Appendix B Case study: Australian Animal Health Laboratory (AAHL)

SUMMARY OF KEY FINDINGS

- AAHL provides Australia with important disease mitigation and outbreak response mechanisms for animal and zoonotic (human pathogens of animal origin) diseases that could devastate industries such as beef production (worth $7.1 billion in 2012-13), aquaculture (worth $1.1 billion in 2011-12), horse racing (worth $6.2 billion per annum) and livestock breeding. AAHL also has an important role to play in protecting human health, which delivers benefits across the economy as a whole.
- AAHL is actively involved in providing protection from threats of
  - Foot and mouth disease (FMD)
  - Transmissible Spongiform Encephalopathy
  - Hendra virus
  - Middle Eastern respiratory syndrome
  - Avian influenza
  - Insect-borne diseases
  - Aquatic animal (finfish, molluscs and crustaceans) diseases
- The insurance value in relation to foot and mouth disease (FMD) alone is some $431 million per annum, which exceeds AAHL's annual operation costs by more than seven times (see Table A2).
- Insurance values in relation to AAHL's work on other Biosecurity threats add considerably to the insurance value benefits delivered in relation to FMD. For example, there are several studies that suggest that an avian influenza pandemic would reduce Australian GDP in the first year alone by up to 10 per cent of GDP.

B.1.1 Purpose and audience

This independent case study has been undertaken to assess the economic, social and environmental impact of CSIRO's Australian Animal Health Laboratory (AAHL). The case study has been prepared so it can be read as a standalone report or aggregated with other case studies to substantiate the impact and value of CSIRO's activities.

The report is provided for accountability, communication and continual improvement purposes. Audiences for this report may include Members of Parliament, Government Departments, CSIRO and the general public.

B.1.2 Background

AAHL was officially opened in 1985 (although research work began in 1984). It plays a vital role in protecting the health of Australia's livestock, aquaculture species and wildlife from the impact of infectious diseases. This in turn helps to ensure the ongoing competitiveness of Australian agriculture and trade.

AAHL can respond rapidly to disease outbreaks that could have serious national impact

Importantly, AAHL has the capability to respond rapidly to disease outbreaks that could have serious national impact. AAHL also helps to protect the general public from the threat of zoonotic diseases (viruses that pass from animals to humans).

Before AAHL opened, most samples that needed to be tested for exotic animal disease were sent overseas for analysis. This took considerable time and resulted in a loss of control over important trade-related information for Australia. The establishment of AAHL meant exotic diseases could be diagnosed within Australia, providing protection and support for Australia's trade in the export of animal products and live animals. Since opening, AAHL has supported Australian state veterinary laboratories by testing hundreds of thousands of samples and has helped to detect and characterise many new viral diseases.

The AAHL facility would cost $1.4 billion to build now

The AAHL building alone would cost in the order of $1.4 billion to replace.[4] This excludes the cost of the land and the costs and time in replacing the massive staff capability that has been assembled. Its annual operating budget is approximately $60 million, with approximately two-thirds met from the CSIRO and the remainder from the Commonwealth Department of Agriculture, industry, international agencies and other smaller sources of funding.

AAHL received NCRIS funding for the recent construction of the Physical Containment level 4 (PC4) Zoonosis Suite as well as a PC3 laboratory to study arboviruses. In addition, some funding was provided for the work on Hendra virus through the Intergovernmental Hendra Virus Taskforce. Details of AAHL's revenue are shown in Table B1.

Table B1 **AAHL resourcing ('000)**

	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
Income						
CSIRO operational funding	5404	7003	8441	9735	9595	8152
Department of Agriculture Operational Funding	7138	7159	7252	7391	7545	7665
External revenue	10850	13334	11137	12640	9762	11128
Support services						
CSIRO Support services	12511	12815	12332	10922	13408	14928
Depreciation						
CSIRO Funded Depreciation	2233	2906	3206	4953	4541	5563
CSIRO Government Funded Depreciation	12997	12997	12997	12997	12997	12997
TOTAL	**51133**	**56214**	**55365**	**58638**	**57848**	**60433**

Source: CSIRO

Table B2 **AAHL expenditure ('000)**

	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
Salaries	16032	18972	20459	21453	19017	18745
Travel	1479	1440	946	1000	975	907
Operating	5881	7084	5425	7313	6910	7293
CSIRO support services	12511	12815	12332	10922	13408	14928
Depreciation						
Depreciation AAHL P&E	697	1139	1270	1271	1635	1508
Depreciation AAHL Building	14533	14764	14933	16679	15903	17052
	51133	**56214**	**55365**	**58638**	**57848**	**60433**

Source: CSIRO

B.1.3 Approach

The approach taken in this case study is based on CSIRO's impact framework and generally aligns with the nine-step process described in the CSIRO's impact evaluation guide, namely:

1. Initial framing of the purpose and audience of the impact evaluation.

[4] CSIRO 2014 estimate of building replacement cost, excluding demolition and land costs.

