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Leverhulme Centre for Integrative Research on Agriculture and Health

Economic Impact of Disease Control – Veterinary Vaccination Strategies

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Veterinary Vaccinology Network Meeting 2015

Birmingham, UK

16th and 17th February 2015

Acknowledgements

- VEEPH Group at RVC: Barbara Haesler, Liz Jackson, Pablo Alarcon, Paula Dominguez-Salas, Betty Bisdorf, Will Gilbert
- Thank you to the organisers for the invitation to present at the meeting with a special mention for Bryan Charleston
- With the case study work I want to acknowledge:
  - Madelon Meijer, Gabriel Hoyos and Martín Sonco on the analysis of FMD in Bolivia
  - Nick Taylor and Jan Hinrichs on the analysis of vaccines in SE Asia
- I want recognise the support of Norbrook Pharmaceuticals and LCIRAH in the work I carry out

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Introduction
- Background

- The last 40 years has seen a **rapid change** in the way animals are managed and valued
- A high proportion of **food animals** are part of increasingly standardised food systems where **individual animal value is minor**
- There is a high level of care and attention for individual **domesticated pets** and **recreation animals** reflecting the **high value** people place on the individual lives of these animals
- For different reasons there is a greater **demand** for good health in food, companion and recreation animals

Introduction
- *The challenge*

- Rapidly **changing** societies have historically created health problems
- The current rate of change has thrown up **new challenges** in terms of emerging and re-emerging diseases
- Addressing these with **adequate investments** in health education, research and institutional development is a major challenge

This is a societal resource allocation and socio-economic challenge

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Introduction
- economics and its application

- Economics provides **frameworks** for exploring these changes and how technical tools such as vaccines can be best employed
- It also allows an investigation of the **roles** of the **individual**, the **private companies** and the **public organisations** in the costs associated with vaccination
- It should aim to match **private** and **governmental response** to livestock disease, animal health and welfare with the **importance and the role of animals** in each society

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Introduction
- structure of the presentation

- A framework to approach animal health problems
- Discuss the application of this framework to vaccines and vaccination
- Present two case studies
  - FMD in South America
  - HPAI in SE Asia
- Some reflections

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A framework to approach animal disease management

- how to prioritise vaccine development

- how to prioritise vaccination campaigns

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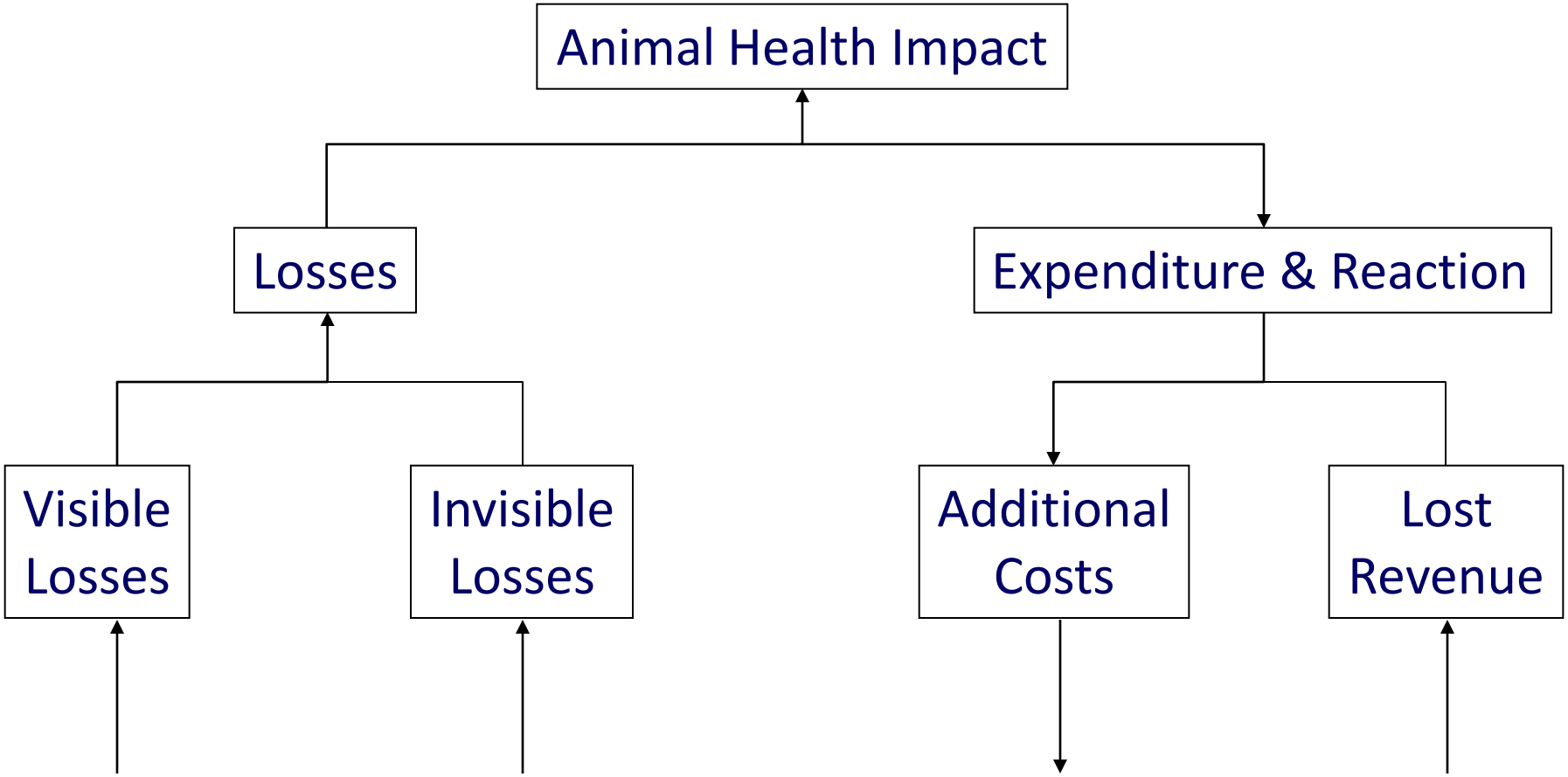


