The economic and social impact of the Institute for Animal Health’s work on Avian Infectious Diseases

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1. Introduction

DTZ was commissioned by the Institute for Animal Health (IAH) to prepare a case study of the economic and social impact of IAH’s work on avian infectious diseases. This short report offers:

- An overview of the economic importance of avian products;
- Key challenges facing the UK and global poultry sector;
- An overview of IAH’s global work in relation to control of some major diseases; and
- Assessment of the resulting economic impact of IAH’s research in the UK and abroad.

The ability to prevent or control avian disease outbreaks is of growing importance as poultry are an increasingly significant source of nutrition across the world. Figure 1.1 shows the rapid growth in world poultry meat production which is expected to continue. At the same time significant increases in productivity have been achieved through industry efficiency, breeding and disease control supported by IAH. These improvements have led to a reduction in days to slaughter to the current six weeks.

Figure 1.1 Growth in world poultry meat production

1 http://www.fao.org/docrep/W5146E/w5146e06.htm#meat%20production
As well as avian diseases per se, the risk of disease transmission between poultry and human populations is growing, especially in developing countries. IAH’s work in this area is therefore of substantial economic importance.

Globally, there are an estimated 51 billion chickens, 46 billion for meat and 5 billion for eggs worth some £17 billion in 2005\(^2\). The global poultry sector has undergone major structural changes during the past two decades due to introduction of modern intensive production methods, genetic improvements, improved preventive disease control and biosecurity.

In the UK, around 850 million broiler chickens are reared for meat each year, producing 1.46 million tonnes worth £1.215 billion in 2007. UK egg production is worth a further £410 million per annum.

The UK hosts a considerable share of world breeding stock production with the two major players, Aviagen and Cobb Vantress, accounting for 80-85% of the market\(^3\). In this respect, the UK punches well above its weight on the international stage.

The structure of the global poultry industry is shown in Figure 1.2. The structure is the same in the UK, highlighting how small numbers of high value, genetically pure, disease-free birds are the source of UK and international poultry production.

**Figure 1.2 Structure of the UK poultry industry from pedigree to consumer.** The left and right hand diagrams show the structure of the broiler (chicken meat) and commercial layer (eggs for consumers) industries respectively.

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\(^2\) International Food Policy Research Institute.

\(^3\) Ibid.
Source: Aviagen

Much of IAH's work has focused on improving health and welfare starting at the top of the pyramid so that the benefits are felt throughout the industry.

Section 2 goes on to outline key challenges and how IAH is working to address them.
2. UK and Global Poultry Challenges

A number of key challenges are faced by the UK and global poultry sectors. These challenges include a range of poultry and human diseases as well as sustainability and productivity issues. IAH is working through its research and with industry to address many of these challenges.

The main disease challenges are as follows:

<table>
<thead>
<tr>
<th>Nature of Threat</th>
<th>Avian Infectious Disease</th>
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</table>
| Threats to Avian Species | - *Eimeria* (Avian Coccidiosis)  
- Marek’s Disease Virus (MDV)  
- Avian Leukosis Virus (ALV)  
- Coronaviruses (specifically Infectious Bronchitis Virus or IBV)  
- Avian Pathogenic *E.coli* |
| Threat to Humans and Avian Species | - Avian Influenza (AIV) or ‘bird flu’, HN51  
- *Campylobacter jejuni*  
- *Salmonella enterica* |

Key sector challenges include:

**Productivity** – import price competition is strongly driving improved sector productivity through disease prevention and control.

**Genetic resistance** – improving genetic resistance of poultry to infectious diseases to reduce the costs of therapeutic drugs

**Pathogen resistance** - combatting pathogen resistance to existing vaccines and therapeutic drugs which may see a renewed threat from MDV and the potential to devastate the UK’s elite stock of commercial breeders.

**Vaccine efficiency** - the need to develop vaccines that are more efficient to deliver, more effective and safer.

**Human pandemics** – the need to learn about, prepare for and mitigate the effects of avian to human disease transmission. There have been four pandemics in the last 100 years and in each case, viruses crossed from avian species to humans – ‘Spanish Flu’ killed between 20-80 million in 1918.