2. Identify nature of impacts (*what is the impact pathway, what are the costs and benefits*)
3. Define a realistic counterfactual (*what would have occurred in the absence of CSIRO*)
4. Attribution of research (*CSIRO vs. others' contribution*)
5. Adoption (*to date and in future*)
6. Impact (*timing, valuation, distributional effects among users, effects on non-users*)
7. Aggregation of research impacts (*within program of work*)
8. Aggregation of impacts (*across program of work*)
9. Sensitivity analysis and reporting.

This case study examines potential impacts from a small subset of AAHL's research activities.

B.1.4 Project origins and inputs

AAHL's mission is:

> To protect a healthy, productive and prosperous future for Australia's animals and people by delivering world renowned science that will further our understanding and management of infectious diseases

AAHL's research aligns with the goal of the Biosecurity Flagship

AAHL's work also aligns well with the goal of the Biosecurity Flagship by reducing risks from disease and improving the effectiveness of mitigation and eradication responses. The diagnostic skills and knowledge of scientists at AAHL form an important component of Australia's preparedness to deal with an emergency animal disease outbreak. Despite Australia's strict quarantine procedures, there is still a risk that an exotic (foreign) animal disease could be introduced into Australia. The potential impacts, dependent on the disease, include illness in humans, domestic animals and wildlife and cost to the economy of billions of dollars through loss of trade, tourism and other costs associated with recovery from a disease outbreak.

AAHL plays an integral role in investigating exotic and emergency disease outbreaks …

AAHL plays an integral role in investigating exotic and emergency disease incidents, allowing such diseases to be ruled out or to ensure rapid implementation of control strategies. It also provides diagnostic testing services for surveillance programs such as the National Arbovirus Monitoring Program, the Northern Australia Quarantine Strategy and the National Transmissible Spongiform Encephalopathy Surveillance Program.

… and identifying and characterising new diseases

AAHL has also been crucial in identifying and characterising new diseases including Hendra Virus, Australian Bat Lyssavirus, Pilchard Herpes Virus and Abalone Herpes Virus.

Quality assured diagnostic tests are critical to the success of surveillance programs and to the accurate diagnosis and control of disease outbreaks. A state-of-the-art high throughput testing laboratory, the Diagnostic Emergency Response Laboratory was opened in 2008 and can be operated in two different modes – routine or outbreak – dependent on the circumstances.

There is an increased incidence of emerging human infectious diseases of animal origin around the world. Zoonotic diseases have caused fatalities in humans including viruses borne by bats that can be transmitted either directly or indirectly to humans such as:

- Hendra and Nipah viruses,
- Australian bat Lyssavirus,
- Sudden Acute Respiratory Syndrome (SARS)
- Middle Eastern Respiratory Syndrome (MERS)
- Zaire Ebola virus.

AAHL's expertise is internationally recognised

AAHL has developed world-leading methodologies to isolate bat viruses and is now internationally recognised for this work. AAHL research has led to the characterisation of new viruses and development of a vaccine as in the case of Hendra virus; and the successful isolation of the SARS virus from the Chinese horseshoe bat.

B.2 Program activities and outputs

In the current strategy period there has been important work undertaken in relation to:

- Foot and mouth disease (FMD)
- Transmissible Spongiform Encephalopathy
- Hendra virus vaccine
- Middle Eastern respiratory syndrome (where the work is now gearing up)
- Avian influenza
- Insect-borne diseases
- Aquatic animal (finfish, molluscs and crustaceans) diseases
- Testing

B.2.1 Foot and mouth disease preparedness

FMD is a serious biosecurity threat to Australia …

… an FMD outbreak could cost the Australian economy $50 billion over 10 years

Activity

Fo*ot and mouth* disease (FMD) is the most serious biosecurity threat facing Australian agriculture and an FMD outbreak could cost the Australian economy up to $50 billion over 10 years (Buetre B. *et al*., 2013). Australia has been free of the disease since 1872 (AHA, 2014) but many of our neighbours in Asia are not as fortunate. In many Asian countries, the livelihoods of the people are dependent on their livestock and as FMD affects both milk production and reproduction, the disease can have a severe and relatively quick impact on many people.