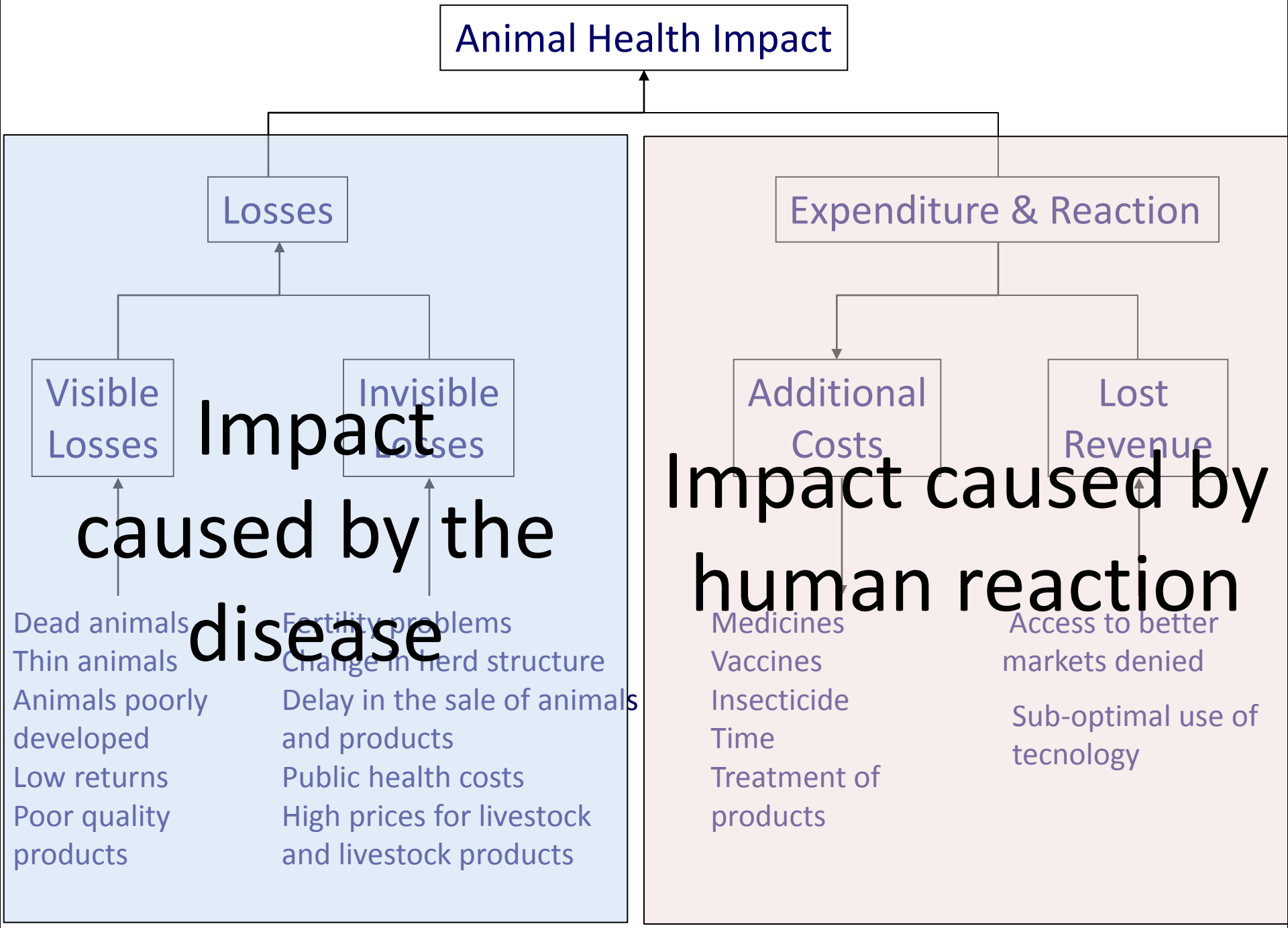
Dead animals
Thin animals
Animals poorly developed
Low returns
Poor quality products

Fertility problems
Change in herd structure
Delay in the sale of animals and products
Public health costs
High prices for livestock and livestock products

Medicines
Vaccines
Insecticide
Time
Treatment of products

Access to better markets denied
Sub-optimal use of tecnology

Rushton et al, 1999; Rushton, 2002; Rushton, 2009


Animal Health Impact
Losses
Expenditure & Reaction
Visible Losses
Invisible Losses
Additional Costs
Lost Revenue
Impact caused by the disease
Impact caused by human reaction
Dead animals
Thin animals
Animals poorly developed
Low returns
Poor quality products
Fertility problems
Change in herd structure
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Public health costs
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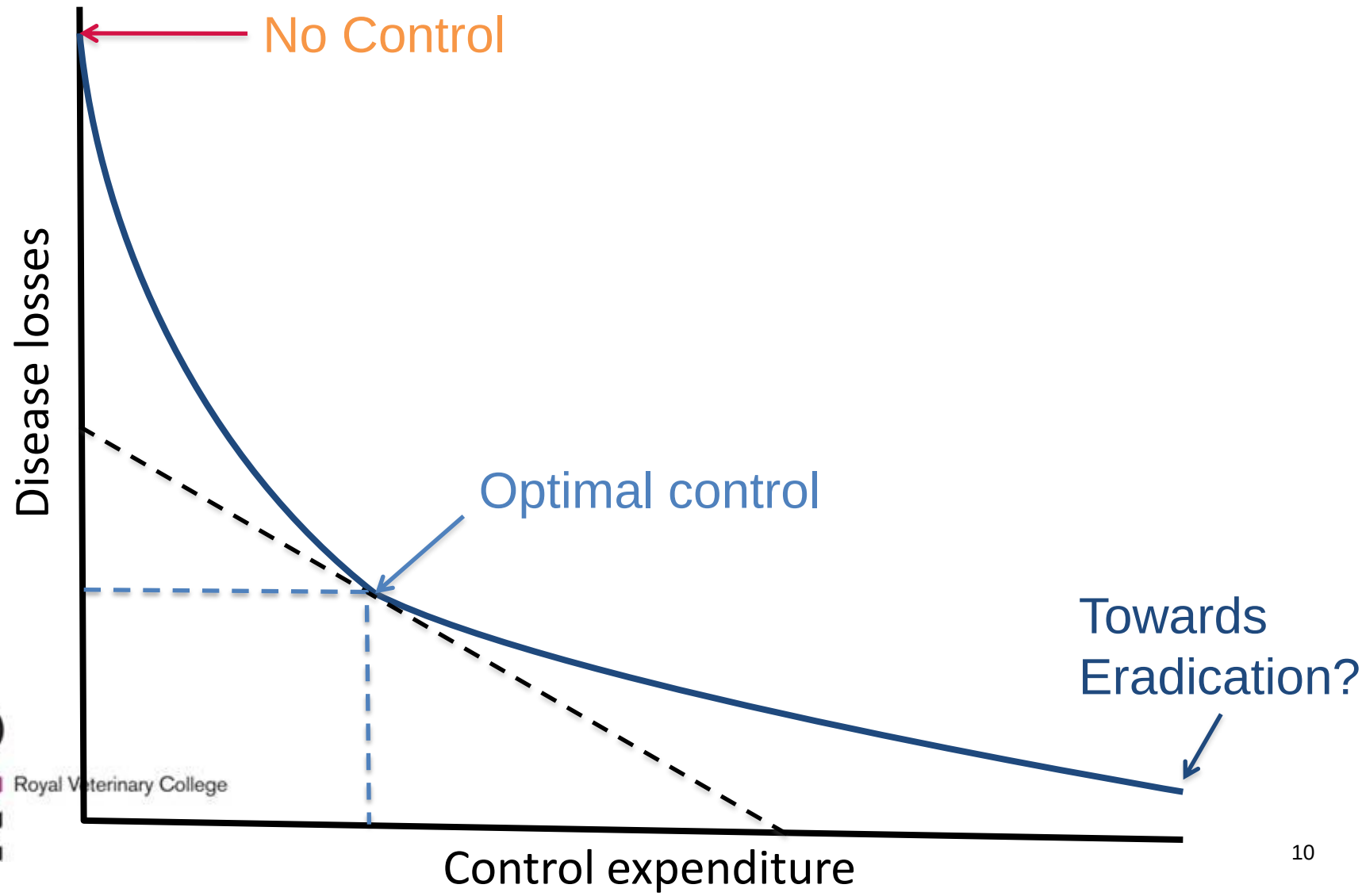
Disease Loss – Expenditure Frontier (adapted from McInerney, 1996)