**High-level biocontainment laboratory facilities** – the need for investment in facilities for live vaccine research such as highly pathogenic Avian Flu as current facilities are capacity constrained.
3. The Role of IAH

3.1 International profile

IAH has an international profile in avian infectious diseases evidenced by the following:

- IAH led development of key vaccines to control *Avian Coccidiosis* and *Marek’s Disease*.
- IAH research led to **control of the Avian Leukosis Virus** which had driven several international commercial poultry breeders out of business.
- IAH holds the **World Reference Laboratory for OIE** for Marek’s Disease.
- IAH has **a number of genetically pure, pedigree, poultry flocks** required to understand host-pathogen interactions.
- IAH is a key **centre of excellence in research to counter Campylobacter, Salmonella, and E. coli** and their effects on animals and humans.
- IAH has **generated over £2.0 million in royalties** from sales of the Paracox-8 and Paracox-5 vaccines that combat coccidiosis in chickens.
- IAH was the first research institute in the world to **complete a genetic sequence for a coronavirus (Infectious Bronchitis Virus)** thus aiding understanding and vaccine development of this poultry pathogen and other coronaviruses such as SARS, Bovine coronavirus, Feline coronavirus and Transmissible Gastroenteritis Virus of pigs.

3.2 IAH activities

IAH research into avian infectious diseases is targeted at:

- understanding **host:pathogen interactions** and their impact on health and welfare;
- understanding the **avian immune system** and immune responses;
- the role of genetics in **breeding birds with natural resistance** to infection, to reduce the need for vaccinations and drugs;
- making **vaccination and vaccines cheaper, more effective and efficient**.

In addition, IAH undertakes disease surveillance, advisory work to government and training of industry personnel and PhD students to develop a core of future scientists. For example:

- IAH’s role as host of the **World Reference Laboratory for Marek’s Disease** means that it receives samples from any new world outbreak to diagnose the strain and catalogue it.
- IAH provides advice to government veterinary officers, industry contacts, the media and civil servants in respect of key avian infectious diseases around the world. For example, during recent outbreaks of the H5N1 strain of avian flu, IAH advised on how

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IAH as World Organisation for Animal Health.

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the disease is transmitted, its implications, appropriate infection controls and correct vaccine application.

- IAH helps to develop the capacity for research within UK and international academia, industry and government, through Research Council and industry-funded PhD studentships.

- IAH also helps to develop the capacity for research within industry through a well developed programme of animal health-related and disease-specific industry training.

3.3 Market failure

IAH is a Biotechnology and Biological Sciences Research Council (BBSRC) research centre receiving the majority of its funding from BBSRC and Defra. The institute is seeking to address what is known as a ‘market failure’.

The OECD defines a market failure as a “situation in which market outcomes are not optimal. Market failures provide a rationale for Government intervention”\(^5\). The activities of IAH address market failure, since they produce outcomes that the market alone would not deliver.

The table below shows the activities of IAH and the market failures they address.

<table>
<thead>
<tr>
<th>IAH activity</th>
<th>Market failure addressed</th>
<th>Nature of market failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>UK &amp; international government advice</td>
<td>Public good</td>
<td>There is not enough incentive for the private sector to pay for avian diseases research and advice, as everyone benefits.</td>
</tr>
<tr>
<td>Surveillance and vaccination research</td>
<td>Externalities</td>
<td>The private sector under invests in this kind of research, as the costs are high, probability of success is uncertain, and the benefits only arise during an outbreak. However, the benefits to society are desirable, and cost-effective when centrally managed.</td>
</tr>
<tr>
<td>Disease control training</td>
<td>Asymmetric information / Natural monopoly</td>
<td>The agricultural sector does not have full understanding of the range of avian diseases or how to prevent outbreaks. A central repository of expertise can deliver more effectively than individual companies, with a higher chance of success.</td>
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4. Economic impact assessment

To estimate the economic impact of IAH’s avian infectious disease related activities, we have followed the guidance of the HM Treasury Green Book\(^6\).

We can measure the value of IAH activities in relation to avian infectious diseases through society’s willingness to pay for IAH advice and through the estimation of the potential scale of losses to industry if IAH was not available to provide advice.

4.1 Willingness to pay for IAH activities on avian infectious diseases

Society’s willingness to pay for IAH work on avian infectious diseases can be estimated through the funding made available plus training and awareness raising activities.

