Economic sustainability of antibiotic-free pork production

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Introduction

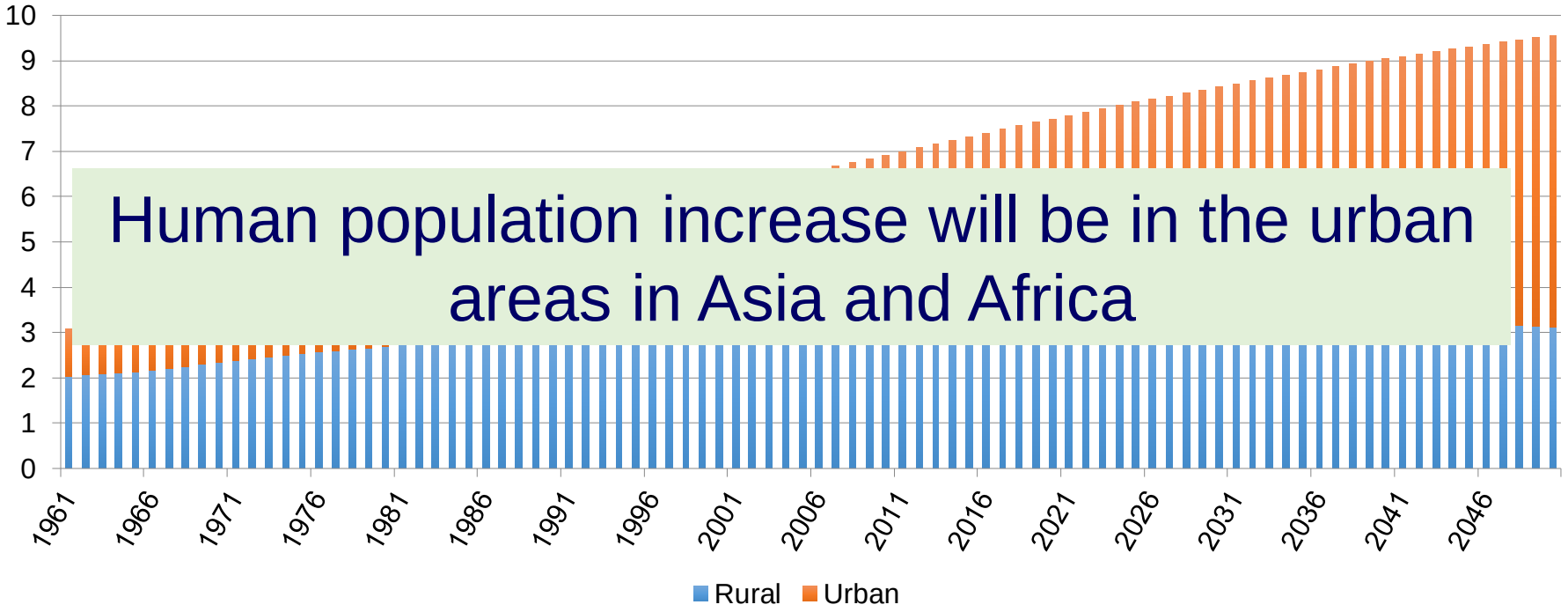
- In the debate on how to manage antimicrobial resistance (AMR) there is a consensus on the need to reduce antimicrobial use (AMU)
- A goal is to largely eliminate the use of antibiotics in livestock production, and other pharmaceuticals and active agents that would promote AMR
- Whether this is possible initially is a technical question
- Whether ***Antibiotic free pork production is economically sustainable*** is an economic, social and political question

Introduction

- To explore this question we will discuss and describe:
  - Context of pig production and the resulting benefit from those systems
  - Difference between an economic and technical approaches and how to explore the economics of antimicrobial use and resistance in pigs
  - Targeted review of studies on the economics of antimicrobial use
  - A potential way to approach interventions for an economic perspective in order to inform policy
  - Reflections on whether antibiotic free pork production is economically sustainable in the current social, economic and political context

The context

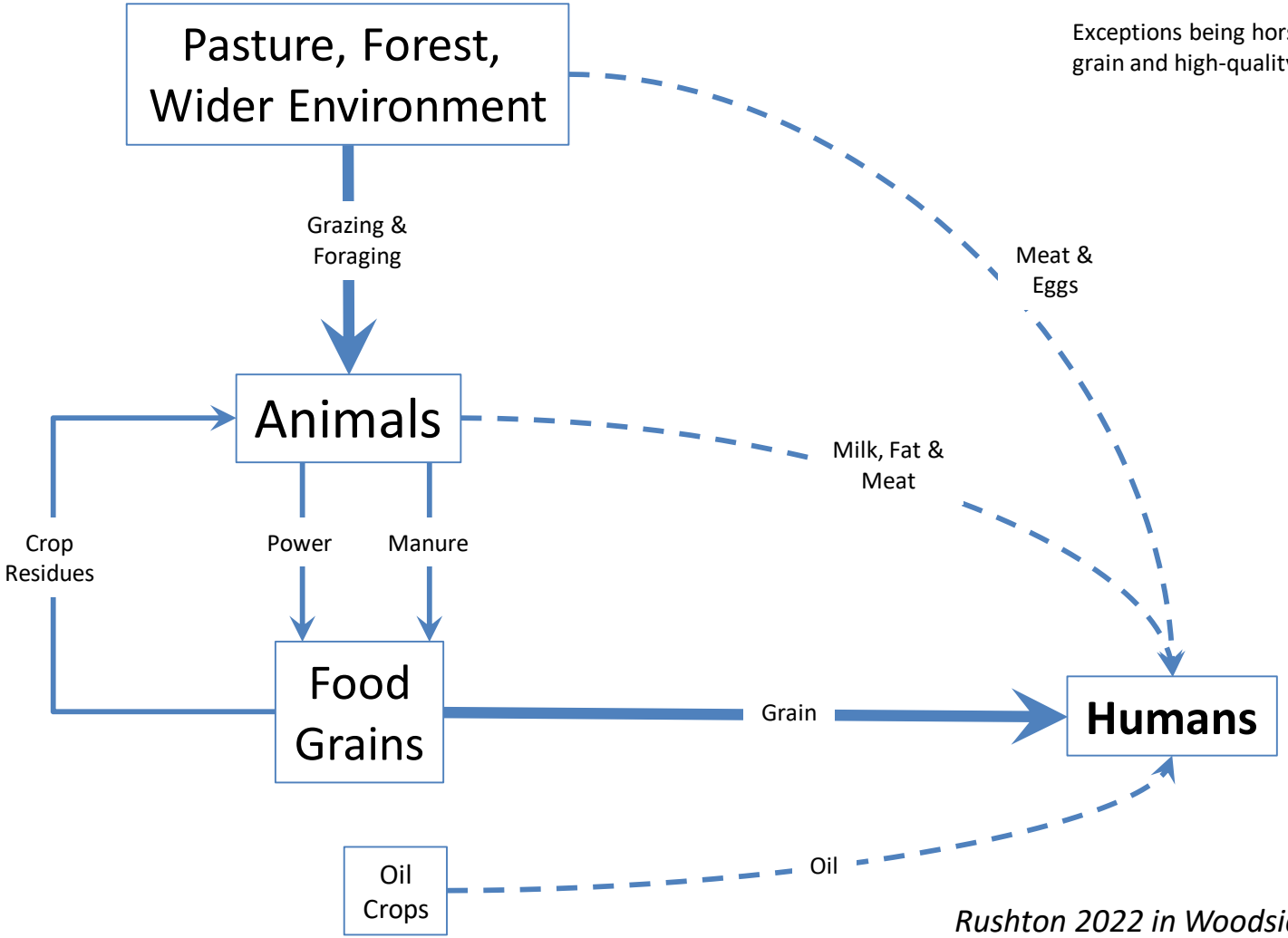
Context - the human population



Context – pig production, food system and food companies

- Changes in food systems are linked to ***supply and demand*** and the attitude to profits of food companies
- These companies have the power to influence behaviours, particularly at farm-level
- Food systems companies are generally stock listed and therefore report and respond to the stock markets – they are primarily profit driven and these profits depend on how markets and prices are regulated
- These companies hold political power