Australia remains very much at risk of a FMD outbreak

While Australia is classified as free from FMD, the disease is endemic in much of the Asian region and the ease and rapidity of international travel by large numbers of people means that Australia remains very much at risk of an outbreak.

The AAHL facility has both the infrastructure and scientific capability to manage testing and research requirements during an FMD outbreak. However, all 'peace time' research on the virus is performed in partner laboratories overseas.

As vaccination is a key control measure that will be used in the face of an outbreak, CSIRO is working with these partner laboratories to study the effectiveness of FMD vaccines in target animal species to verify that the currently available vaccine strains in the Australian vaccine bank will protect against newly emerging strains of the virus.

Outputs

In the current CSIRO strategy period (2011-15) AAHL scientists are helping several countries in the region to improve their diagnostic capabilities and research into FMD, which in turn helps AAHL better understand the FMD virus strains circulating in the region.

As vaccination is a key control measure that will be used in the face of an outbreak, CSIRO continues to work with various other laboratories to study the effectiveness of FMD vaccines in target animal species to verify that the currently available vaccine strains in the Australian vaccine bank will protect against newly emerging strains of the virus

B.2.2 Transmissible Spongiform Encephalopathy

Activities

AAHL is the reference laboratory for the National Transmissible Spongiform Encephalopathy (TSE) Surveillance Program. TSE includes bovine spongiform encephalopathy (BSE, referred to in the media as mad cow disease) and scrapie in sheep. Australia is free of these diseases and has been designated a “negligible risk” status (the lowest risk) by the World Organisation for Animal Health (OIE).

AAHL’s role supports trade by helping to maintain a surveillance system for TSEs that is consistent with the OIE Terrestrial Animal Health Code. This assures all countries which import cattle and sheep commodities that Australia remains free of these diseases. It is important that Australia meets this requirement to assure continued access to export markets.

Outputs

The principal Transmissible Spongiform Encephalopathies (TSEs) of concern to Australia are BSE and scrapie. Australia has never had a case of BSE and had only an isolated case of scrapie in 1952. Diagnosis of any TSE in Australian livestock would have major impact on both domestic and international markets.

AAHL tests an average of 400 samples each year from diseased animals to rule out TSEs. AAHL also plays a major role in the national TSE freedom assurance program (TSEFAP), testing an average of 300 samples collected at abattoirs each year as part of the national surveillance program to assure our international trading partners that Australia’s status as free of these diseases is being monitored and maintained.

These programs have resulted in the diagnosis of several cases of atypical (spontaneous) TSE in recent years and AAHL has played a central role in assuring Australian regulators and international partners that these cases are of no public health or trade significance, but rather indicate that the surveillance system is effective.

B.2.3 Hendra virus vaccine

Activities

The Hendra virus that was first identified by AAHL scientists in horses in 1994 is a Biosafety Level-4 disease agent, which is the most dangerous level of pathogen in the world. CSIRO isolated and identified the virus within two weeks of it being reported. A horse vaccine was identified as a crucial element of the strategy for breaking the cycle of Hendra virus transmission from animals to people, as it prevents the horse developing and passing on the disease.

Developing a vaccine was crucial to breaking the cycle of Hendra virus transmission

While Hendra virus has relatively limited transmission, it has fatal outcomes. The 1994, 2005 and 2011-14 Hendra virus outbreaks in Queensland and New South Wales highlight the risk such serious pathogens pose to the Australian community. AAHL’s work on the Hendra virus has involved innovative science and international collaboration.

In 2008 an international research team including AAHL scientists evaluated a recombinant subunit vaccine formulation to protect a small animal model against the lethal Nipah virus. This research provided significant input to the development of a prototype Hendra virus vaccine for horses.

Outputs

In May 2011 CSIRO announced a prototype vaccine, and along with its collaborators, launched the Equivac® HeV vaccine in November 2012. It breaks the only known Hendra virus transmission pathway from horses to humans. To date, the infection pathway of humans with Hendra virus has been from bats to horses, then from horses to humans. There is no evidence of human to human transmission or of direct bat to human transmission.