From 2003/04 to 2008/09, the total paid by the public sector for IAH’s avian infectious disease research was £32.8 million or £5.5 million per annum. Funding fluctuated from £4.7 million in 2005/06 to £6.3 million in 2008/09:

Figure 4.1 Funding for IAH research on Avian Infectious Diseases 2003/04 to 2008/09

IAH plays a significant role in training PhD students and industry personnel. More than 300 PhD students have been trained in the last 20 years. Industry training activities have reached more than 40 countries worldwide with 10-20 delegates per annum coming for anything from a week to a month for training.

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\(^6\) [http://www.hm-treasury.gov.uk/economic_data_and_tools/greenbook/data_greenbook_index.cfm](http://www.hm-treasury.gov.uk/economic_data_and_tools/greenbook/data_greenbook_index.cfm)
4.2 Wider economic impact of IAH activities on avian infectious diseases

4.2.1 Disease Impacts Achieved

**Avian Leukosis Virus** – In the mid 1990s, there were 8 or 9 primary breeding companies supplying the world poultry sector with breeding stock of meat-type birds. These high value breeding stocks were virtually wiped out by ALV such that, in 2010, only two firms, Aviagen and Cobb-Vantress, survived to have significant impact in the international market providing 80-85% of this market. IAH's work, with partners, led to the elimination of ALV from breeding flocks thus safeguarding the global turnover of these businesses.

In helping to eliminate ALV, IAH has contributed to safeguarding an estimated 3,200 jobs and £400 million of worldwide turnover in the primary breeding sector, at global sites owned by Aviagen, Cobb-Vantress and other producers. Moreover, breeding stock that is free of ALV also perform better so that productivity has been enhanced.

**Marek's Disease** - MDV is prevalent globally and causes estimated annual losses of up to £1.4 billion in the poultry industry. MD is controlled by widespread use of vaccines, and the global MD vaccine industry itself is estimated to be around £400 million annually. IAH was the first to develop a successful vaccine against MD. If these had not been developed, it is possible that the poultry industry would not exist at all in its current form. A benefit-cost index\(^7\) of the Marek's Disease vaccine to the production of human food was estimated in the mid-1980's to be 44.3, meaning that for every pound spent on research there would be a return of around £44.30 in economic benefits, for example through decreased costs of production of poultry meat and eggs.

If this ratio is applied to spend on Marek's Disease since 2003/04, then the economic benefits generated by IAH in respect of Marek's Disease may be valued at £297 million since 2003/04 (in current prices) or £50m per annum with the potential to save up to £1.4 billion. IAH is working to develop replacement vaccines to ensure ongoing protection from Marek's Disease.

**Eimeria** - IAH developed the first, safe, live, attenuated vaccine, Paracox-8, in 1989, with financial support from British Technology Group and Schering-Plough Animal Health. This has allowed the industry to maintain poultry without the need for the use of drugs to control intestinal coccidial parasites.

The market for coccidiosis vaccines is worth around more than $20 million per annum and IAH has received more than £2 million in royalties from total sales of Paracox to 2010. The Paracox-8 vaccine is used throughout the EU and beyond to protect virtually all the highly valuable breeding stock in over 30 countries. A second vaccine, Paracox-5, was developed in 2000 for the control of coccidiosis in broilers. A highly important feature of the use of coccidiosis vaccines is that the need to add anticoccidial drugs to poultry feedstuffs is completely eliminated.

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\(^7\) The History of Avian Medicine in the United States V. Insights into Avian Tumor Virus Research; Ben R. Burmester, H.Graham; Avian Diseases, Vol. 23, No. 1 (Jan. - Mar., 1979), pp. 1-29
4.2.2 Potential Future Disease Impacts

As well as the impacts already achieved, IAH is actively working or considering strategies for a range of other infectious diseases which may have future impacts.

**Infectious Bronchitis Virus (IBV)** – IAH research may result in more effective vaccines against IBV, reducing losses. Defra-funded research (2000) estimated direct disease costs for the sector of £24 million. If this work, or IAH’s work on genetic resistance to the virus, is successful, then IAH could help to substantially reduce IBV losses to the UK and international poultry sector by some £30 million per annum in 2008 prices.