Major shift in food production



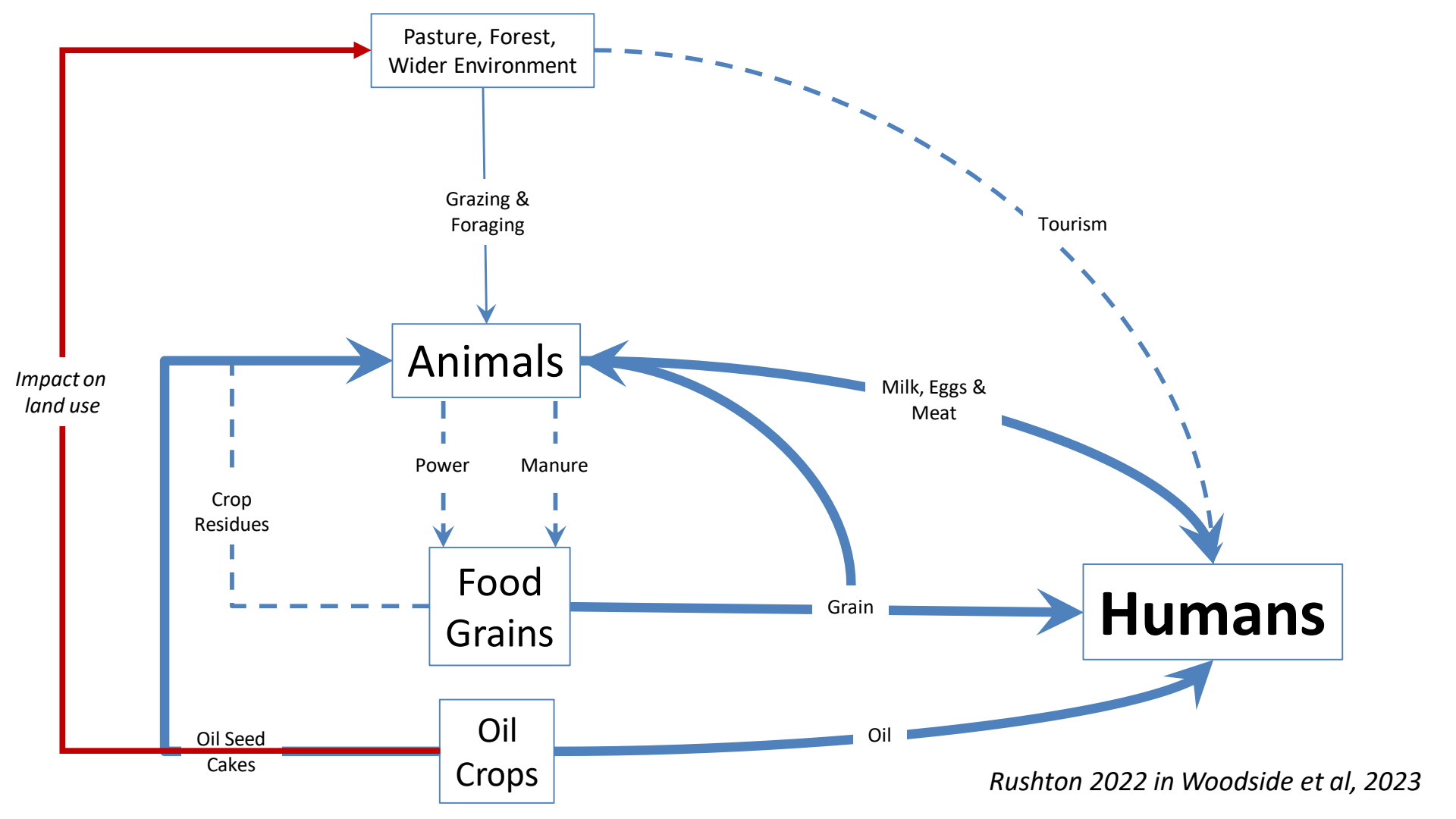
Rushton 2022 in Woodside et al, 2023

What has changed?
- agricultural technology

- There have been three agriculture **revolutions**
  - green, oil crop, livestock
- Animals have become less relevant as a source of power replaced by the **combustion engine** and non-renewable fossil fuels with CO2

Cheap feed grains, Cheap food

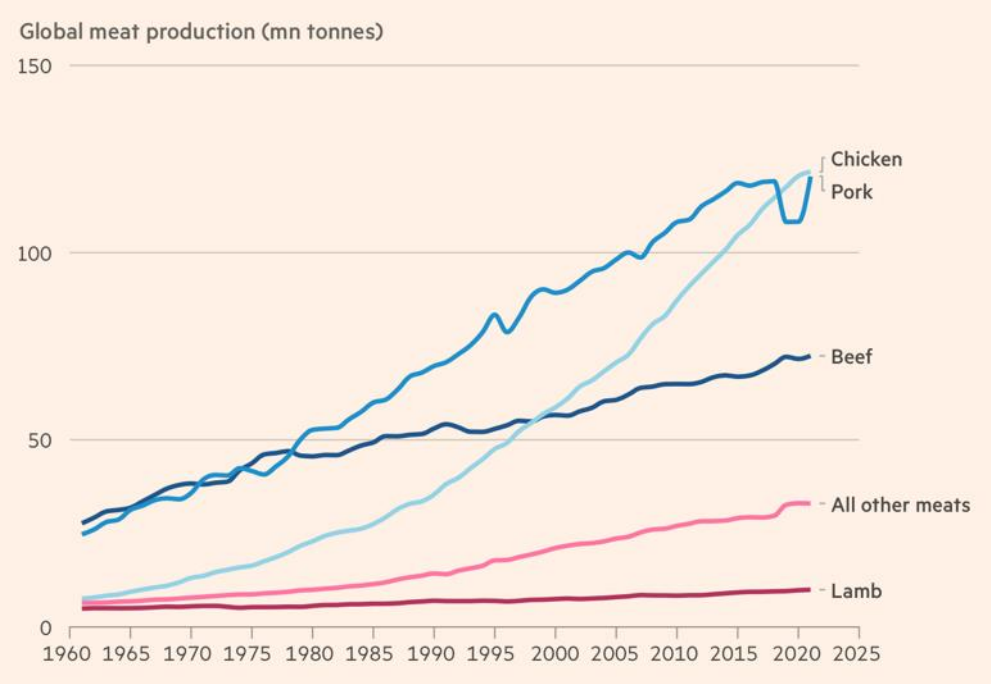
  - Different soil types coming under crop management
  - More land coming under cultivation
- Less dependency on **animal manure** which has largely been **replaced** by **chemical fertiliser**



Rushton 2022 in Woodside et al, 2023

The impacts of the food systems changes

Global meat production (mn tonnes) from Financial Times based on FAOSTAT data



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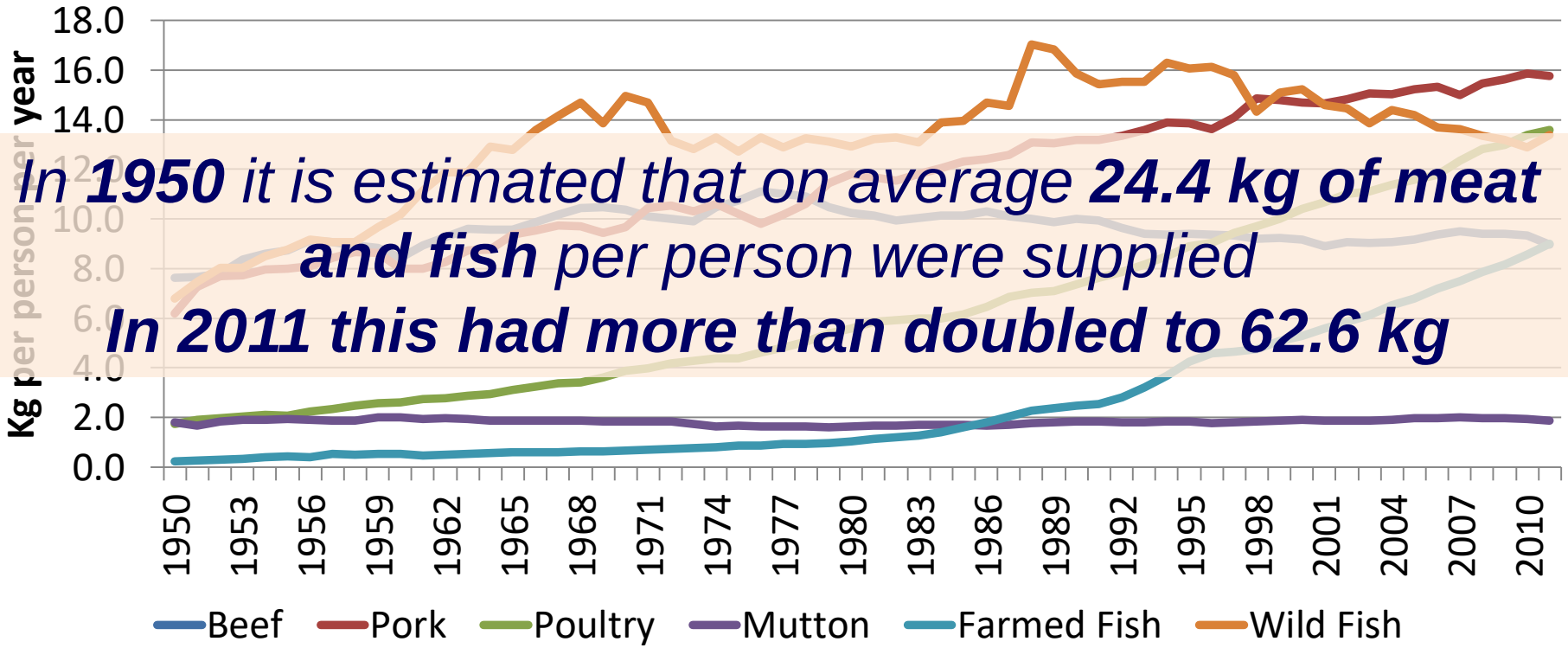
Global meat and fish supply

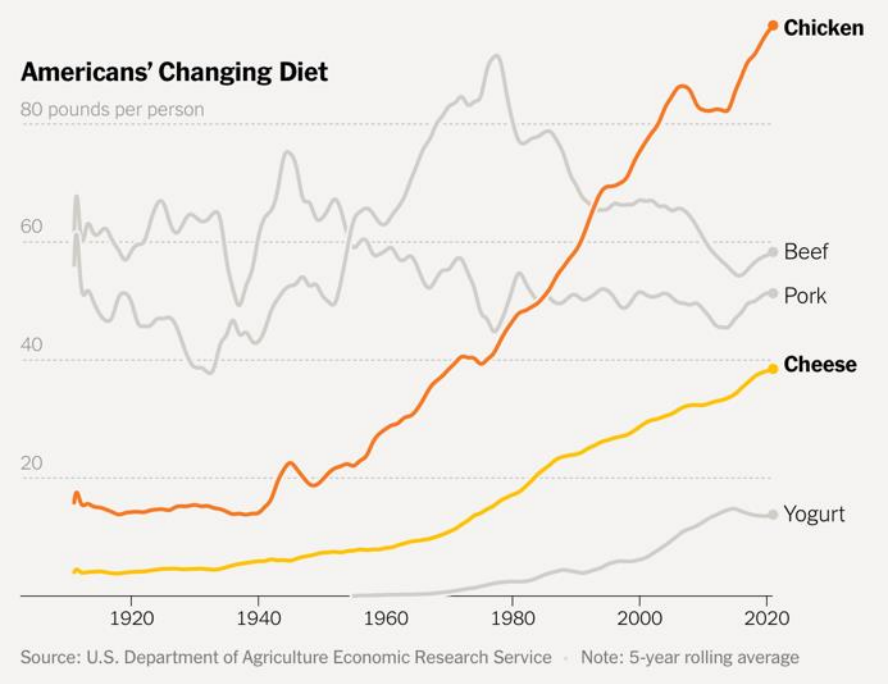


*In **1950** it is estimated that on average **24.4 kg of meat and fish** per person were supplied*