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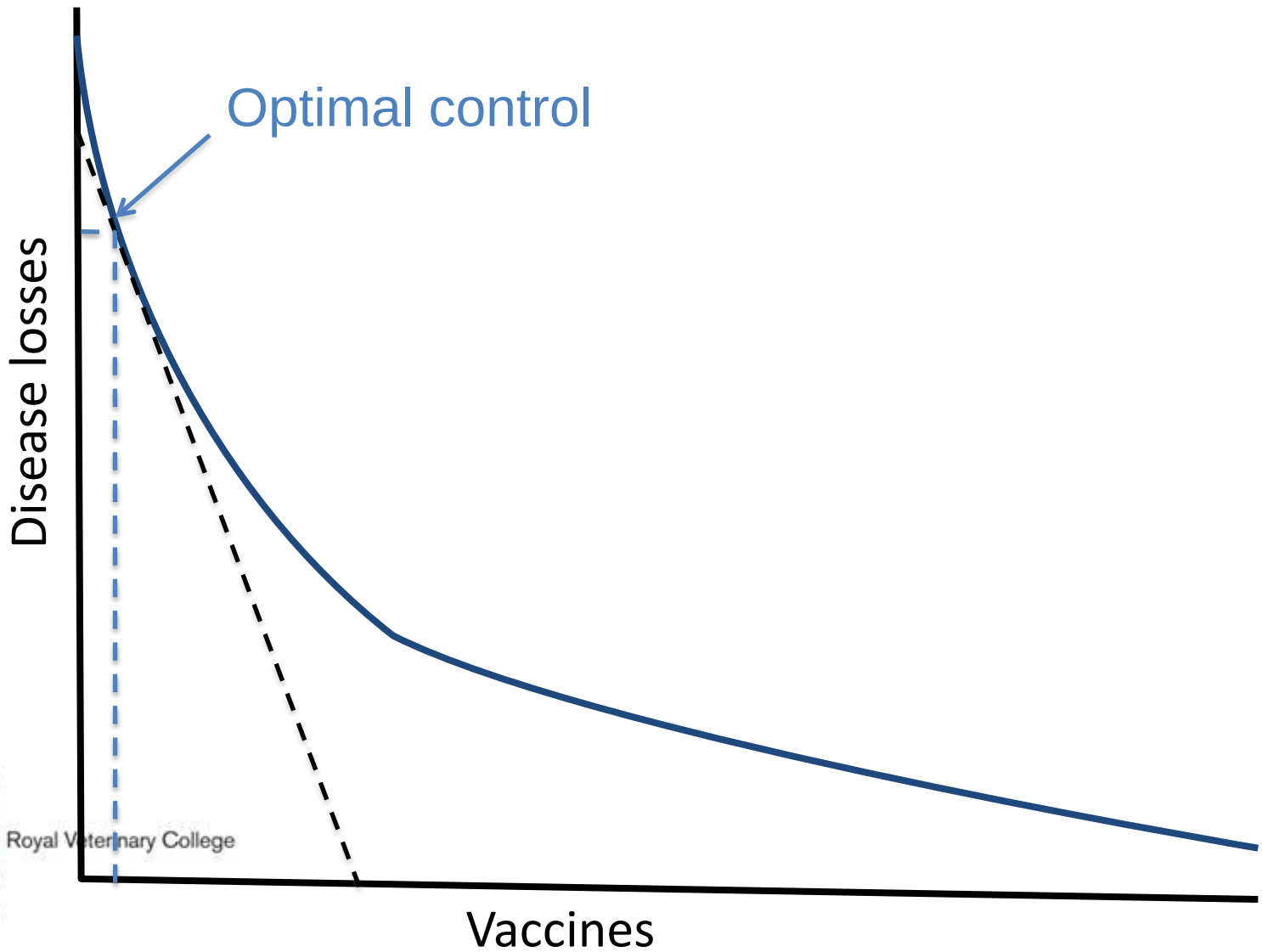
Low coverage levels

- High price of vaccine relative to the price of units of production loss



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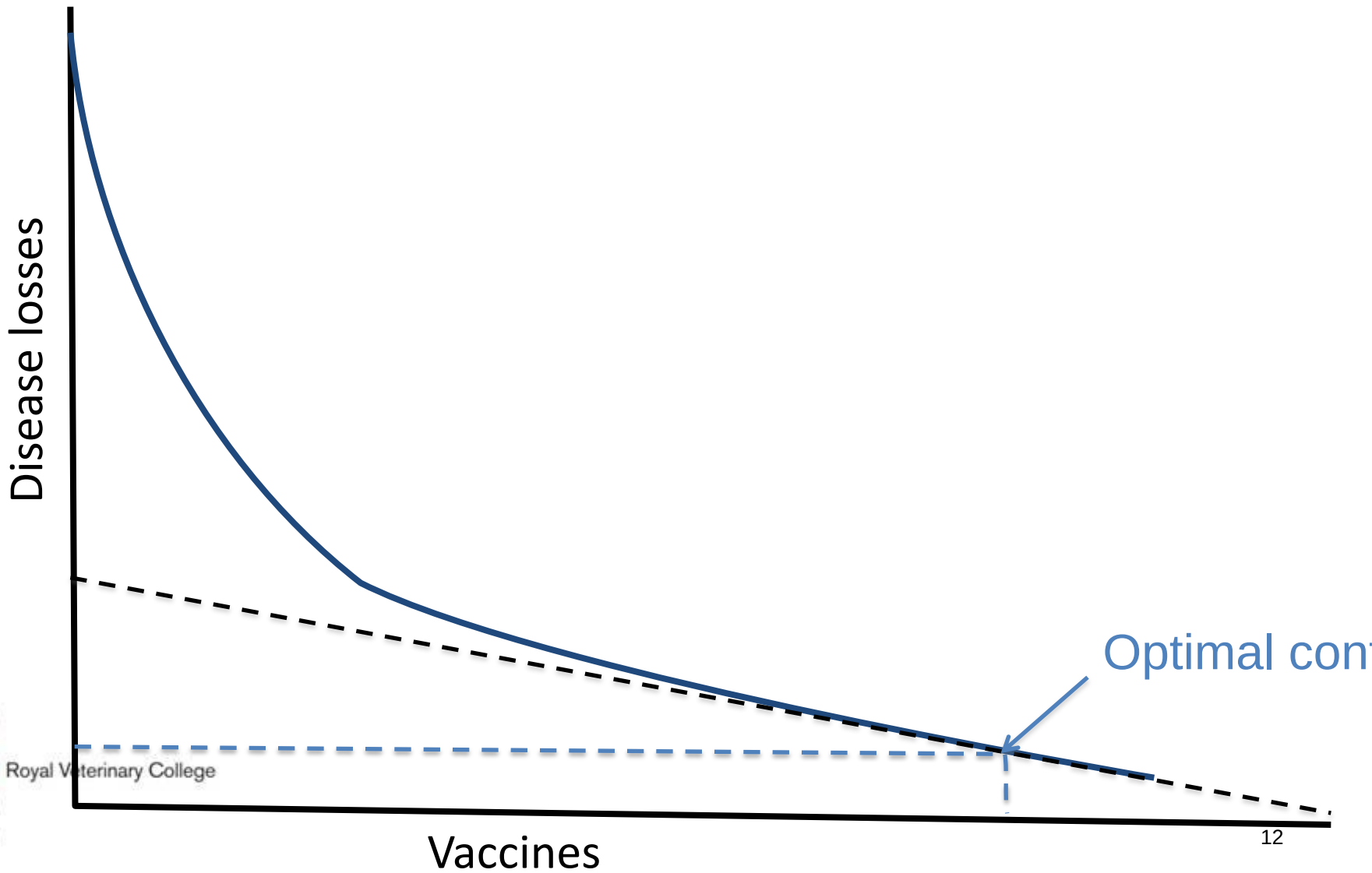
Good coverage levels

- Low price of vaccine relative to the price of units of production loss



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Key issues

Cost of vaccination relative to losses avoided is critical

Vaccine and vaccination costs can be manipulated

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Critical aspects of vaccine cost
- dose price

- **Development costs** – fixed cost with different components
  - Matching the vaccine to the circulating pathogen
    - Need for a surveillance system
  - Laboratory and scientific expertise
    - Need for an effective education system
- **Manufacturing costs** – a set of variable costs
  - Will reflect the scale of the production
  - More doses demanded gives the potential to lower the unit costs