AAHL is the only laboratory in the world capable of studying horses at PC4

The development of the vaccine was the result of a close collaboration between CSIRO and the Uniformed Services University of the Health Sciences (the US federal Health Sciences University) supported by the US National Institutes of Health and Pfizer Animal Health Australia (now Zoetis Australia). The high containment facility at AAHL was essential for evaluating its beneficial effects as AAHL is the only laboratory in the world with a large animal facility capable of studying horses at PC4. This work could therefore not have been undertaken anywhere else.

Following a surge in Hendra virus cases in 2011, regulatory authorities agreed to assess the Hendra virus horse vaccine with high priority during its registration process. The Intergovernmental Hendra Virus Taskforce was formed, and the National Hendra Virus Research Program allocated funding to ensure critical timelines for vaccine development were maintained.

In 2012, the Australian Pesticides and Veterinary Medicines Authority granted the Hendra virus horse vaccine (Equivac® HeV) a Minor Use Permit after the vaccine met all essential safety, quality and efficacy requirements. Later that year, Pfizer Animal Health (now Zoetis Australia) made the Equivac® HeV vaccine available, under permit, for accredited veterinarians to administer to horses. It is recommended that horses receive three doses of vaccine and then subsequent boosters. More than 200,000 doses have now been administered in Australia.

Equivac® HeV is the world's first commercial vaccine for a Bio-Safety Level-4 disease

By March 2013 CSIRO scientists confirmed that horses were immune to a lethal exposure of the Hendra virus six months post vaccination. The Australian Veterinary Association now recommends that all horses in Australia are vaccinated against the Hendra virus. Equivac® HeV is a world-first commercial vaccine for a Bio-Safety Level-4 disease agent.

This vaccine enables commercial and private equine activities to continue with minimal negative impact by increasing personal safety for horse owners, vets and others who regularly interact with horses. The vaccine has reduced costs attributed to future disease response and containment and also minimised the chances of the Hendra virus mutating and spreading more readily between horses, or from human to human.

B.2.4 Middle Eastern respiratory syndrome

Activities

Middle East Respiratory Syndrome (MERS) is a viral respiratory illness first reported in Saudi Arabia in 2012. It is caused by a coronavirus called MERS-CoV. The disease reservoir host for the virus is the bat and the virus has spread from bats to camels and to people. Most people who have been confirmed to have MERS-CoV developed severe acute respiratory illness following close contact with an infected person. They had fever, cough, and shortness of breath. About 30 per cent of people confirmed to have MERS-CoV infection have died (CDC, 2014) and so far, all the cases have been linked to countries in and near the Arabian Peninsula. There is potential for MERS-CoV to spread further and cause more cases globally. The first imported cases of MERS in the USA were confirmed in travellers from Saudi Arabia in May 2014.

Given AAHL's capability to develop animal models for the study of infectious diseases, AAHL has been researching MERS in mice and ferrets as potential models for human disease.

AAHL's expertise is recognised in its international partnerships

CSIRO and Duke-NUS (an alliance between Duke University in North Carolina, USA and the National University of Singapore) have recently signed a relationship agreement with a view to forming the International Collaborative Centre for One Health to assist in taking a new approach to tackling deadly viruses such as MERS. This partnership approach integrates the disciplines of medical, veterinary, ecological and environmental research to develop new tests for early and rapid detection of emerging infectious diseases.

Outputs

In the current CSIRO strategy period AAHL has ensured that Australia has the ability to diagnose this disease, for public health preparedness and has also commenced some surveillance work in Australian camels.

CSIRO scientists at AAHL have also investigated the suitability of housing alpacas in AAHL's Large Animal Facility as a potential animal model for disease in camels. By understanding the impact of the virus on the immune system of alpacas it is hoped this may lead to understanding why camels are susceptible to infection and how they transmit the disease to people.

B.2.5 Avian influenza

Activities

Avian Influenza is the most likely potential pandemic threat. AAHL is the national reference laboratory for Avian Influenza. When the H5N1 strain spread through China and then Southeast Asia, with increasing numbers of deaths in people, AAHL was contacted by AusAID to work first in Indonesia and Vietnam, and then most of ASEAN countries. AAHL is now recognized for its work on dangerous emerging zoonoses in the region.