In 2011 this had more than doubled to 62.6 kg

http://www.earth-policy.org/data_center/C24

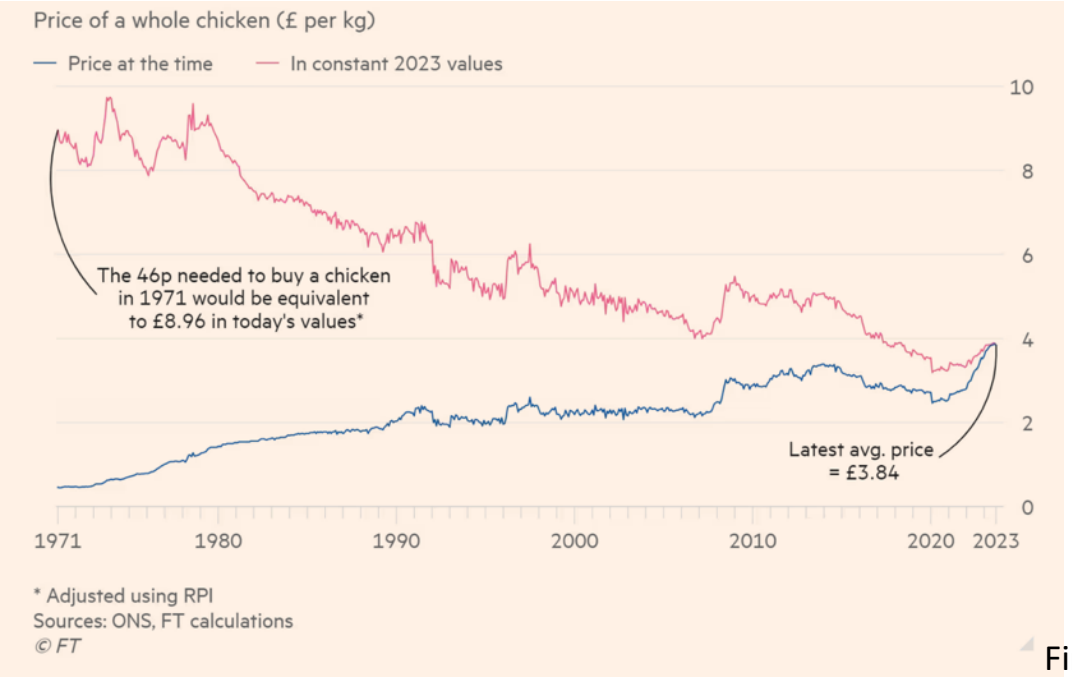
Americans' changing diet (NY Times Dec 2023)



Food expenditure as a proportion of income

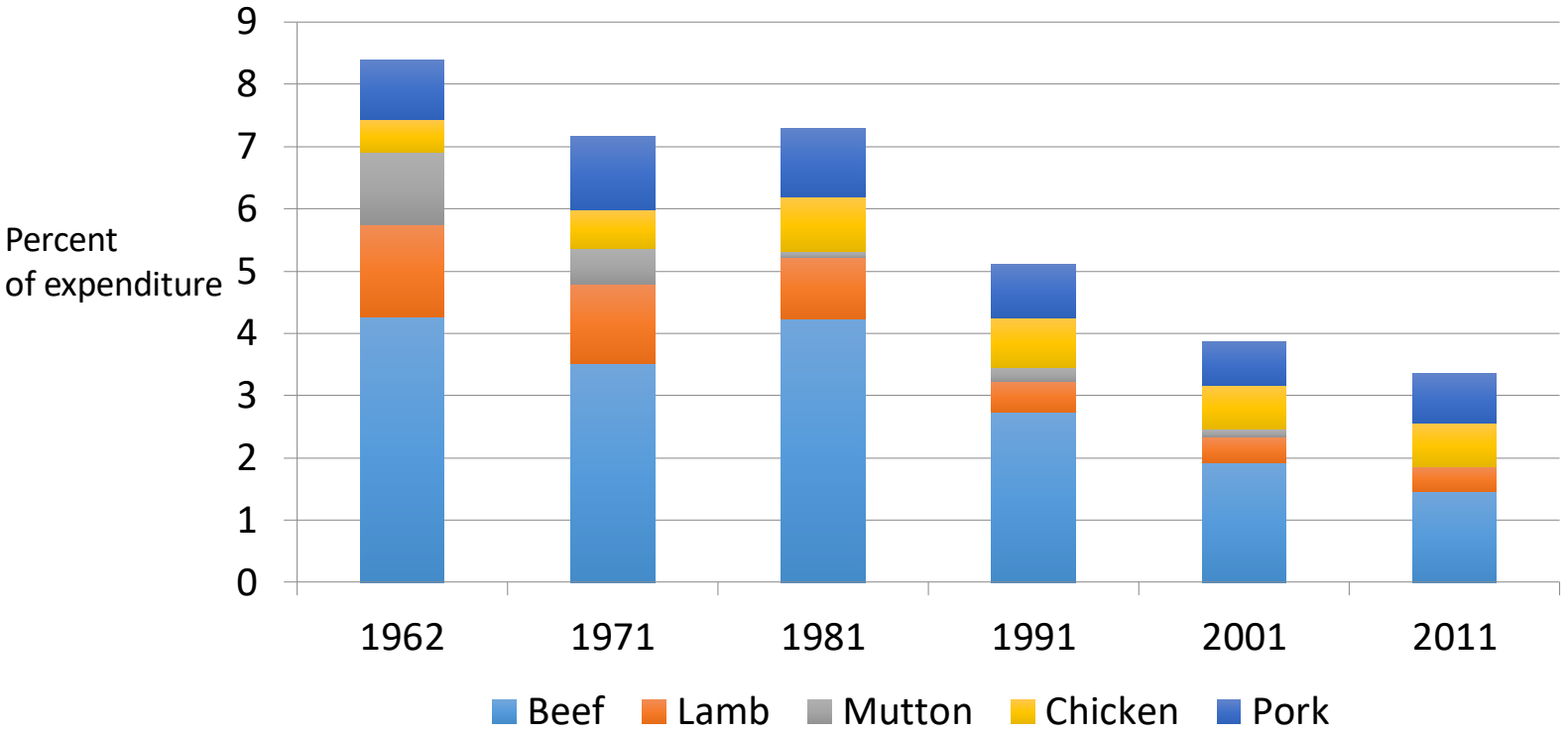
- Rich countries spend between 6 to 10% of income on food
- In Australia "the share of household income spent on food has declined significantly, from 29 per cent in 1988-89 to 21 per cent in 2009-10 and 19 per cent in 2015-16" (Hogan (DAFF/ABARES), 2018)
- Middle income countries this is higher and low and poor countries are still in the realm of 40-50% expenditure

Food has never been so cheap relative to other goods and services



Financial Times, 2024

Share of meat in the Australian expenditure 1962-2011 (Wong et al, 2013)



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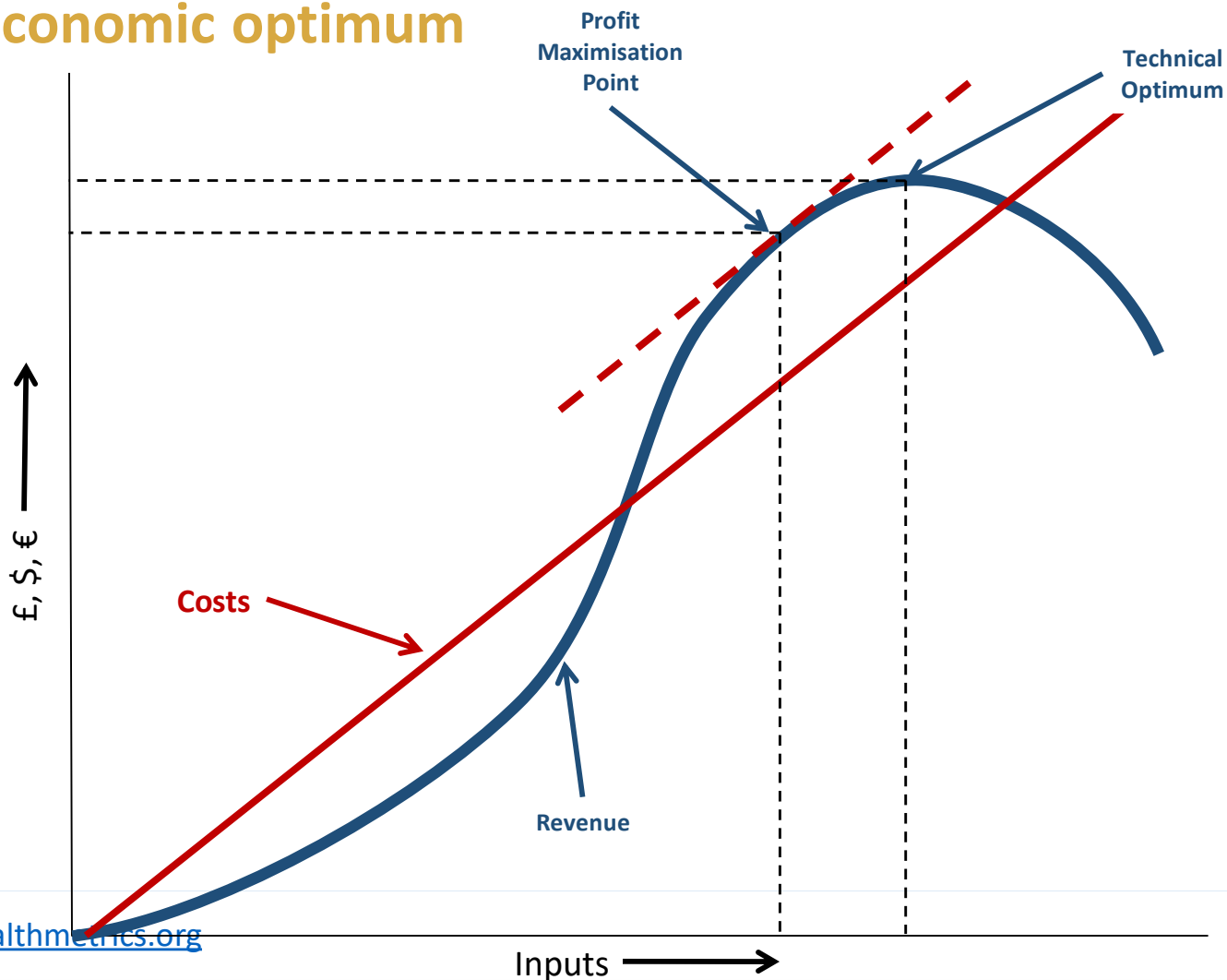
Basis of economics