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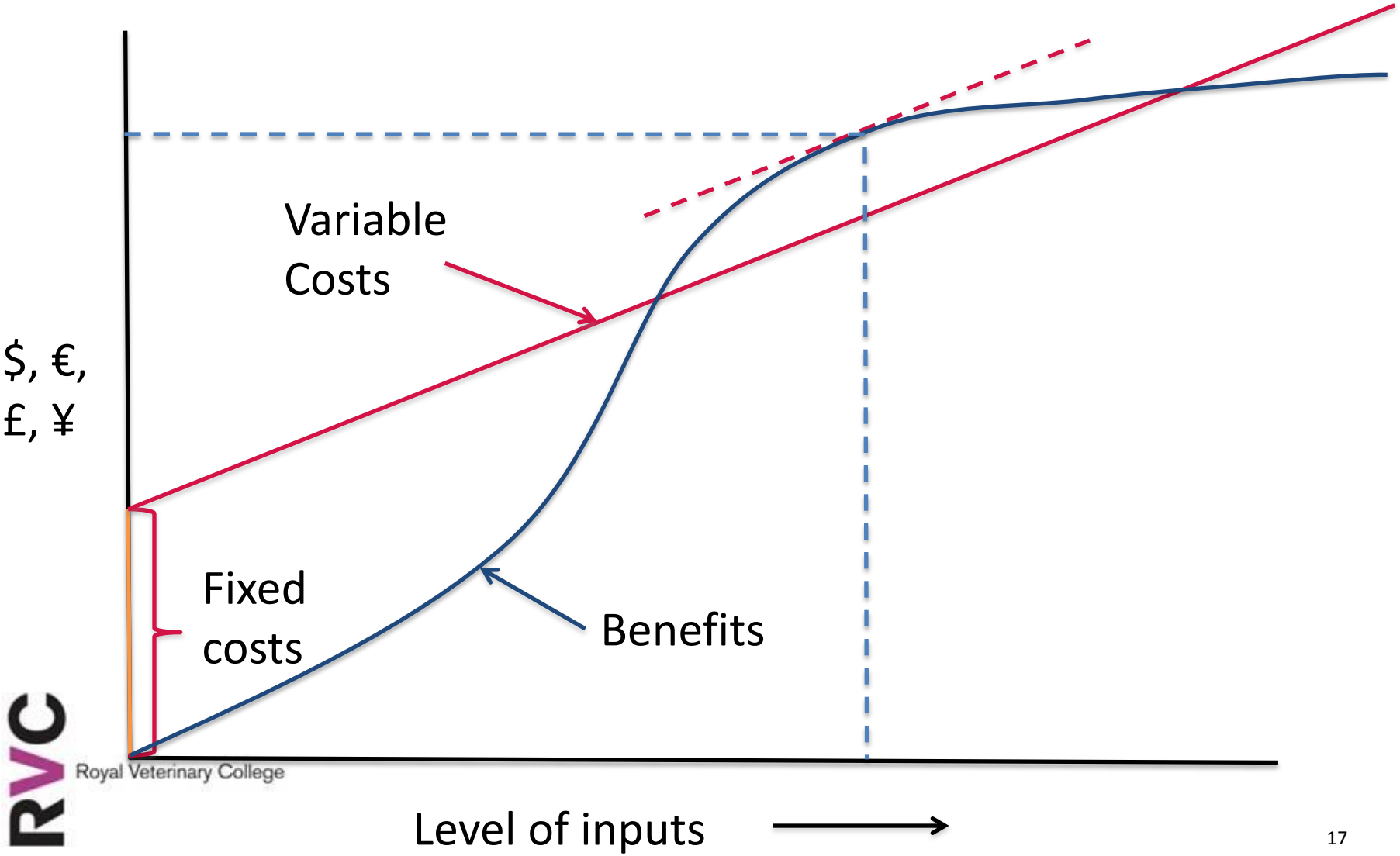
Critical aspects of vaccine cost
- delivery costs

- **Market access** of the animal owners
  - Investments in transport systems – a fixed cost
- The vaccine is **effective after transport**
  - Vaccine design
  - Cold chain development
- **Doses per vials** match the animals per unit
- **Vaccine efficacy** protects animals and limits the need for booster vaccination
- **Impact on production** of the vaccine and its delivery
  - Mortality and morbidity

Critical aspects of vaccine cost

- Vaccine design, vaccine packaging and distribution networks need to match the systems of the animal owners and their animal health advisors
- The vaccine cost is made up of a mixture of fixed and variable costs
- Effective vaccination campaigns requires investments by both the
  - **Public sector** – largely around major fixed costs
  - **Private sector** – largely around the variable costs

Cost-benefit model for livestock disease control with fixed costs (adapted from Tisdell, 2009)



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Case studies

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Applications of economics to vaccination

- A lack of attention because the target group are poor
  - Perry et al (2002) highlighted the need for research on African swine fever
- Impact of use is too high
  - Worries of not being able to regain international markets is frequently placed as a reason not to vaccinate against FMD
  - Much has been published with the use of vaccines in an epidemic situation and what to with the vaccinated animals (Backer et al, 2009)
  - Yet no-one seems to have adequately tackled the thorny issue of the carrier state

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Applications of economics to vaccination

- Difficulties of vaccine development
  - East Coast Fever vaccine has been developed but the associated difficulties of manufacture and distribution limit its use
- Difficulties of delivery
  - Much work has been done on Newcastle disease vaccine to backyard poultry – ACIAR funded work led by Peter Spradbrow in the 1980s and 90s
  - More recent work of Robyn Alders
  - Yet it is still difficult to deliver vaccines to rapid turnover flocks in small units