AAHL is recognized for its work on dangerous emerging zoonoses in the region

AAHL is coordinating animal health (OFFLU) inputs to the WHO vaccine strain selection meetings that choose the antigens for human influenza vaccines, both for seasonal influenza and identified pandemic threats of animal origin. AAHL is also involved in other advisory activities in relation to avian influenza. AAHL is part of the global preparedness effort for a possible pandemic. It also plays an important national preparedness role by ensuring Australia has the capacity to respond quickly to an outbreak of avian influenza in Australia poultry.

AAHL's work on influenza is crucial to Australia's pandemic preparedness

The capability of AAHL to work with influenza viruses that have pandemic potential allowed Australia to have a human vaccine approved by the Therapeutic Goods Administration ready for an H1N5 epidemic and a stockpile of vaccine is available (Department of Health and Ageing, 2009).

Outputs

In early-2013 a new avian influenza threat, the H7N9 strain, emerged in China which threatens Southeast Asia and beyond. In response to the outbreak, AAHL has developed diagnostic test kits for the H7N9 strains and through its international connections assisted FAO to make these available among regional countries. The kits were exported to laboratories in 13 countries across the region to enable rapid diagnosis and facilitate effective disease control strategies.

AAHL's H7N9 test kits were exported to laboratories across the region

AAHL has become a trusted adviser in the region and AAHL's contacts with SE Asian Avian Influenza laboratories and knowledge of the disease in the region is recognised globally.

During the late-2013 outbreak of avian influenza around Young in NSW, AAHL undertook research to rapidly characterise the virus, proving that it was a local H7N2 strain and not the highly pathogenic strain circulating in Asia. If it had been found to be H7N9 it would have been the first case outside China. Because H7N9 is known to infect humans, the profile of the response would have had to be quite different. Even so, the outbreak led to the destruction of 450,000 chickens with a resulting shortage of eggs in NSW in the lead-up to Christmas (DPI (NSW), 2014).

B.2.6 Insect-borne diseases

Activities

Mosquitoes, midges and ticks, transmit many disease-causing viruses. These can affect livestock, wildlife and human health. With the impact of climate change, urbanisation and global travel, this mode of disease transmission is likely to become the most significant in the spread of new and emerging diseases across the world.

Insect borne diseases are an emerging challenge

Some of the most serious of these viruses (arboviruses) include yellow fever, West Nile virus, Japanese Encephalitis and Rift Valley fever. Although these viruses are not endemic in Australia, they are studied by AAHL's scientists from a surveillance and research perspective.

Other arboviruses such as bovine ephemeral fever (BEF), bluetongue, epizootic haemorrhagic disease, Dengue fever, Kunjin and Ross River virus are already in Australia and are closely managed in order to reduce the spread and impact of these diseases to livestock and people. AAHL is the national reference laboratory for the arbovirus surveillance program.

By studying the factors that influence arboviruses, immune response and the distribution of these carrier insects (vectors), AAHL has been able to develop intervention strategies and provide Australia with early warnings of new or exotic diseases.

The PC4 Insectary was built under NCRIS and houses colonies of exotic and endemic insects

AAHL's arthropod research program is underpinned by insectaries within both the Physical Containment levels 3 and 4 areas of AAHL. The PC4 Insectary was built under the Australian Government's National Collaborative Research Infrastructure Strategy (NCRIS) and houses colonies of exotic and endemic insects. PC4, being the highest level of biocontainment, will allow testing of Australian biting arthropods for their ability to transmit some of the most dangerous exotic viruses known. The insectary is available for use by Australian and international researchers for collaborative studies of arthropod-borne diseases.

Outputs

AAHL programmes in the current CSIRO strategy period (2011-15) include work on bluetongue virus. Bluetongue virus is carried between animals through the bite of the culicoides biting midge. This viral disease is clinically unapparent in cattle and yet seriously affects sheep. Though endemic in northern Australia with little impact, any spread to the sheep populations of southern-Australia would cause a severe impact and significant trade losses to our sheep industry.

AAHL monitors culicoides midge population movements across southern Australia

AAHL's work on the culicoides midge involves surveillance studies on their occurrence in southern Australia, monitoring of midge population movements across the Timor Sea, and studying their genetics and investigating the ability of local southern species to transmit the virus. Projects on the bluetongue virus involve researching how the virus evolves and changes and understanding the pathogenesis of transmission of the virus by midges.

