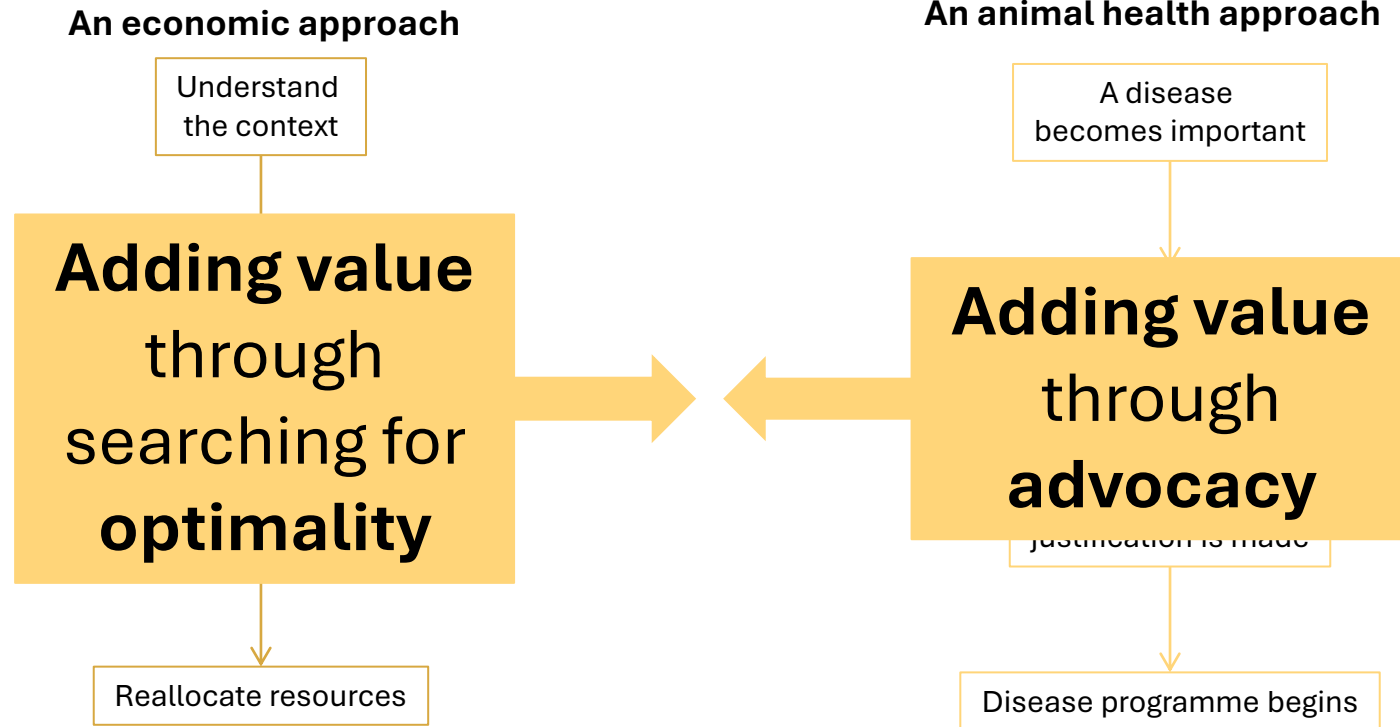
- ***Behavioural economics:***

- To understand farmers
 - their levels of their trust in the system/government,
 - willingness to report
 - acceptance of control measures,
- Help them balance disease control with protecting their livelihoods, their economies, their culture.