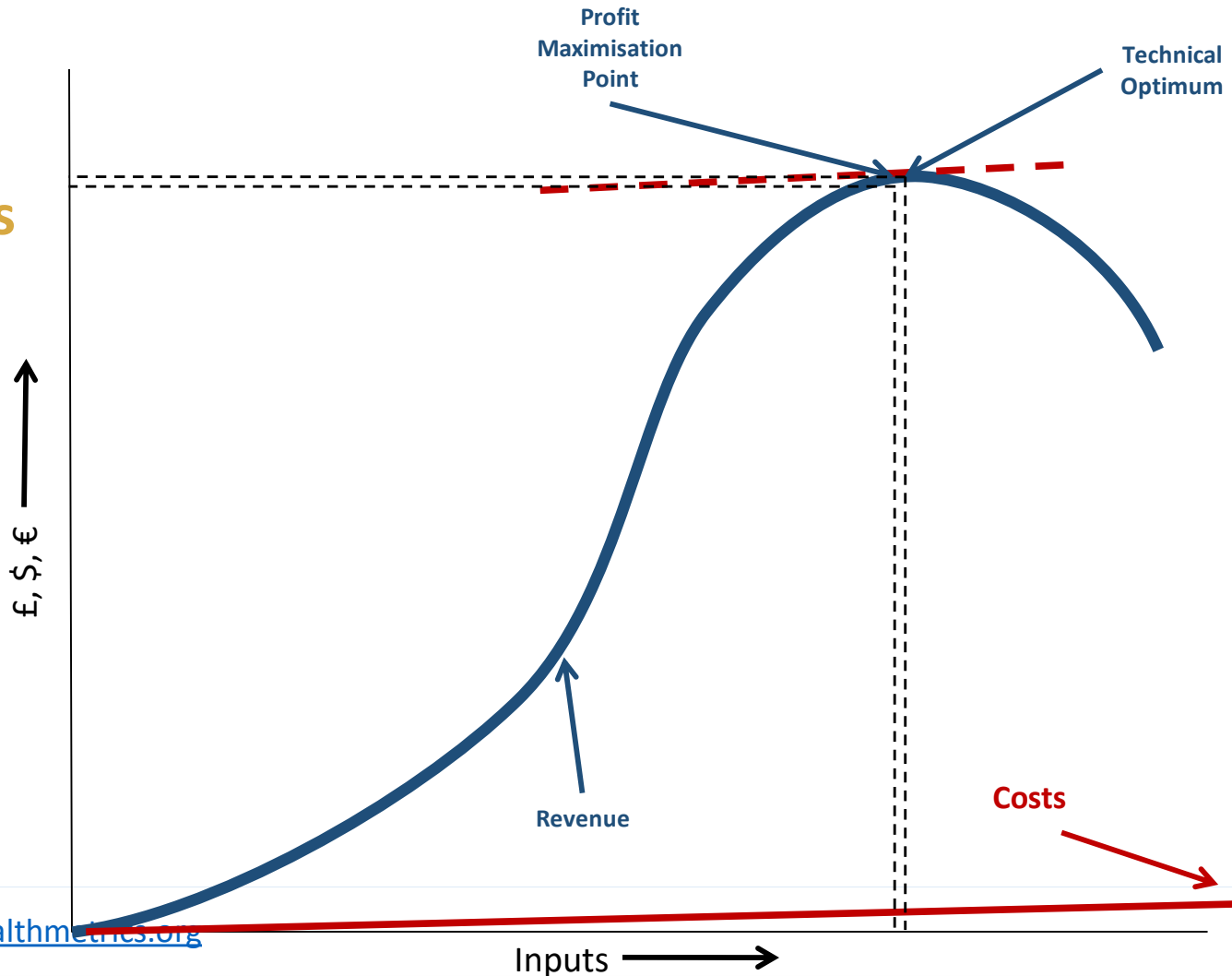
What is economics?

- A strict definition of economics would be the *study of the use of scare resources with competing demands*
- The starting point when using an economic approach would be to develop an **understanding of the allocation of resources** in the system of interest, in order to:
  - Describe current allocation of resources
  - Determine if the allocation is **optimal**
  - Assess if the **reallocation** will lead to a situation closer to optimality
- Good economics looks at trade-offs, it explores prices, rules of exchange and the existence of unintended consequences (externalities)

Economic optimum



Economic optimum for antibiotics



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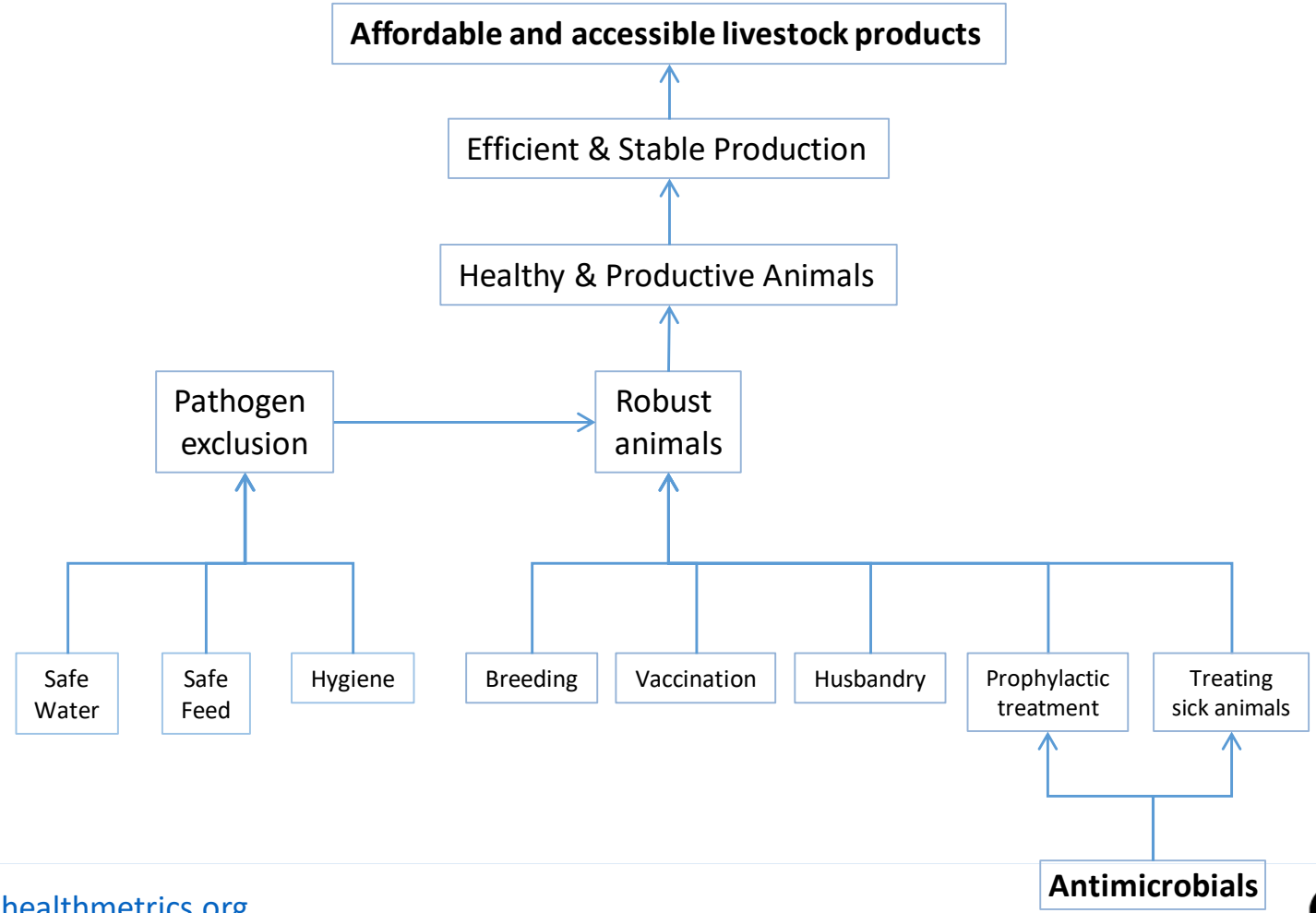

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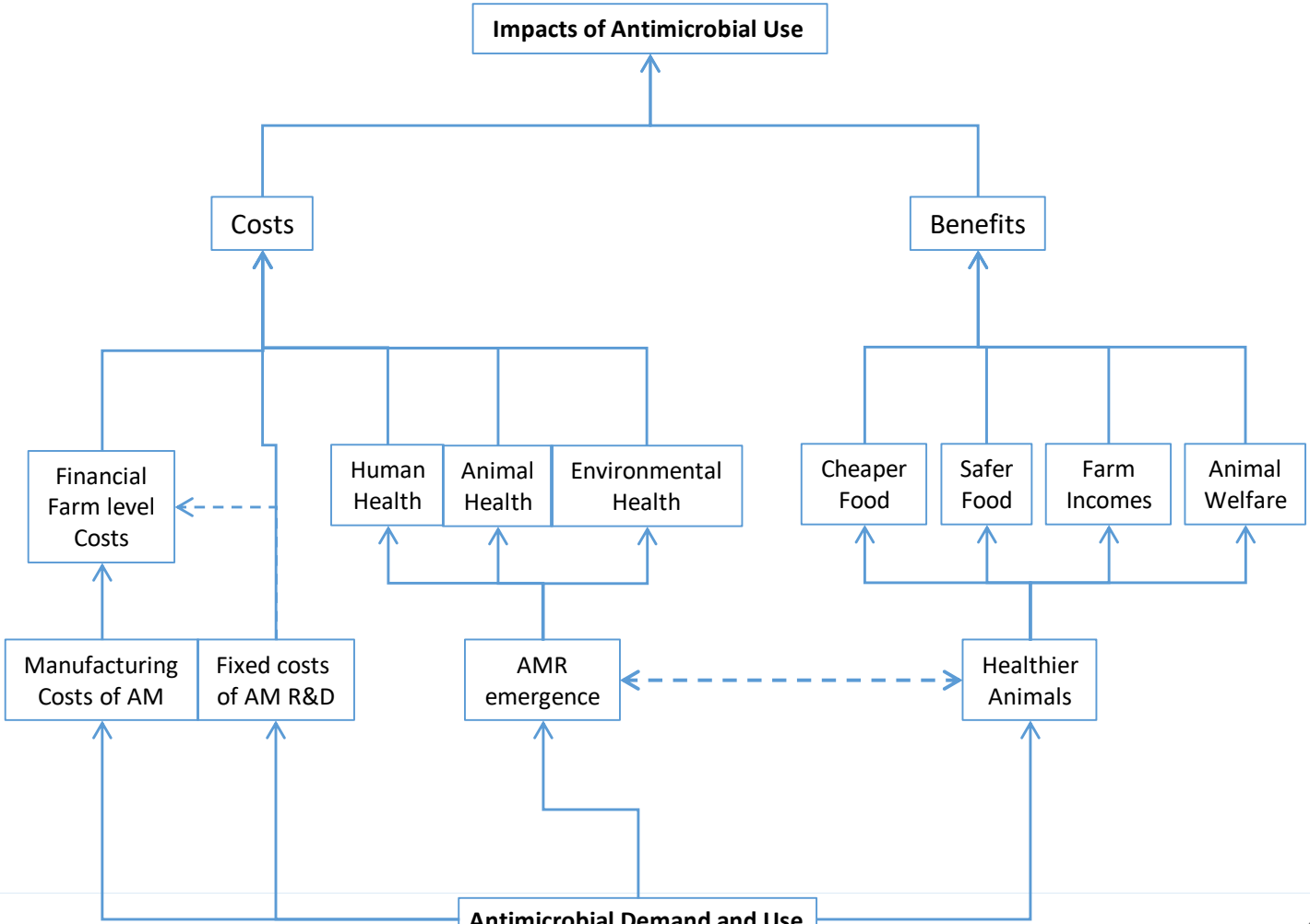

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Do we have enough evidence on whether antibiotic free pork is economically sustainable? - A brief review of the literature

Overall impression of European pig systems (from Nunan, 2022)

- Legislation exists for pig health and welfare, but management remains poor
  - Pigs are frequently kept in barren environments, at high stocking densities
  - Legislation does allow sows to be kept in stalls for the first four weeks of pregnancy, which are often narrow steel cages
  - Piglets are weaned from their mothers far too soon, leading to stress and diarrhoea
- Overall these conditions do not encourage or even allow pigs to raised, or cared for, in antibiotic free systems, in fact the systems incorporate antibiotics in pig management

https://epha.org/wp-content/uploads/2022/02/report-ending-routine-farm-antibiotic-use-in-europe-final-2022.pdf

Where is antimicrobial use focused in pig production?