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Extensive cattle systems

- FMD vaccination in Bolivia

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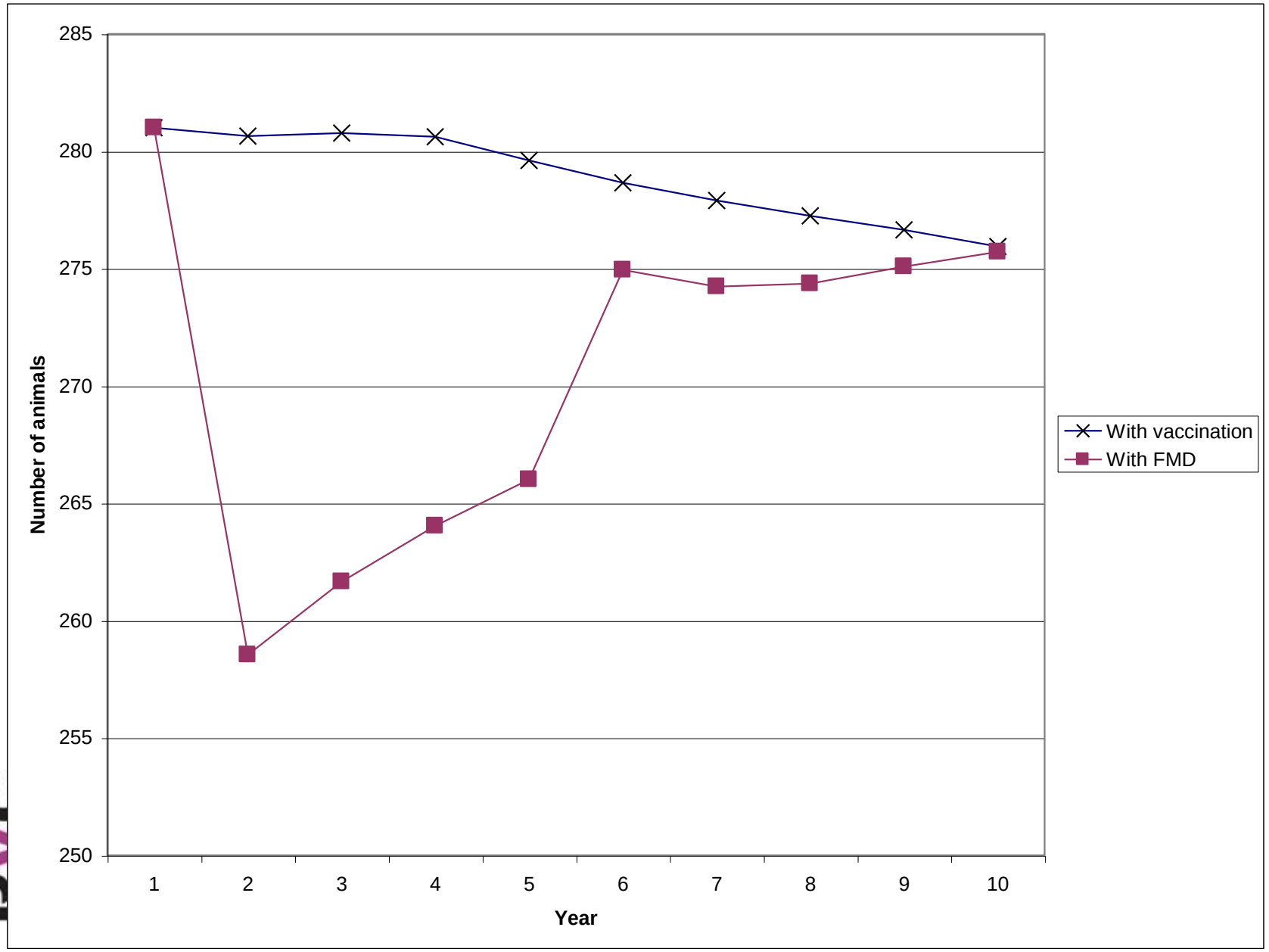
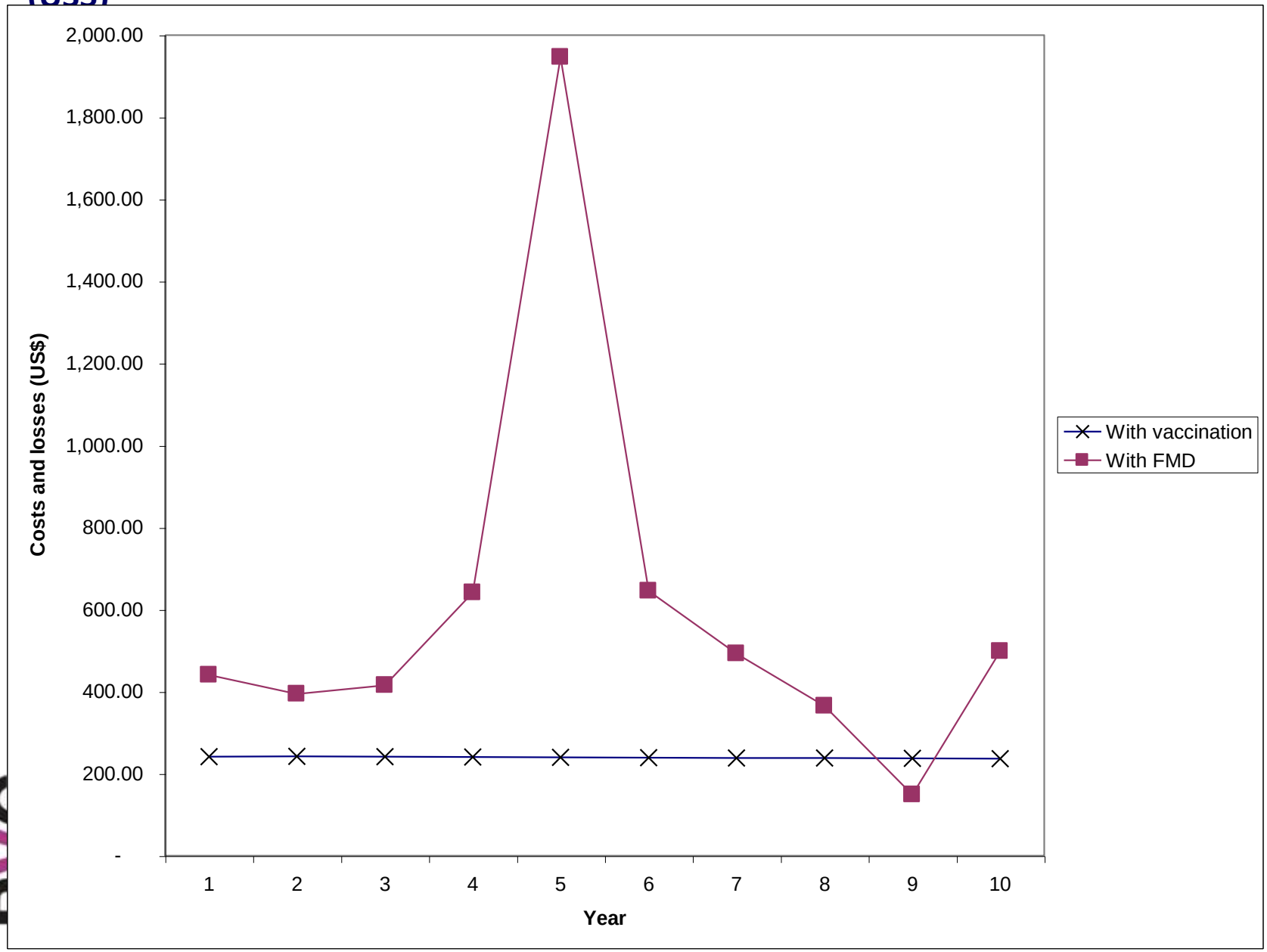
FMD control in extensive beef systems- the case of Bolivia

- In Bolivia vaccinations campaigns were being used to control and eradicate FMD.
- These campaigns had differing rates of success, but it was particularly difficult to achieve high levels of vaccination coverage in the extensive beef systems.
- In order to understand the difficulties encountered with the campaigns an economic analysis of the impact of FMD was carried out to determine the incentives to participate

Projections for herds with vaccination against FMD (i.e. no disease) and a herd without vaccination and an outbreak of FMD in the first year of the simulation



Undiscounted costs and disease losses for a herd with vaccination and a herd without vaccination and an outbreak of FMD in the first year of the simulation (US$)



FMD control in extensive beef systems- the case of Bolivia

- **FMD vaccination** in extensive beef systems was estimated **not** to be **economically profitable**
- A critical aspect was the vaccine efficacy which required at least two vaccinations per animal per year in systems where animals are seen once a year
- Since this analysis more efforts were centred on vaccinating animals in the difficult areas of the country with some success

Highly Pathogenic Avian influenza

- vaccination in SE Asia

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HPAI vaccination effectiveness

- Does the vaccine provide protection?
  - With HPAI this question should reviewed constantly
- Can the vaccine be moved from production to farm without losing efficacy?
- Which poultry production systems will be targeted?
- How will the vaccination be applied – campaign, scheduled or a combination?

HPAI vaccination effectiveness

- Who are the producers of the targeted poultry and what do their production systems look like?
- Who should deliver the vaccine and how will they be rewarded?
- What are the monitoring points and who should do the monitoring?
- What will it cost?
- Who will pay?
- Is it cost-effective? – needs to be in the context of a strategy for disease prevention, control and eradication