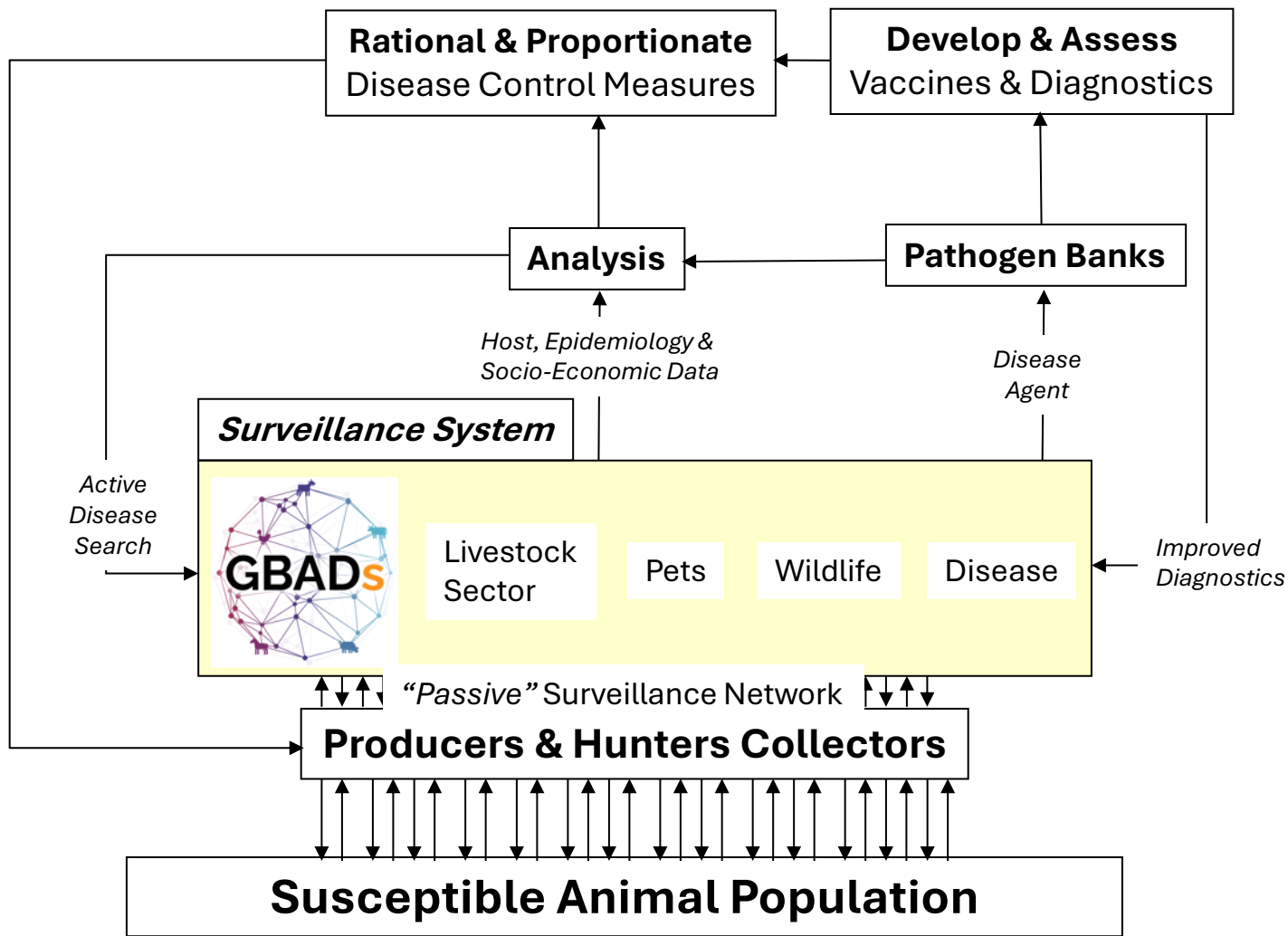
- ***Data infrastructure and data analysis:***

- Data systems are needed to monitor and adjust ongoing programmes
- They are also needed to measure success and show funders what has been done
- And we need new economic analyses to raise funds

Encouraging transdisciplinary approaches



Rushton 2017



GBADs supporting the PPR analysis

Problem

- We recognise that parametrisation of GBADs models can be time-consuming
- Such inefficiencies limit the scalability and responsiveness of burden estimation models

Response

- We are developing a centralised, accessible, and well-curated library of GBADs model parameters for estimation of burden of PPR in small ruminants in 6 East African countries
- We are seeking support to implement and expand this work in the near future



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An Roinn Talmhaíochta,
Bia agus Mara
Department of Agriculture,
Food and the Marine

BILL &
MELINDA
GATES
foundation



Cefas
Food and Agriculture Organization
of the United Nations



World Organisation
for Animal Health
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<https://animalhealthmetrics.org>