- In Sweden antimicrobial use was nearly seven times lower than in France, and use in Belgium and Germany was even higher than in France (Sjölund et al. 2016)
- Most of the difference in use occurred in weaners
- In Belgium, France and Germany, antibiotic use increased sharply at weaning time, but in contrast in Sweden it fell
  - As a result, weaning piglets in the first three countries received 20 to 30 times more antibiotics than they did in Sweden

Where is antimicrobial use focused in pig production?

- The most obvious explanation for the large difference in antibiotic use at weaning was the later weaning of piglets in Sweden where the median age of weaning was 35 days, whereas in France, Belgium and Germany it was between 22 and 25 days
- In the latter three countries, some farms even began weaning at 19 days, earlier than the 21 days permitted by EU legislation
- Shortening the time from birth to weaning increases the litters and piglets per sow per year

Is reduction of antimicrobial use in livestock feasible?

- Reduction of AMU in livestock is a broad strategy
- It assumes that AMU is at an inappropriate level and one that can be reduced with r… …l, 2015)
- Yet it … …iew
  - US … …icrobials (Si…
  - A … …shed of birds pe…
  - A company in Indonesia report that the change in AMU increases production costs and mortality rates in broiler chickens
  - Our modelling work indicates significant impacts of coccidiosis (Gilbert et al 2020)

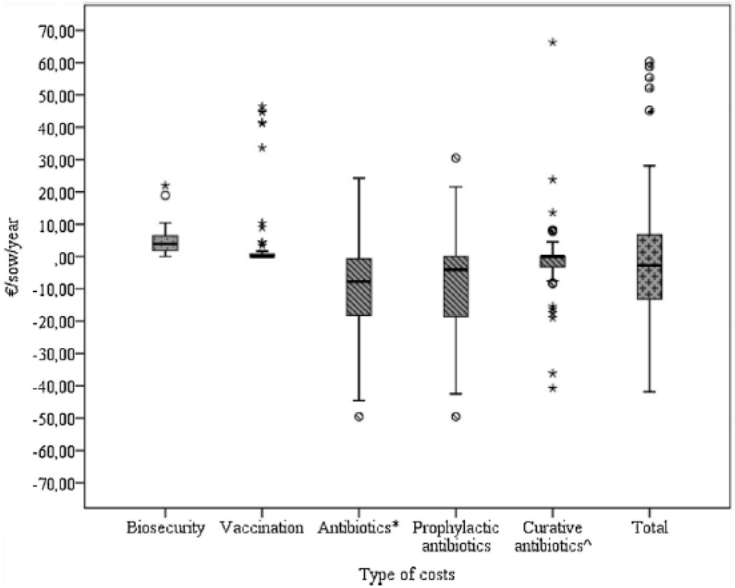
AM free systems are possible in some parts of the broiler sector, but
AM free systems are more difficult to achieve in the pig sector

Denmark and the “Yellow Card” system

- The types of interventions employed by Danish pig farmers after the introduction of the “Yellow Card” scheme were: vaccination, reduced group use of AMs and staff education (Dupont et al. 2017)
- This was associated with a steep decline in AMU (Jensen et al. 2014)
- In our opinion there appears to have been minimal impact on the production and productivity of these systems, but antibiotic use is still present

MINAPIG

- Alternatives to AMs in pig production based on expert opinion in 6 European countries developed a prioritised list without any detail on costs (Postma et al. 2015)
- A field study of Belgian pig farmers defined an overall intervention of vaccination and biosecurity changes leading to reduced AMU (Rojo-Gimeno et al. 2016) and suggested that intervention reduced AMU, maintained or improved farm profits
- A summary of measures taken to reduce AMU in pig systems in 4 European countries provides costs of the changes and the benefits (Collineau et al. 2017)



(Rojo-Gimeno et al. 2016)

Is it possible to raise pigs in antimicrobial free systems?

- The *Raised without antibiotics* system has lower costs for antibiotics but higher wage costs and raised costs for vaccines
- Wage bills rise as a result of higher levels of management, handling of ear tags and hygiene (Vesterlund Olsen et al, 2023)

Table 6. Costs of producing a finisher at 115 kg live weight in the five production systems, € per pig.

	Standard, no technology adoption	*Animal welfare*	*Raised without antibiotics*	*Free range*	*Organic*
Feed costs	74.1	74.1	74.1	79.3	144.6
Antibiotics costs	1.6	1.6	1.1	1.2	1.1
Other unit costs	10.9	12.1	15.0	15.3	17.4
Labour costs	12.8	18.9	14.8	22.6	31.8
Straw and other manipulable materials	0.3	1.5	0.3	3.2	3.9
Other capacity costs[1]	8.1	9.0	8.3	13.4	18.9
Total costs	124.6	139.2	130.5	156.6	251.9

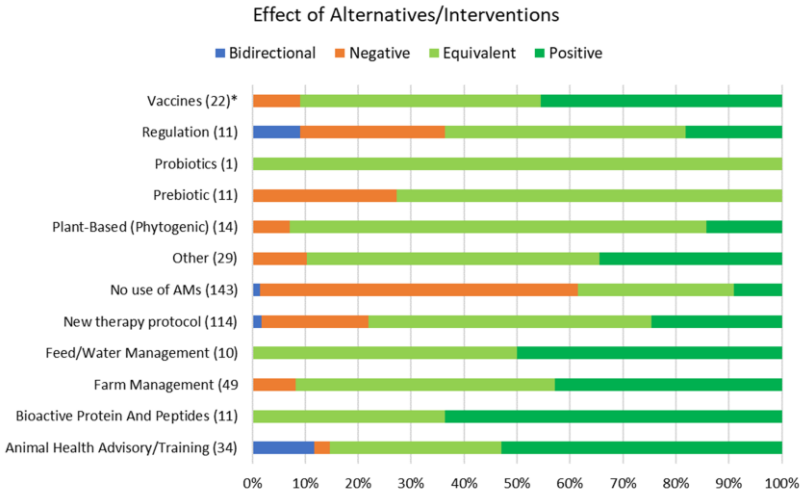
[1] Includes energy, maintenance, insurance, and miscellaneous fixed costs.

Anecdotal evidence - British pig company

- Breeding sows kept in separate farm units
- Weaned pigs are separated and moved to geographically different units using an all-in all-out system
- They are then moved again to another geographically different unit to finish – all-in all-out
- Finally moved to slaughter
- This system produces pigs raised without antibiotics with two caveats
  - Some farm units have difficulty in maintaining health status – environment
  - Some farmers are not good at health management – human behaviour
- Overall this requires major shift in infrastructure and management

Assessment of the impact of antimicrobial reduction interventions (Sucena Afonso et al, 2023)

- Information the cost-effectiveness of alternatives to AMs are scarce, which hampers the willingness/ability of farmers in changing their production practices.
- Bridging that knowledge gaps empowers farmers to take action.



*Relative distribution of the reported direction of effect in indicators across the different alternatives/intervention categories (*number of assessments within parenthesis)*

Will people pay for lower use of antibiotics?

- In Europe people say they want high animal welfare standards and in willingness to pay studies say they will pay more, yet most shop on price
- In China people want food safety and state they would pay a premium (6-20% more) for lower antibiotic use (Denver et al, 2023)

Table 1. Categorization of respondents in the four countries according to whether they eat pork and the price premium they were willing to pay for more sustainable pork (shown as column% within countries).

Group of respondents	Denmark	Germany	UK	China
Don't eat or buy pork	7	16	20	10
No WTP	8	5	11	11
Low WTP (1–5%)	20	18	26	26
Medium WTP (6–20%)	46	43	28	44
High WTP (over 20%)	11	13	8	8
Don't know	8	7	8	2

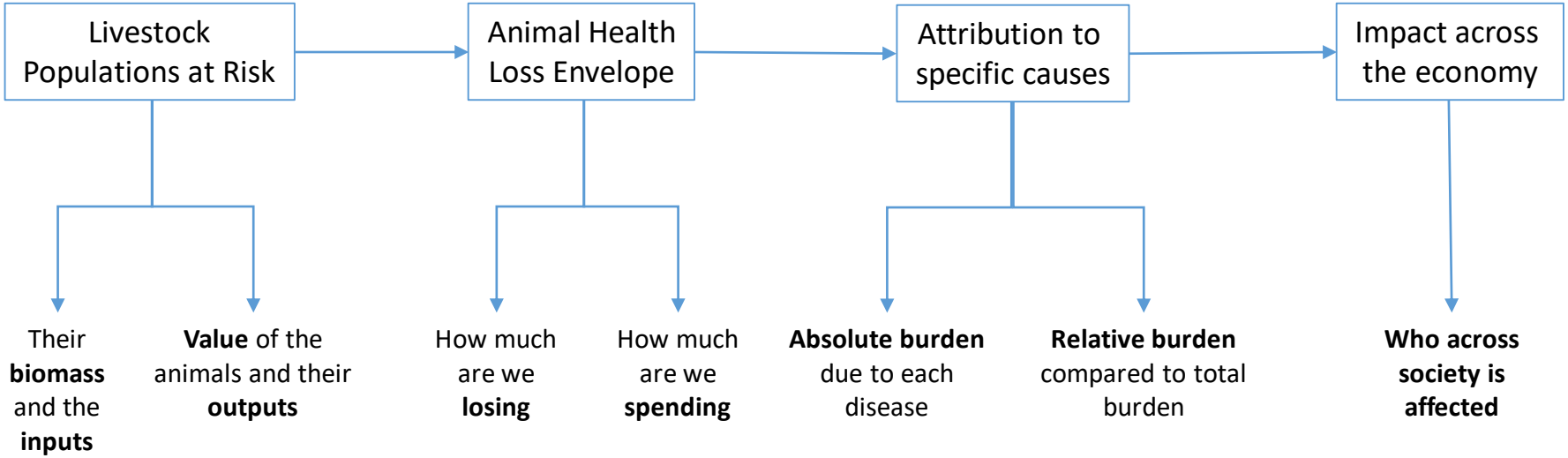
Note: Based on weighted data. WTP=willingness-to-pay. 'Don't know' refers to the share of the respondents answering 'Don't know' to their WTP for more sustainable pork. Percentages are rounded to integers, meaning that they do not necessarily sum to 100. Number of respondents: Denmark=1504; Germany=1513; the UK=1501; China=1511.