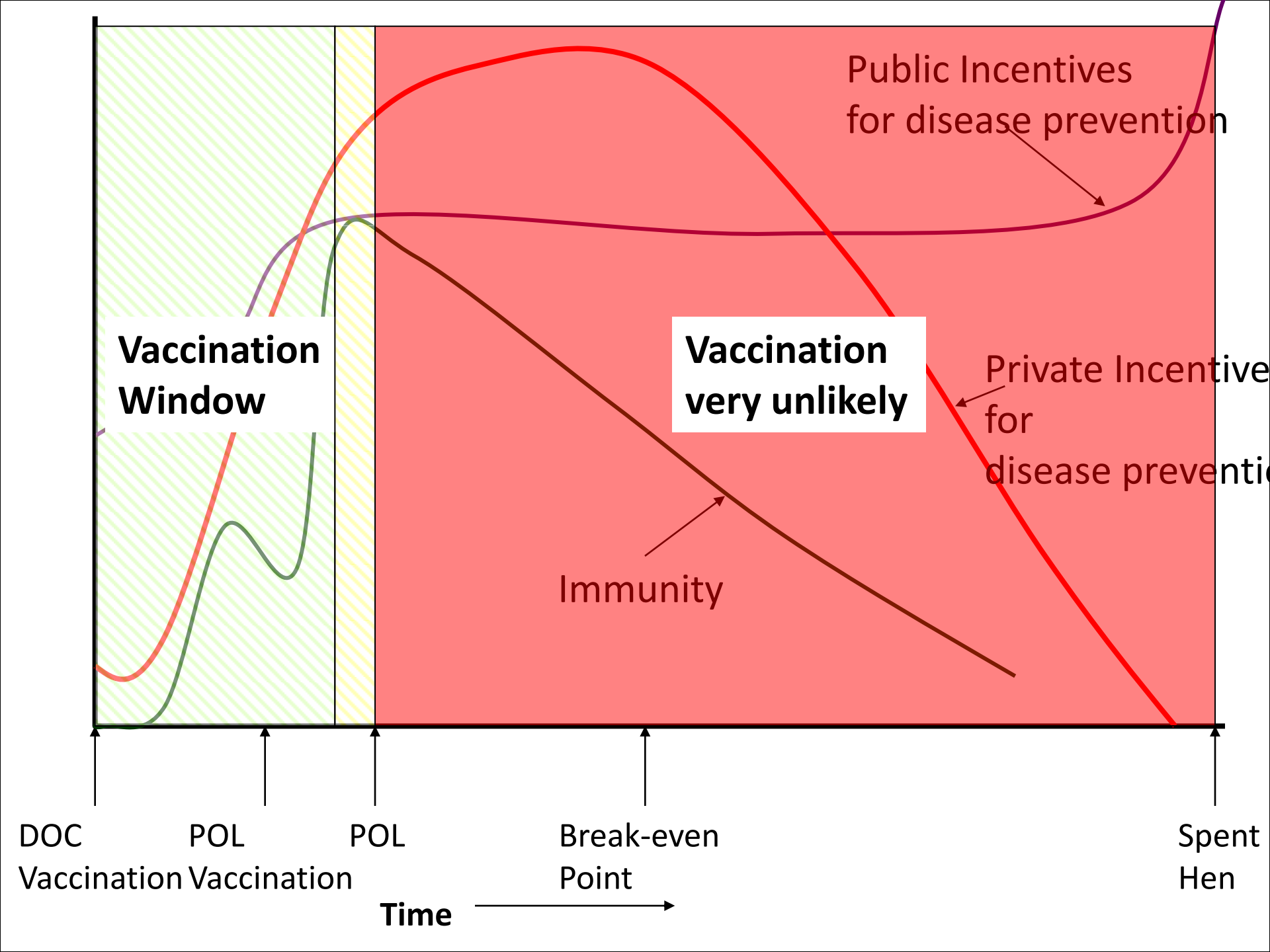
Incentives for vaccination

- Incentives to vaccinate are different depending on the production system
- Incentives to vaccinate will change over the production cycle
- These incentives should shape the vaccine delivery process and the use of other tools for the producers that are targeted

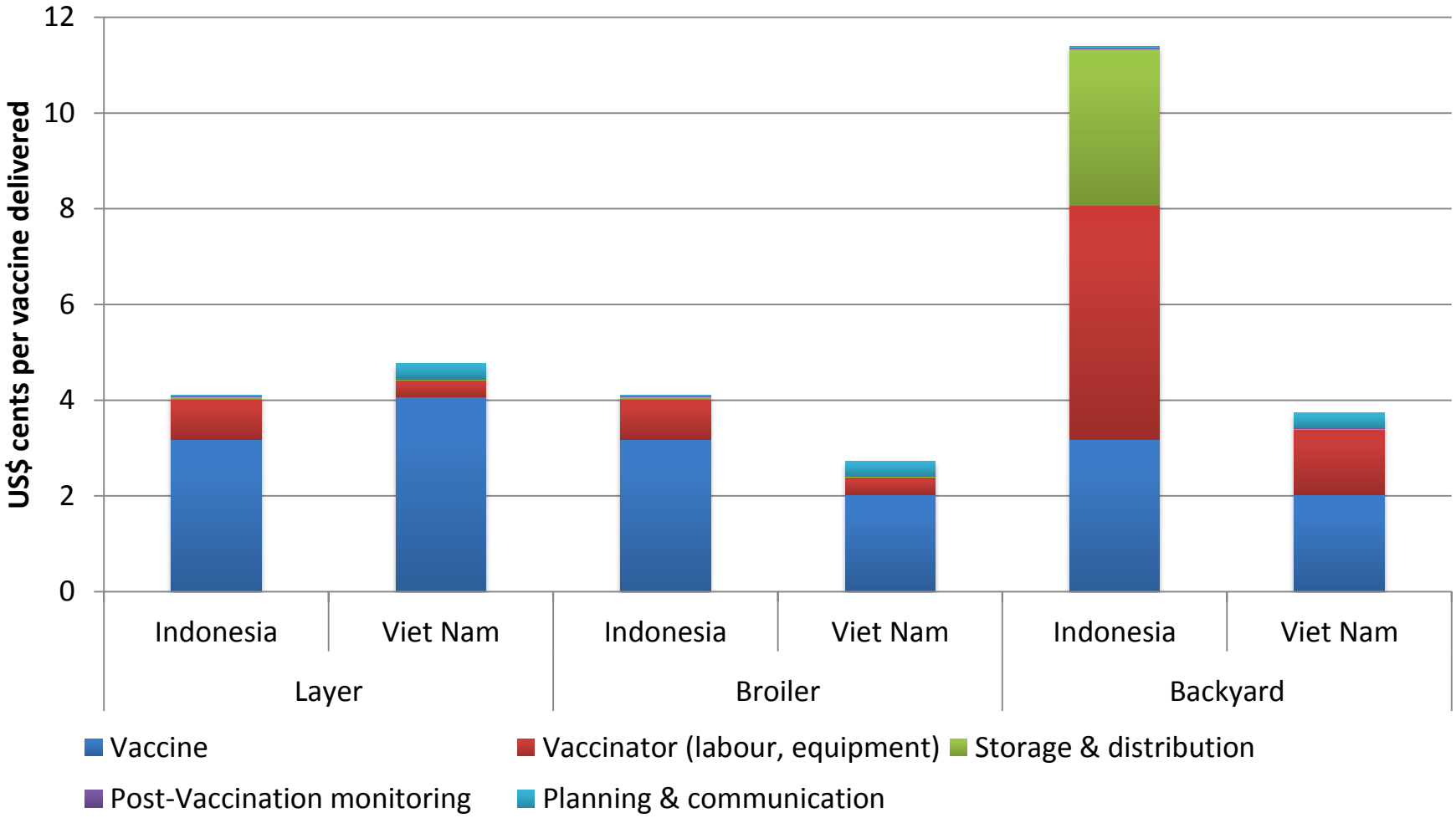
Public incentives are unlikely to be the same as private incentives

An example – layer producer

- A layer producer who raises their own birds i.e. from day old chick (DOC) to point of lay (POL)
- Let's assume the producer has an all in all out system
- The value of their birds will vary over time, lowest at the beginning and end of the production cycle
- The points when it will be acceptable and beneficial to have animal health interventions will differ over the cycle


Public Incentives
for disease prevention
Vaccination
Window
Vaccination
very unlikely
Private Incentive
for
disease preventi
Immunity
DOC
Vaccination
POL
Vaccination
POL
Break-even
Point
Spent
Hen
Time