By researching the immune mechanism that protects insects from the diseases they carry, it may be possible in the future to create poor virus transmitters thereby breaking the transmission cycle.

Current research programs are also delivering results in the study of Bovine Ephemeral Fever (BEF), commonly known as three day sickness. BEF is a disease of cattle and occasionally buffaloes, marked by short fever, shivering, lameness and muscular stiffness. Transmitted by mosquitoes, the disease is widespread in northern Australia.

BEF is of concern to the livestock industry as it causes serious economic losses through deaths, loss of condition, decreased milk production, lowered fertility of bulls, mismothering of calves, delays in marketing and restrictions on the export of live cattle.

CSIRO's arbovirus research team at AAHL are working to improve the BEF vaccine, understand the factors controlling the occurrence of BEF in animals, the evolution of the virus in Australia, as well as contributing to surveillance programs by characterising new and emerging virus strains.

B.2.7 Aquatic animal diseases

Activities

AAHL maintains a significant diagnostic and research capability for aquatic animal diseases, particularly those caused by exotic, and new and emerging, infectious agents. This work supports capture fisheries, aquaculture, and natural resources. AAHL projects in the current CSIRO strategy period (2011-15) include work on Ostreid herpesvirus (affecting edible oysters), Abalone herpesvirus (affecting farmed and wild abalone), Megalocytivirus (affecting a range of finfish species) and Yellowhead virus (affecting a range of prawn species).

AAHL's work supports Australia's aquaculture industry

Most recently, work has been focussed on viral agents causing diseases currently affecting Australia's largest aquaculture industry, Tasmanian salmonid farming. Using whole genome sequencing technology, AAHL is characterising viral isolates from diseased salmon. This research has demonstrated that an Orthomyxovirus initially isolated from salmon in 2006, and more recently in 2012, is in fact closely related, if not identical, to an Othomyxovirus isolated from healthy pilchards in 1998 and again in 2007 from South Australian waters, and in 2013 from pilchards in Tasmanian waters. This research clearly demonstrates that there are unique viruses present in wild fish species in Australian waters that can cross over to aquaculture species with serious consequences.

This research is part of a larger project on virus characterisation, contracted by the Tasmanian salmonid industry, and is vital to this industry's overall health strategy to develop viral vaccines. Salmonid farming delivered an annual value of some $516 million to fishermen in 2011-12 (RIRDC, 2014). The gross value of Australia's aquaculture production was $1.05 billion in 2011-12 (ABARES, 2013b).

Outputs

AAHL scientists have undertaken the painstaking research required to validate a number of molecular diagnostic tests for Abalone herpesvirus, Ostreid herpesvirus, Megalocytivirus and white spot virus (of prawns) so that diagnostic laboratories within the Australian network, state veterinary authorities and the Australian Chief Veterinary Officer are confident in the performance of these tests when used for surveillance, diagnosis and import and export testing. Moreover, research on the yellow head complex of viruses has demonstrated the emergence of novel genetic variants necessitating further research on their pathogenicity and on development and validation of further diagnostic tests for this virus complex.

AAHL has continued its long association with the Tasmanian Department of Primary Industry, Parks, Water and Environment and the Tasmanian Salmonid Growers Association. AAHL is a partner in an overall strategy to provide high quality health services to the salmonid industry. The results of research on the characterisation of the three significant viral pathogens, the Orthomyxovirus, the Aquabirnavirus and the Aquareovirus, are forming the groundwork on which the salmonid vaccine development program is being based.

B.2.8 Testing capability

Activities

Testing is, arguably, the most important work done by AAHL. It underpins Australia's multimillion dollar animal exports

AAHL maintains a significant diagnostic capability for animal diseases. The maintenance and continuous upgrading of this capability to cover new diseases or to incorporate new laboratory technologies is the most significant scientific activity at AAHL. AAHL works with State veterinary laboratories by testing samples for disease exclusion in the following categories:

- Category 1 – testing of animals being imported and exported to and from Australia
- Category 2 – testing of diagnostic samples provided by State veterinarians showing signs of clinical disease for serious problems such as avian influenza
- Category 3 – required when veterinary officers suspect an outbreak of exotic disease due to evidence such as a mass bird die-off in the case of influenza. FMD and zoonotic diseases fall in this category.