Overall

- The literature is messy in the area of the AMU/AMR complex in livestock
- You can find good and bad news on antimicrobial use in pig systems in the literature
- Evidence has to be interpreted depending on who has generated it
- The way we are measuring production, burdens of disease, public health externalities needs some further thought

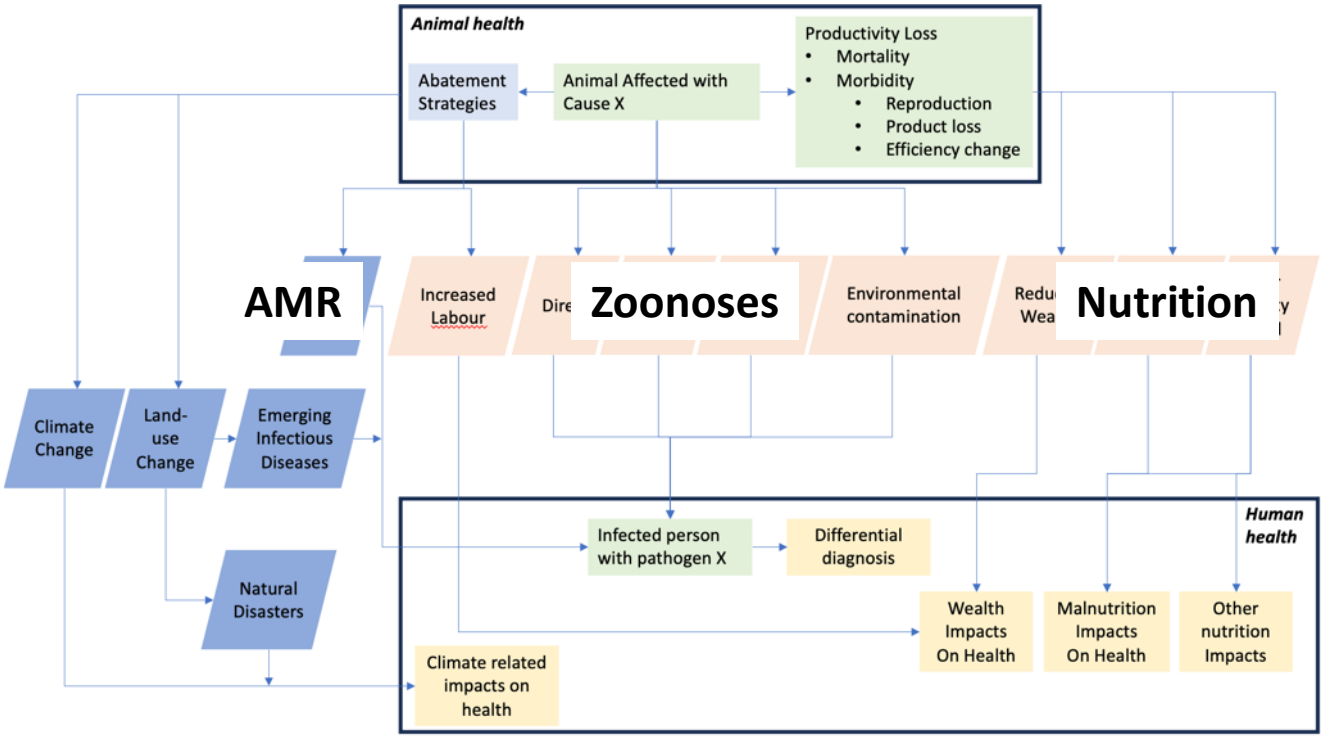
A more structured approach

GBADs - Analytical structure to provide clarity on data and analysis



Adapted from Rushton et al 2021

Framework to capture interactions between human and animal health



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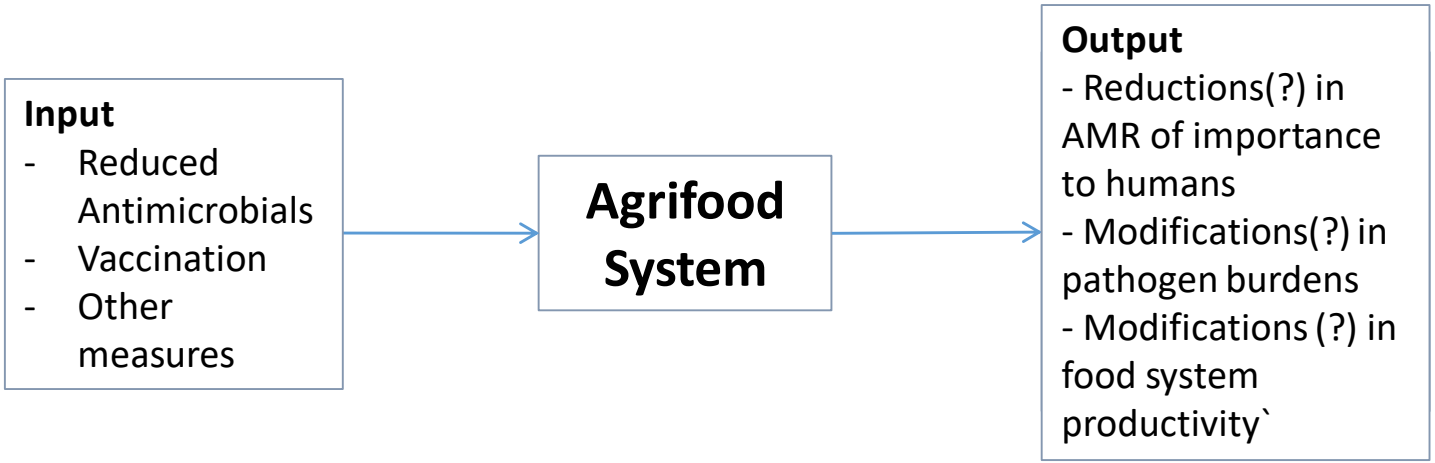
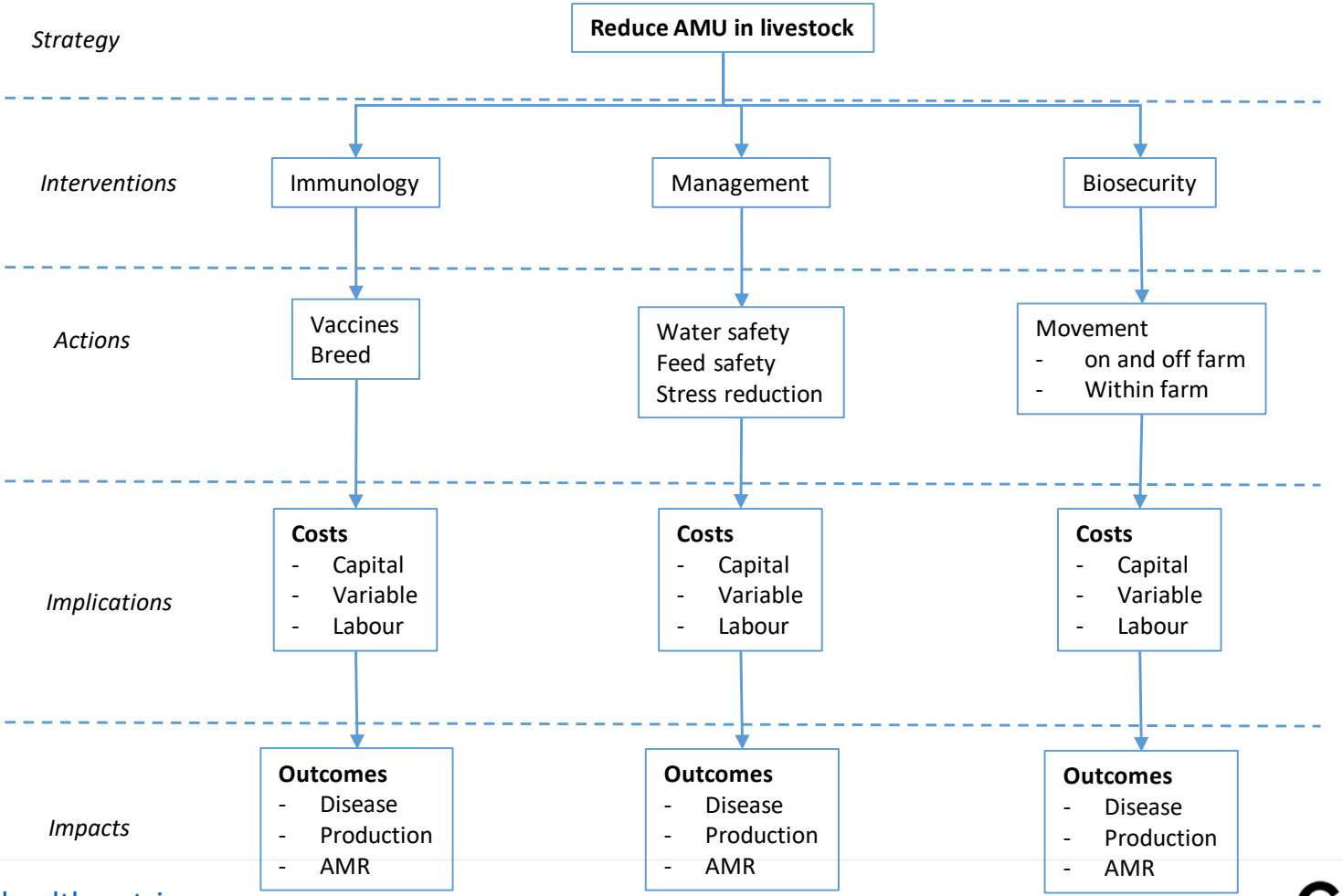
Courtesy of David Pigott, Brecht Devleesschauwer