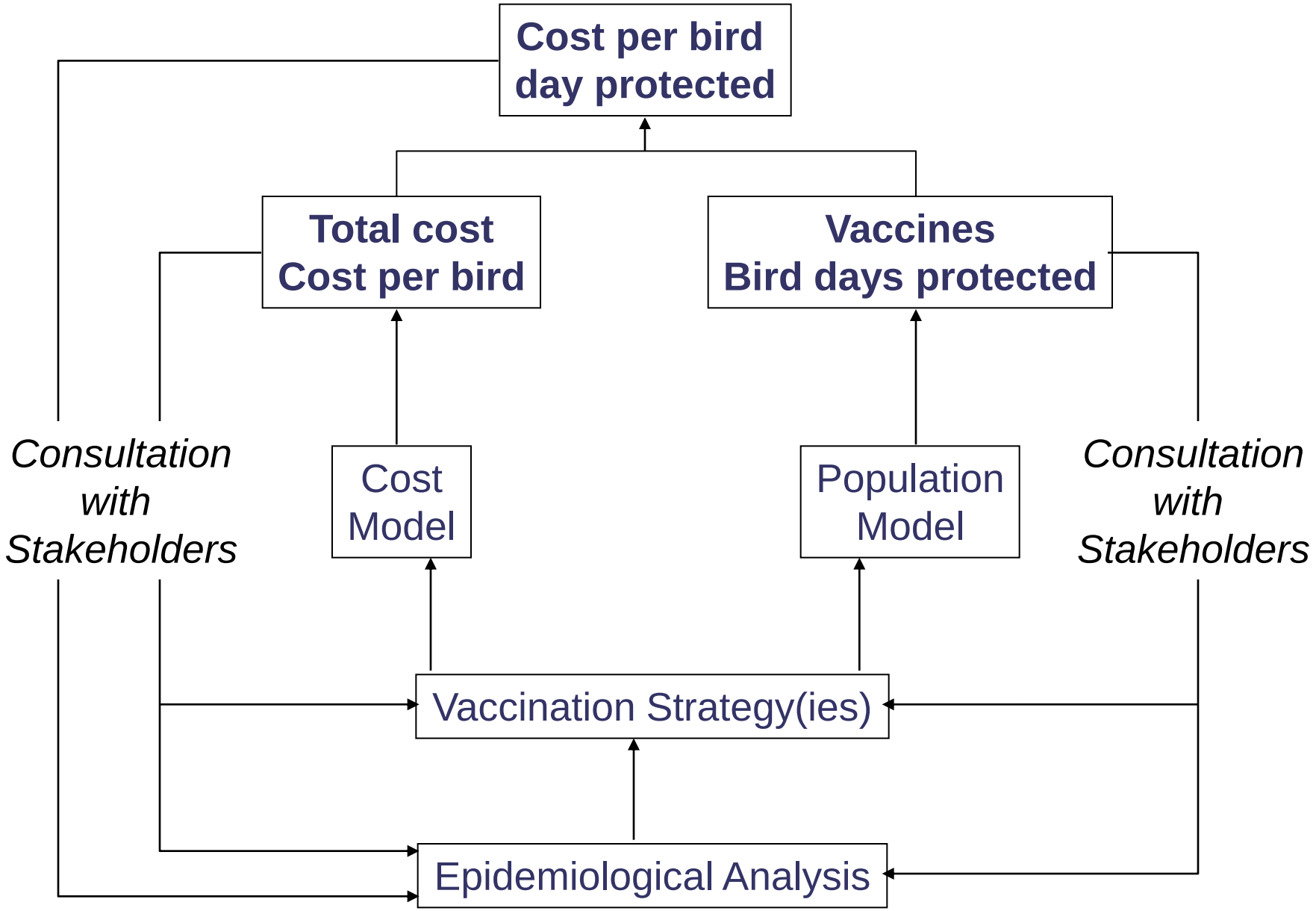
Estimated cost of vaccine delivery in different poultry systems of Viet Nam and Indonesia



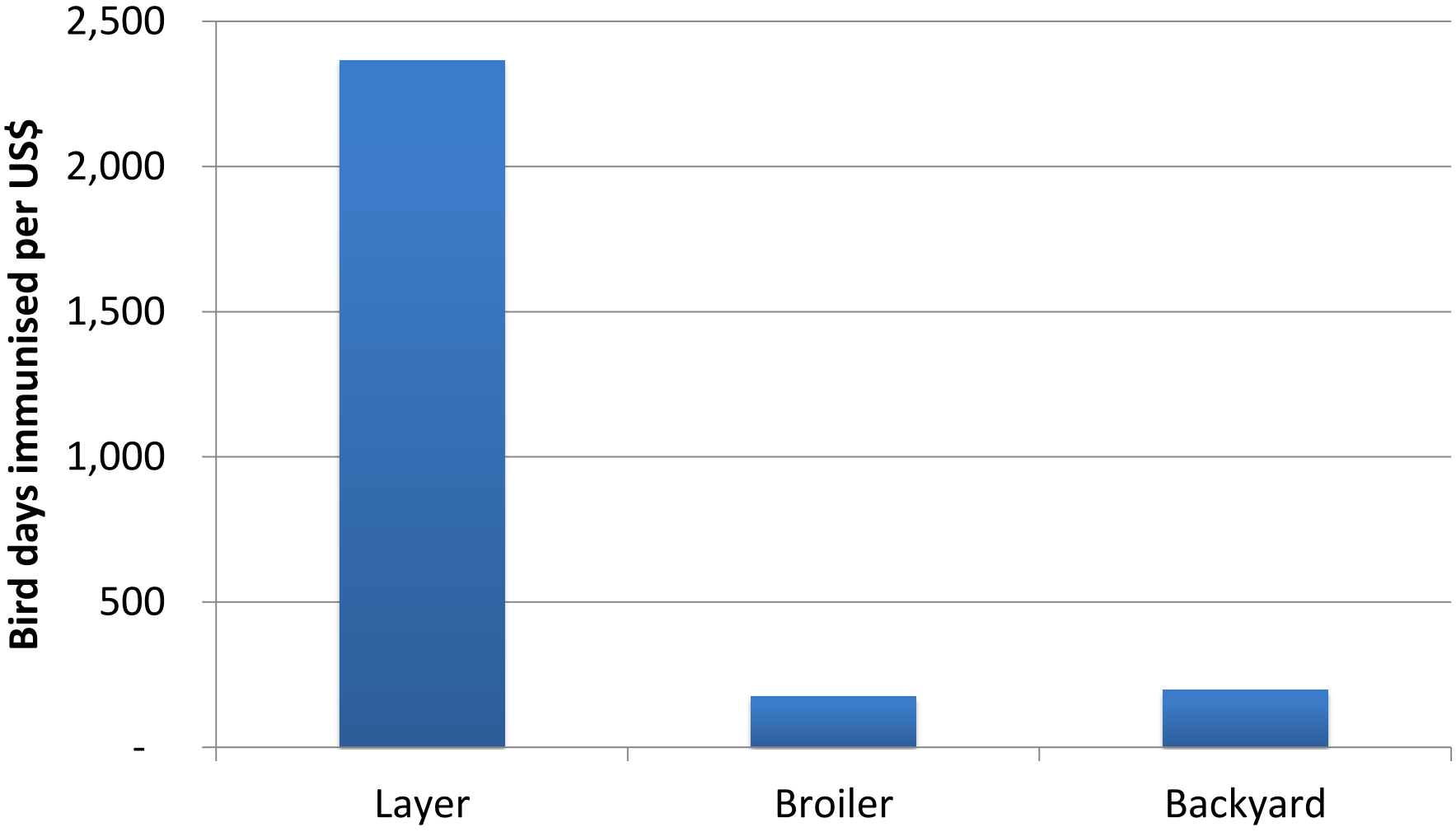
Using the costs of vaccination

- The costs of vaccination require thoughts on resource use and who bears these costs, which are socio-economic subjects
- A cost-effectiveness of a proposed vaccination strategy requires a combination of epidemiology and economics
- Allocation of resources becomes more critical if public resources for HPAI control and prevention are reduced
- Cost-effectiveness analysis can guide the process of resource allocation

Cost-effectiveness models for vaccination



Initial cost-effectiveness analysis



Costs and breakeven analysis for HPAI vaccination in SE Asia

Production system	Vaccinations required per production Cycle	Vaccination costs per production cycle (US$)		Breakeven outbreak frequency in years	
		min.	max.	min.	max.
Broiler grandparent stock	4	0.16	0.19	289	1141
Broiler parent stock	4	0.16	0.19	5	39
Layer	4	0.16	0.19	11	32
Crossbreed Broiler	2	0.05	0.08	4	35
Commercial broiler	2	0.05	0.08	1	14
Backyard flock		0.72	2.19	1	6

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Modified from Hinrichs et al. 2010

