Economic Impact of Disease Control – Veterinary Vaccination Strategies

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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
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
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
A framework to approach animal disease management
- how to prioritise vaccine development
- how to prioritise vaccination campaigns
Animal Health Impact

Losses

Visible Losses
- Dead animals
- Thin animals
- Animals poorly developed
- Low returns
- Poor quality products

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

Expenditure & Reaction

Additional Costs
- Medicines
- Vaccines
- Insecticide
- Time
- Treatment of products

Lost Revenue
- Access to better markets denied
- Sub-optimal use of technology

Rushton et al, 1999; Rushton, 2002; Rushton, 2009
Animal Health Impact

Losses
- Visible Losses
  - Dead animals
  - Thin animals
  - Animals poorly developed
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- Invisible Losses
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Impact caused by the disease

Impact caused by human reaction

Expenditure & Reaction
- Additional Costs
  - Medicines
  - Vaccines
  - Insecticide
  - Time
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Expenditure & Reaction

Impact caused by the disease
Disease Loss – Expenditure Frontier (adapted from McInerney, 1996)

No Control

Optimal control

Towards Eradication?
Low coverage levels
- High price of vaccine relative to the price of units of production loss

![Graph showing disease losses and vaccines with optimal control point.](image-url)
Good coverage levels
- Low price of vaccine relative to the price of units of production loss
Key issues

Cost of vaccination relative to losses avoided is critical

Vaccine and vaccination costs can be manipulated
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
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)
Case studies
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
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
Extensive cattle systems
- FMD vaccination in Bolivia
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
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

Private Incentives for disease prevention

Immunity

Vaccination very unlikely

Vaccination Window

DOC Vaccination Vaccination

POL Vaccination Vaccination

POL Break-even Point

Time →

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

<table>
<thead>
<tr>
<th></th>
<th>Indonesia</th>
<th>Viet Nam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Layer</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Broiler</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Backyard</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

- **US$ cents per vaccine delivered**
- **Vaccine**
- **Vaccinator (labour, equipment)**
- **Storage & distribution**
- **Post-Vaccination monitoring**
- **Planning & communication**
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

Cost per bird day protected

Total cost
Cost per bird

Consultation with Stakeholders

Cost Model

Vaccines
Bird days protected

Population Model

Consultation with Stakeholders

Vaccination Strategy(ies)

Epidemiological Analysis

Consultation with Stakeholders
Initial cost-effectiveness analysis

- Layer: 2,500
- Broiler: 100
- Backyard: 200

Bird days immunised per US$
Costs and breakeven analysis for HPAI vaccination in SE Asia

<table>
<thead>
<tr>
<th>Production system</th>
<th>Vaccinations required per production Cycle</th>
<th>Vaccination costs per production cycle (US$)</th>
<th>Breakeven outbreak frequency in years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>min.</td>
<td>max.</td>
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<tr>
<td>Broiler grandparent stock</td>
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<tr>
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<td>Crossbreed Broiler</td>
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<tr>
<td>Commercial broiler</td>
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<tr>
<td>Backyard flock</td>
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<td>0.72</td>
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</tbody>
</table>

Modified from Hinrichs et al. 2010
Reflections
Susceptible Animal Population

Producers & Hunters Collectors

Surveillance System

Rational & Proportionate Disease Control Measures

Develop & Assess Vaccines & Diagnostics

Analysis

Surveillance System

Socio-Economic

Poultry Sector

Wildlife

Disease

“Passive” Surveillance Network

Improved Diagnostics

Active Disease Search

Data

Virus Banks

Disease Agent

Vaccines & Diagnostics

Analysis

Rational & Proportionate Disease Control Measures
The Livestock Sector, Companion Animals and Wildlife

- Disease
- Costs & Cost-effectiveness
- Disease prevention & control strategies
- Sustainability, justification, cost-benefit analysis
- Disease Impact

Policy Dialogue

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
Further information

• For more information on NEAT please look at
  • [www.neat-network.eu](http://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](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.rvc.ac.uk/Postgraduate/Distance/Index.cfm)
  • [http://www.atp-ilhp.org](http://www.atp-ilhp.org)
References

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