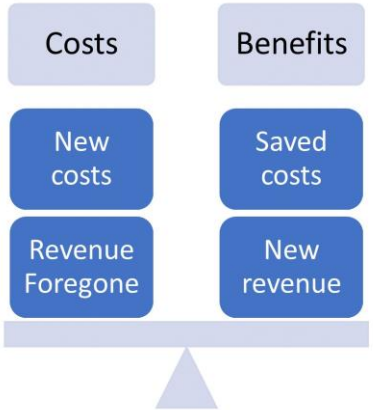
Framework for interventions



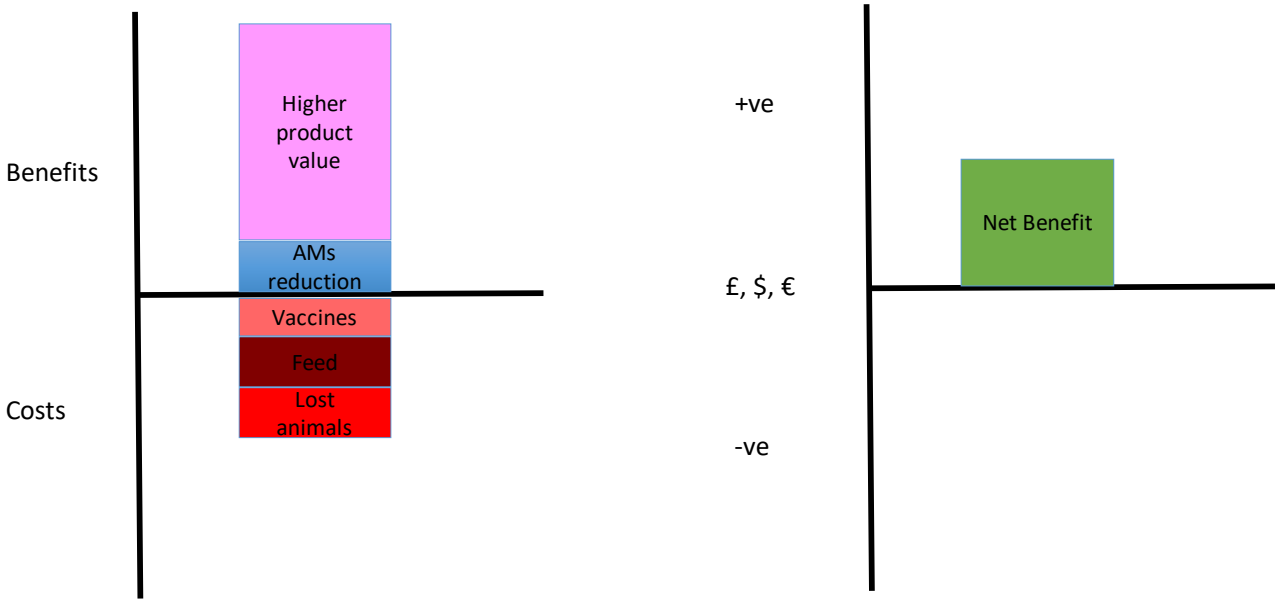

Strategy
Reduce AMU in livestock
Interventions
Immunology
Management
Biosecurity
Actions
Vaccines
Breed
Water safety
Feed safety
Stress reduction
Movement
- on and off farm
- Within farm
Implications
Costs
- Capital
- Variable
- Labour
Costs
- Capital
- Variable
- Labour
Costs
- Capital
- Variable
- Labour
Impacts
Outcomes
- Disease
- Production
- AMR
Outcomes
- Disease
- Production
- AMR
Outcomes
- Disease
- Production
- AMR

Cost analysis of interventions

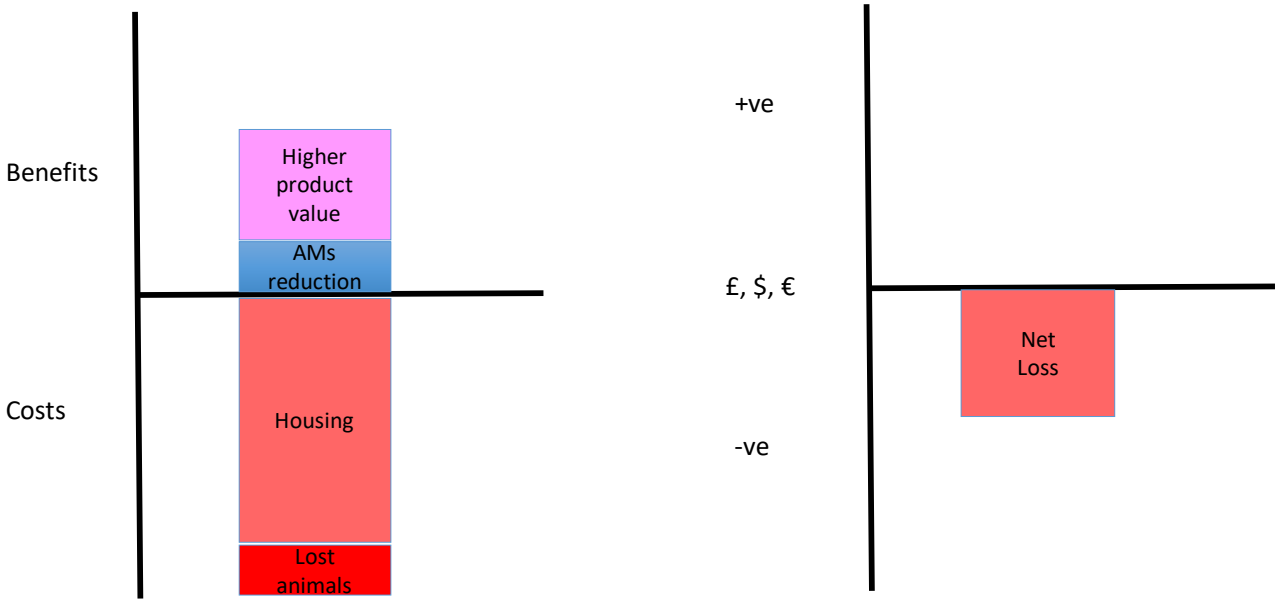
- Need to break up the additional costs and additional benefits from AMU changes
- Additional benefits
  - Costs saved in antimicrobials
  - New revenue with sale of product to AM free product lines
- Additional costs
  - New costs
    - Vaccination
    - More feed due to higher FCR
  - Lost revenue
    - Losses of animals due to higher mortality



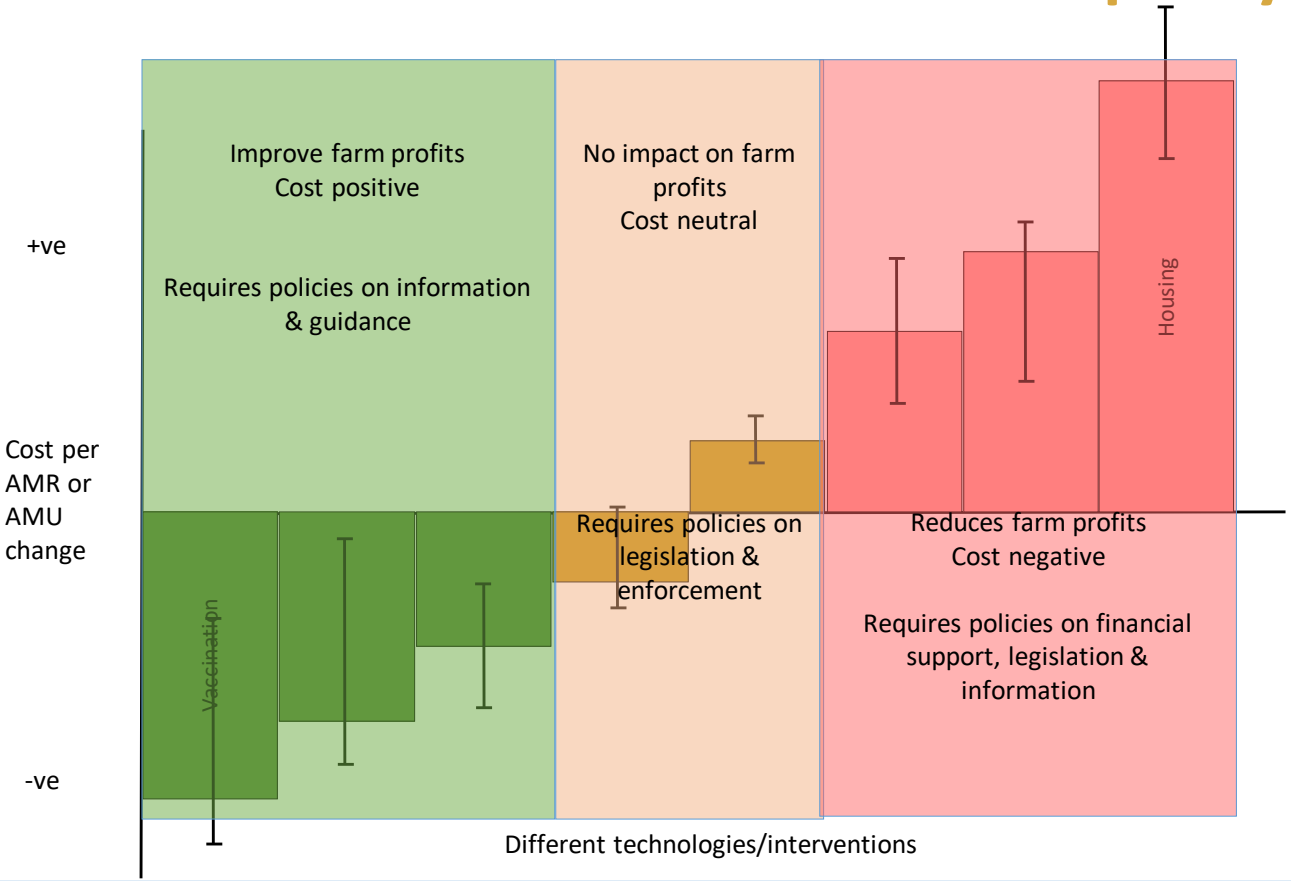
Potential vaccination intervention



Potential housing intervention



Marginal abatement cost curve to inform policy



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Modified from MacLeod & Moran, 2017