Reflections

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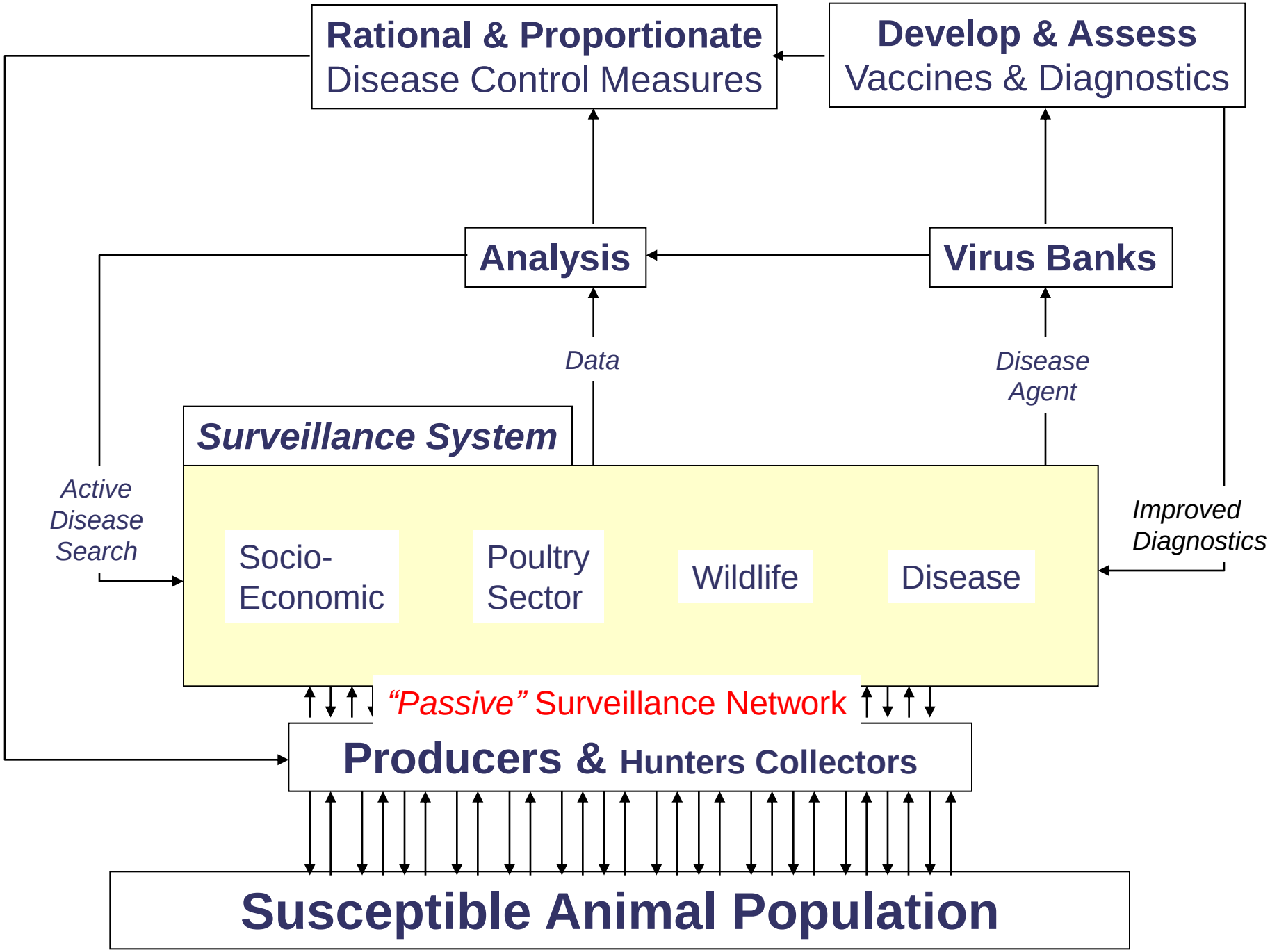
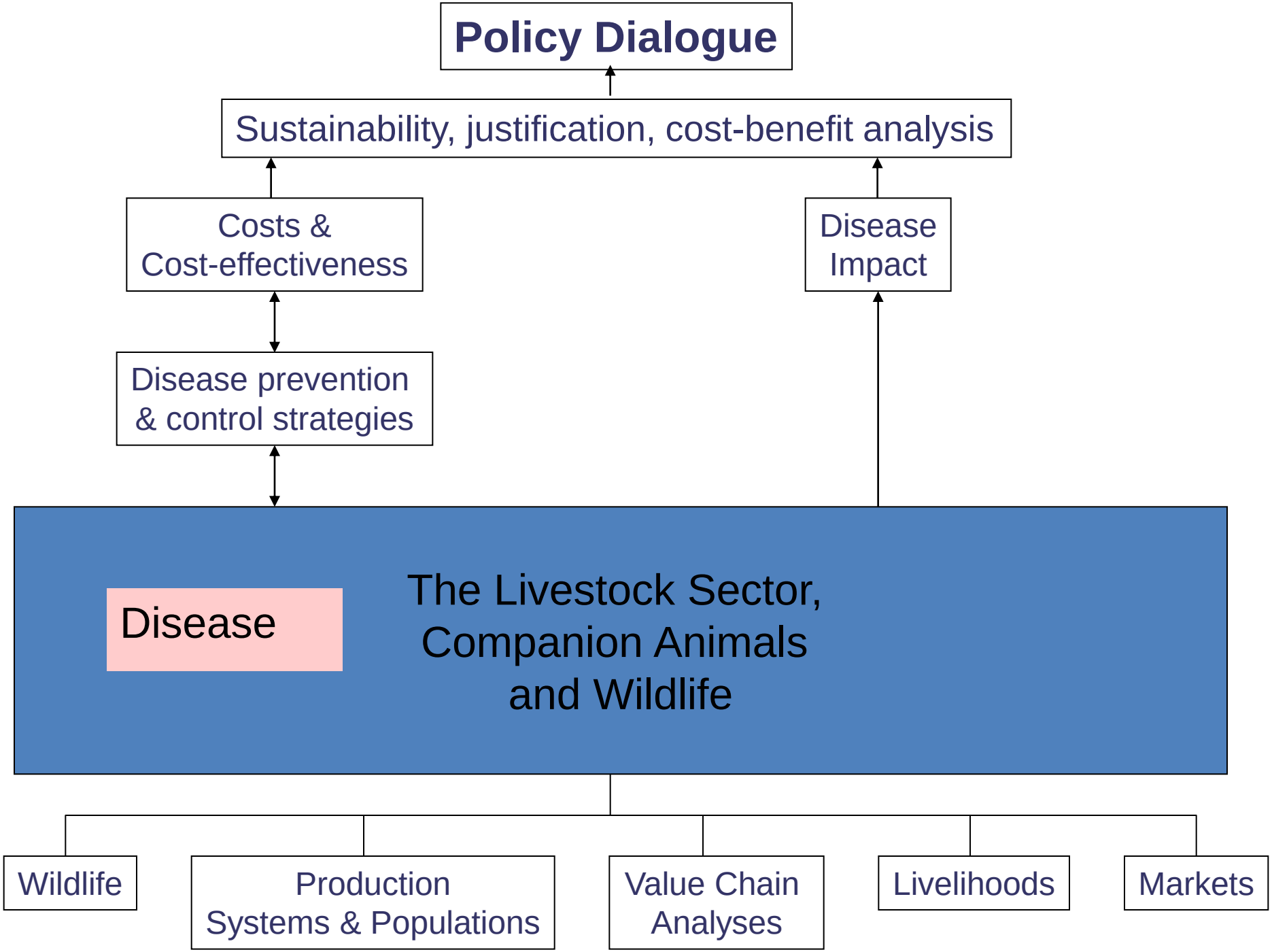

Rational & Proportionate
Disease Control Measures
Develop & Assess
Vaccines & Diagnostics
Analysis
Virus Banks
Data
Disease
Agent
Surveillance System
Active
Disease
Search
Improved
Diagnostics
Socio-
Economic
Poultry
Sector
Wildlife
Disease
"Passive" Surveillance Network
Producers & Hunters Collectors
Susceptible Animal Population


Policy Dialogue
Sustainability, justification, cost-benefit analysis
Costs & Cost-effectiveness
Disease Impact
Disease prevention & control strategies
Disease
The Livestock Sector, Companion Animals and Wildlife
Wildlife
Production Systems & Populations
Value Chain Analyses
Livelihoods
Markets

Key messages

- Vaccine development and vaccine delivery need to be assessed with information on the **target production systems of the vaccination**
- Understanding the production systems allows estimates of the **production losses** that can be **avoided** by vaccination
- Understanding the **costs** of development and delivery allows the identification of the need for **public and private sector partnerships**
- **The context and cost analysis are critical**

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Further information

- For more information on NEAT please look at
  - www.neat-network.eu
- For information on the work we are involved in with agriculture and health please look at
  - http://www.lcirah.ac.uk/home
- For courses offered at RVC please look at
  - http://www.rvc.ac.uk/Postgraduate/Distance/Index.cfm
  - http://www.atp-ilhp.org

Lifelong Learning

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