AAHL performs a large number of diagnostic tests every year

Some 797 tests are currently available and ready for immediate use. Of these, 371 tests are accredited within AAHL's Quality Assurance system, covering 55 terrestrial and 40 aquatic animal diseases. In the past year, AAHL received and responded to 592 cases that were either Category 2 or 3 (i.e. dealt with potential reportable emergency animal disease and/or had history of human exposure and required urgent results to determine response and/ or treatment regime). AAHL has performed between 85,000 and 68,000 diagnostic tests annually over the past 5 years.

Outputs

AAHL's diagnostic testing services for surveillance programs validate the nation's reputation as a safe and reliable trading partner and maintain the nation's competitive position in the global trade of animal products and live animals.

These services also enhance pre-border security by providing diagnostic support to our Asian neighbours.

Some 797 tests are currently available and ready for immediate use. Of these, 371 tests are accredited within AAHL's Quality Assurance system, covering 55 terrestrial and 40 aquatic animal diseases. This is, arguably, the most important work carried out at AAHL, as it constitutes the essential elements of the diagnosis, surveillance and response activities that facilitate the animal health certification required by Australia's multimillion dollar export trade in animals and animal products. The total value of Australia's meat exports (including live sheep and cattle) was $7.89 billion in 2012-2013 (ABARES, 2013a).

In the past year, AAHL received and responded to 592 cases that were either Category 2 or 3 (i.e. dealt with potential reportable emergency animal disease and/or had history of human exposure and required urgent results to determine response and/ or treatment regime). AAHL has performed between 85,000 and 68,000 diagnostic tests annually over the past 5 years.

CSIRO has led the development of the LEADDR network

CSIRO has also led the development of the Laboratories for Emergency Animal Disease Diagnosis and Response (LEADDR) network. The LEADDR network ensures harmonisation between diagnostic testing at AAHL and state laboratories. This has increased the efficiency of Australia's testing network and its capacity to meet surges in demand that arise during disease outbreaks.

B.2.9 Awards and public recognition

Research at AAHL has been awarded

The Hendra vaccine program has been recognised internationally as an outstanding example of bringing together the veterinary and medical professions to control a major public health threat.

The efforts of the research team at AAHL to inform and help the veterinary profession and horse industry understand the mechanisms of transmission and infection control have been recognised through an Equine Veterinarians Australia Award for Service to the Horse Industry, and an Australian Veterinary Association Meritorious Service Award in 2013.

The Hendra Virus Research Team won a prestigious Eureka Award in 2014

The work on the Hendra virus was also recognised with the CSIRO Chairman's Medal 2013 and the ultimate accolade in 2014 with the team winning a prestigious Eureka Award (the Australian Infectious Diseases Research Centre Eureka Prize for Infectious Diseases Research) (AM, 2014).

The Abalone herpesvirus project team, comprising of scientists from DPI Victoria and AAHL were awarded the Daniel McAlpine DPI Science Award in 2010 in recognition of the rapid development and deployment of diagnostic tests for this previously unknown virus.

B.3 Status of Outcomes and Impacts

B.3.1 Nature of Outcomes and Impacts

There are a variety of existing and potential beneficiaries from the work of AAHL. Using CSIRO's triple bottom line benefit classification approach, Table B3 summarises the nature of the outcomes and impacts to date.