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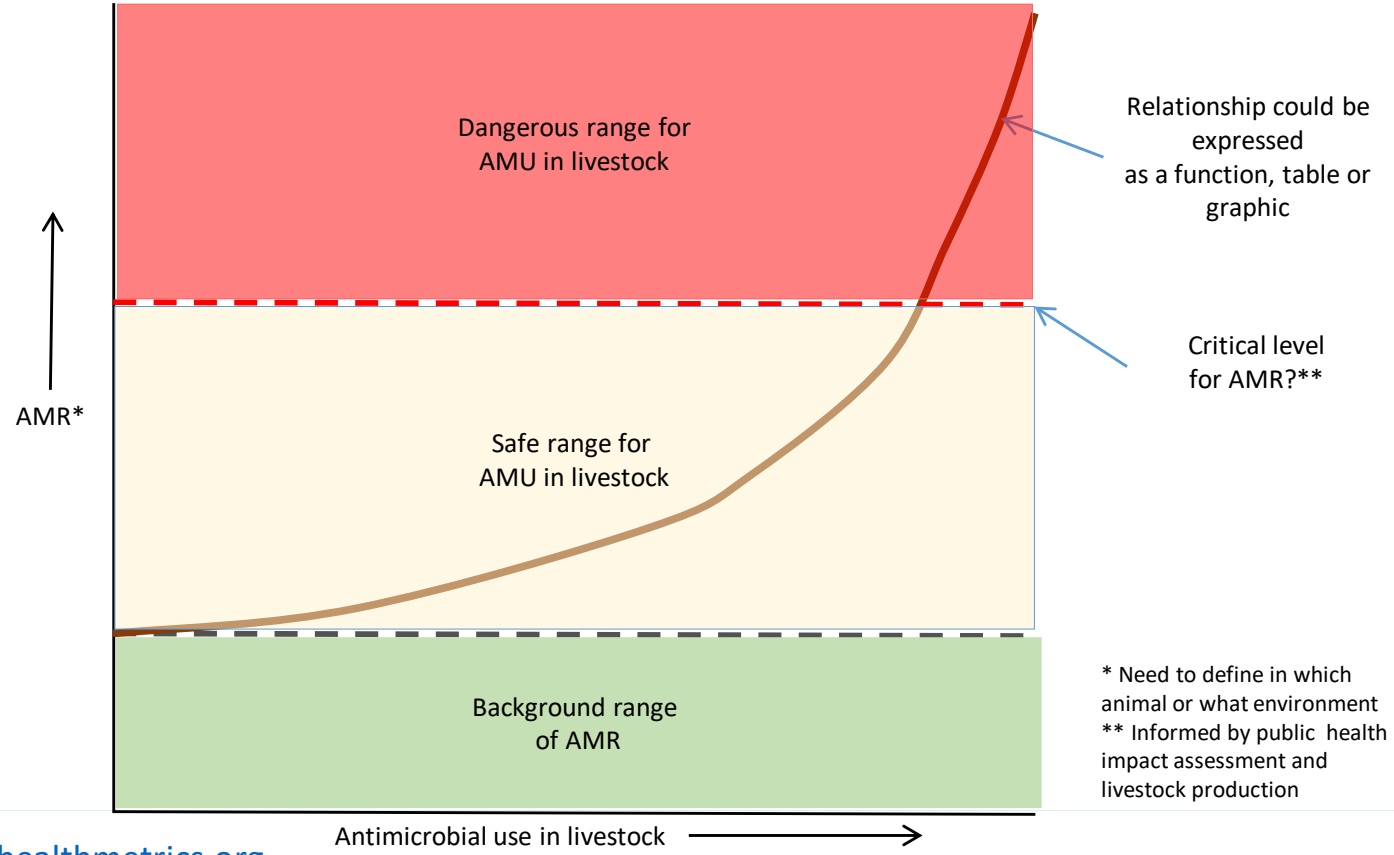
Relationship between AMU and AMR in livestock



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Reflections

Lessons from other species

- Age and parity influence the viability and robustness of offspring
- Not all farms are equal in terms of disease challenge
- Not all farmers are equal with regards their ability to manage the health and welfare of animals

Summary

- Even within the best farms with the best farmers not all batches of pigs will be disease free and therefore not requiring antibiotics
- Within the population of farms there will be a proportion who cannot and do not manage disease well and will need antibiotics

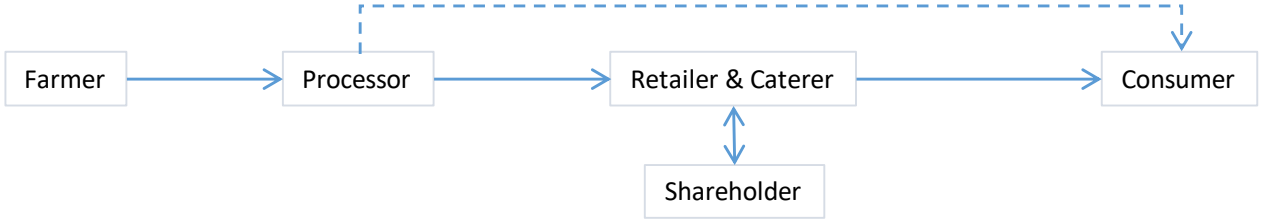
The social, economic and political context

- Our food systems are driven by policies that generate cheap food
- Cheap food is too often taken for granted, and politically dangerous to change
- Yet our current food systems generate major negative externalities:
  - Animal welfare
  - Environment
  - Public health
- The costs of these externalities are not borne by the food system
  - Antibiotic use is generally not a barrier to entry to markets
  - Low or no use of antibiotics is not generally rewarded by the market

Can antibiotic free pork be economically sustainable?

- Technically it seems feasible to have antibiotic free pork with some caveats
- To achieve widespread antibiotic free intensive pig production systems requires major shifts in management and investment in infrastructure
- Prices currently paid for pork would probably put such changes out of reach of the majority of producers
  - widespread change is unlikely to be economically feasible
- Social and political context matter when thinking of change and particularly sustainable change

The food system power and consequences



So how healthy is the system?

Po… product

Low valued animals

Difficulty in managing land, water and animal welfare

Impoverished rural communities that are shrinking

Shareholder Value

Financial Centre Success

…heap …tiful for many

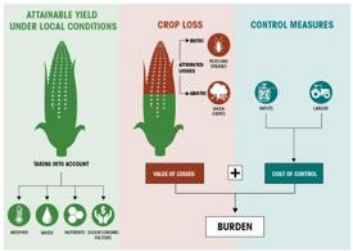
Highly processed food that saves time

Malnutrition contributing to overweight and obesity

Nations with increasing health care bills

One Health and Food System – the need to have strong institutional support

- Laissez faire food policies have led to food systems being driven economic efficiency resulting in ***"food at any cost"*** that generates major negative externalities
- We need **food ministries** with monitoring systems to assess these externalities
- A **paradigm shift** is needed towards a One Health framework in order to improve the food system through a mix of behavioural and systemic changes



One Health and Food System – the need for data to monitor and measure the externalities

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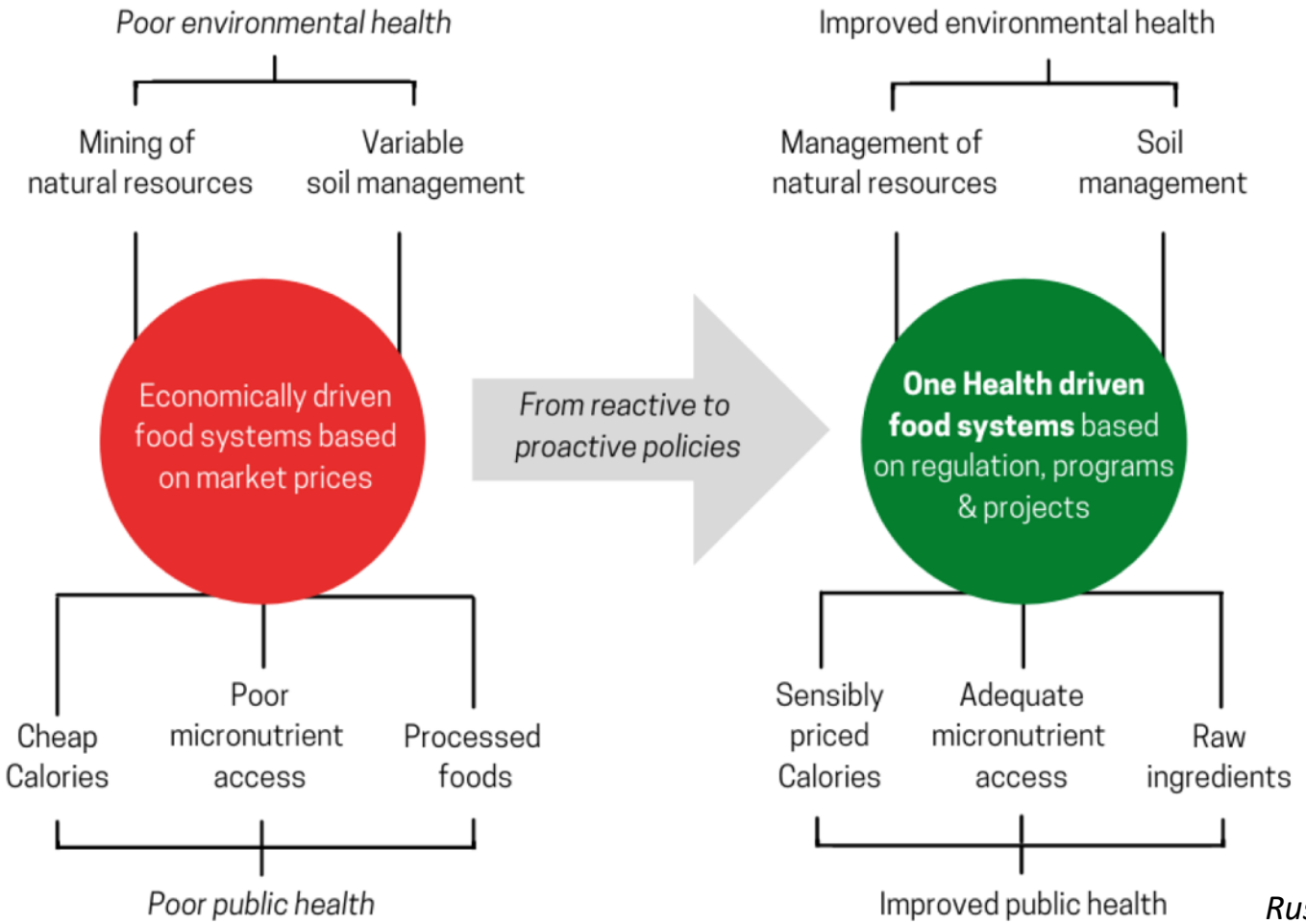

Rushton et al, 2021

One Health oriented Food Systems

Helping **PEOPLE**, Protecting **PEOPLE**
Working with **PEOPLE**

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