**Avian flu** – There is increasing incidence of highly pathogenic outbreaks in the UK. The economic impact of an avian influenza outbreak would be principally felt by the poultry and ancillary industries, with movement restrictions and isolation of birds required. Organic and free-range status would be compromised with domestic and export markets affected.

To date, there have been 10 cases of avian flu in the UK - the most recent confirmed in March 2009 in East Anglia. The last highly pathogenic case was reported in June 2008 and, while the UK quickly regained intra-EU export rights, the UK had to wait until November 2008 for disease free status (using OIE rules for a 3 month period free from highly pathogenic avian flu), permitting resumption of exports to non-EU overseas markets. Most exports from the UK typically go to other EU Member States.

The impact of a pandemic would be more severe than the economic downturn derived from failure of credit markets. For example, “A likely minimum economic cost of a serious global pandemic flu outbreak would be some 1% of world GDP – about $400 billion and could easily rise to more than 5% of world GDP - £68 billion in 2008 prices at the UK level. Severe impacts would be felt on the sector itself, but also aviation, transport and tourism in particular.”

In the event of an avian influenza pandemic, mortality in the UK has been modelled at up to 750,000 lives. Human lives lost could be as high as 7,500,000, assuming a 50% mortality rate among the 25% of the population that might become infected with the pathogen if a pandemic develops.

4.2.3 Vaccinations versus therapeutics

Most of the UK flock of 850 million broilers and layers receive 20-30 vaccines throughout a 6 or 78 week lifespan, respectively, and this is seen as preferable to having to use therapeutic drugs to treat infections, which might impact on the human food chain. However this implies some 21 billion vaccinations are conducted within the UK alone every year.

Vaccines are delivered by spray, through feed and through the water supply. Vaccines for broilers cannot be expensive on a unit cost basis and methods of administration must be en masse. Nonetheless, they are very expensive to administer, as they are highly labour intensive.

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8 World Health Organisation
9 Oxford Economic Forecasting
10 World Health Organisation data indicate that in Indonesia there has been a 82% mortality rate among the 141 individuals infected, while the average mortality to-date in human cases has been 62.5% across all 408 cases up to and including 24th February 2009.
For example, a large site might take a 6-strong team seven full working days to complete. There can also be no guarantee that all birds have been treated, due to the un-targeted nature of administering some of the vaccines.

If we assume that a team is made up of workers of mixed grade, and that these workers work a 39 hour week, then this implies a cost of around £1,300 per flock, or £10.6 million for a single vaccination for the entire UK flock of broilers. This is in addition to the cost of the vaccines.

Given these high costs, IAH is seeking to develop in-ovo vaccination where possible and to improve genetic resistance to infectious diseases, with companies such as Pfizer.

4.2.4 Restrictions on UK agricultural exports

In 2007, the United Kingdom exported 293,580 tonnes of poultry meat and 0.4 million cases of shell eggs to the rest of the EU (plus a very small proportion to rest of the World)\(^{11}\).

The total annual export value at risk from viral pathogens is at least £300 million.

4.2.5 Demand for extensive (free range) farming

The UK is one of the leading markets in improved animal welfare and ethical food production and producers have responded, particularly in the market for eggs. In 2007, 28.4% of the eggs produced in the UK were free range\(^{12}\) (up from 27.2% in 2006). In the first 3 quarters of 2008, the free range share of production had increased to 32%.

However, extensive or free range production exposes farmed birds to external vectors of infection, such as wild birds, disease organisms in soil, flies and wind-borne particles. This has led to re-emerging diseases among free-range birds that had previously been eradicated from intensively reared, indoor flocks. This has a consequent economic loss.

However until IAH started to tackle conditions caused by pathogens such as helminth worms, protozoa (such as *Eimeria*), bacteria and viruses, there had been a relative lack of understanding of how such pathogens might be controlled.

Together with industry, IAH is working to address these re-emerging diseases and to safeguard the growing share of the market taken by free-range production in the UK and ensure that consumer demand for improved animal welfare is satisfied. In 2007, the value of UK free range egg production was an estimated £156.4 million\(^{13}\).

4.2.6 Employment impacts

Basing our model on the National Accounts published yearly by the ONS (Office for National Statistics), we can assess the employment implications of such output losses associated with an avian flu outbreak on the national labour market. Employment within the UK agricultural

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\(^{11}\) 2009 DEFRA statistics

\(^{12}\) A further 5.8% share of egg production (or 1.37 million cases) was organically farmed

\(^{13}\) based on a weighted average price of 77.9p per dozen eggs, compared with the average price of just 57.4p for all eggs
sector is estimated to be 53,600 workers\(^{14}\). The **direct employment impacts** of a AIV outbreak resulting in an international export ban on UK poultry products, if it was not prevented, would amount to the loss of £300 million of sector turnover, from a total of £1.77bn poultry output, suggesting 17% or **9,100 jobs in the UK Poultry sector might be at risk**, depending on the duration of the outbreak.

The **indirect employment impacts**, capturing the links between the agricultural activity and the others sectors of the UK economy, would translate into another **6,400 job losses** in the industrial sectors supplying agriculture at the national level in machinery, chemical products, animal feed, etc.

The **induced employment effects**, which are the consequences of the decrease in national consumption, due to the 9,100 job losses mentioned above, and the income losses associated with them, would add another **2,700 job losses** in the UK economy.

The overall employment impacts of an export ban on all poultry products from the UK, arising from an outbreak of highly pathogenic avian flu in the UK, would potentially put at risk **18,200 jobs throughout the UK economy**.

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\(^{14}\) Estimated based upon a 11.2% share of the £5.7bn Agriculture sector GVA, and an average of £12,069 GVA per agriculture employee in 2007.
5. Summary and Conclusions

The work of IAH helps to safeguard the £1.7Bn UK poultry industry, including £300m of UK annual exports. It does this by undertaking research to understand and remove the threat from major infectious diseases. IAH has a strong track record in successfully mitigating the effects of such diseases or in finding new solutions to diseases following devastating impacts and has made big contributions to animal welfare. Whilst it is almost impossible to place a financial value on welfare matters, the poultry industry reports that the introduction of Paracox vaccines has had a huge impact on animal well-being, in addition to improved productivity.

Many of these impacts have a global reach but we have allocated a share of impact to the UK, where appropriate, based on the UK share of global meat production (1.8%). Specific disease impacts achieved include the following:

- **Marek’s Disease** - economic benefits generated by IAH in respect of Marek’s Disease may be valued at £50m per annum or £0.9m per annum at the UK level.

- **Eimeria** - IAH has received more than £2 million in royalties – a small share of the total vaccine sales.

- **ALV** - safeguarding 3,200 jobs and £400 million of worldwide turnover in the primary breeding sector. The UK is a major centre for poultry breeding so punches well above its weight. It is therefore, not relevant to allocate the UK impact of ALV at 1.8% of the world figure.

The diagram below seeks to summarise the position. As well as achieved impacts, there are a range of potential impacts from the work of IAH together with partners, as follows:

- **Infectious Bronchitis Virus (IBV)** – IAH could help to substantially reduce IBV losses to the UK and international poultry sector by some £30 million per annum in 2008 prices.

- **Avian flu** - The serious threat of avian flu is growing. Globally, scientists recognise that avian flu could have a very significant impact on the poultry industry and, more importantly, a devastating impact on human health and mortality. At the UK level, a serious outbreak could see a drop of 5% in UK GDP equivalent to £68Bn. At the global level, losses could exceed £1.4 trillion.
Perceived Value to British Society:

£1m per annum

Employment impacts

53,500 jobs safeguarded
(18,200 jobs at risk from export ban)

IAH Avian Infectious Diseases spend

£5.5m per annum

PhD Studentships

£700k per annum

Industry Grants & Awards

£300k per annum

Industry Training at IAH

Helping safeguard UK production

£1.7 bn per annum

- £300m of exports
- £156m of free range eggs

Protect primary breeding sector from ALV

(£400m)

Wider UK Economic Impacts :

£1.7bn

Wider Global Economic Impacts :

Up to £1.4 trillion

‘Avian Flu’ risk

(£1.4 trillion+)

Eimeria Vaccine market

(£300m p.a.)

Livestock vaccination

(Eimeria alone
£2m royalties to IAH)

Tackling Marek’s Disease

(£50m per annum)

Securing Global Food Supply

(Nutrition)

Protecting Human Health

(Salmonella/Campylobacter)

Jobs in Developing Economies

Securing Global
Food Supply
(Nutrition)