Table B3 **Impacts and Outcomes of AAHL research**

Outcome Impact	Description
Environmental impact category	
Improved biodiversity *Impact: Ecosystems and Biodiversity* *Reach: State industry*	Access to Hendra vaccine means a reduction in the number of infected horses and less need to dispose of diseased animals. Lower incidence of disease and increased awareness about disease transmission means reduced pressure from the community to kill bats. Benefits to ecosystems/biodiversity through reduction in threats to species. Environmental benefits delivered by healthy bat populations include seed distribution and pollination.
Social impact category	
Improved health outcomes *Impact: Life & health* *Reach: National, global*	Access to an influenza vaccine that best protects against the current influenza virus(es) will reduce illness incidence rates, minimise the risk of a pandemic and save lives. Early warning of emerging health threats will help to develop intervention strategies and reduce the severity of any disease outbreak. The Hendra vaccine is saving lives of those who work with horses (especially veterinarians).
More reliable farm income streams *Impact: Standard of living, resilience* *Reach: National, global*	Reduced incidence of disease among farm animals and less loss of stock is a benefit to the standard of living of farming communities (in Australia and overseas). Development of the Hendra virus vaccine has reduced the risks of disruption to events involving horses (pony club meetings, race meetings, dressage, etc.).
Greater confidence in agricultural industry *Impact: Social licence to operate and community confidence* *Reach: National*	The reduction in disease incidence and the need to cull infected animals provides a higher level of confidence in the sector among the general population. AAHL's work underpins the security of rural employment for farmers and for other businesses in the supply chain. The development of the Hendra vaccine has halted the movement of equine veterinarians away from horse treatment.
Economic impact category	
More reliable livestock trade *Impact: International trade, the macro economy.* *Reach: National*	An outbreak of an animal disease such as FMD would be extremely damaging to Australia's international livestock trade. Outbreaks of FMD in Taiwan and Korea led to the loss of billions of dollars of meat exports. The work done by AAHL provides the buyers of our meat with the confidence that those exports are from disease free herds.
Improved diagnostic testing *Impact: New products or services* *Reach: National, global*	CSIRO can test for a large number of different animal diseases. It conducts many tens of thousands of tests each year.
New vaccines created *Impact: New products or services* *Reach: National, global*	CSIRO developed the Hendra vaccine that is currently being marketed by Zoetis Australia. CSIRO research also helps to ensure the efficacy of the annual influenza vaccine sold by firms such as CSL.

Source: ACIL Allen Consulting

The beneficiaries (and potential beneficiaries) of AAHLs work include:

- Farmers raising animals
- The meat and fish processing industry
- Animal and animal product customers in countries that import from Australia
- Pony clubs and other people involved in equestrian activities
- The Australian community

As shown in Table B3 many of the outcomes and impacts from AAHL's research will have global reach. The benefits of that research will also accrue to our international partners and neighbours both across the region and globally.

B.3.2 Counterfactual

The work undertaken at AAHL could not have been done elsewhere in Australia

Given the unique nature of the AAHL with its high level containment facility, the work described in this case study could not have been undertaken elsewhere in Australia. There are just a few other facilities of this type around the world and the delays in accessing these facilities in a time of an emergency would add significantly to the cost of managing an outbreak of foot and mouth disease. In the absence of AAHL, no other country would have developed a vaccine for Hendra virus.

B.3.3 Attribution

ACIL Allen has assigned 50 per cent of the benefits of FMD preparedness to CSIRO

Outcomes from the work of AAHL can to a significant extent be attributed to CSIRO. ACIL Allen has assigned 50 per cent of the benefits of foot and mouth disease preparedness to CSIRO/AAHL. There are of course other participants in the foot and mouth preparedness strategy who undoubtedly add substantial value to the strategy, but they are not as pivotal to the outcomes as AAHL. The reason for the 50 per cent attribution is that AAHL was the critical contributor and the source of the value. In the event AAHL did not exist there would undoubtedly be other alternative approaches adopted – however these would have been at similar or more likely greater cost. The fact is that AAHL does exist. An alternative facility that played a comparable key role in FMD preparedness, were there one, would be assigned the same percentage of benefits.

Pfizer Australia provided an adjuvant for the Hendra vaccine and took the product to market. ACIL Allen has therefore conservatively assigned 30 per cent of the Hendra vaccine outcome to Pfizer and 70 per cent to AAHL.

AAHL liaises closely with the WHO and the UN FAO on its influenza work

In relation to the work on influenza, AAHL has worked closely with the World Health Organisation and the UN Food and Agriculture Organisation. These international organisations have an important coordinating role. ACIL Allen has attributed 70 per cent of the impact to CSIRO.

B.3.4 Adoption

Adoption rates are likely to be very high

In the event of a serious animal disease outbreak, the adoption rate of AAHL's work is likely to be high. For example, in the event of an outbreak of foot and mouth disease the seriousness of such an event would ensure that adoption rate of AAHL's work would be expected to be 100 per cent.

ACIL Allen understands from its discussions with CSIRO that the take-up rate for the Hendra virus vaccine is currently around 15 per cent nationally, although this figure increases to more than 50 per cent in high risk areas.

B.4 Assessment of impacts

B.4.1 Impacts to date

The impacts to date from AAHL's research lie primarily in costs avoided from outbreaks of animal diseases, or reduced costs due to earlier containment of outbreaks. The direct beneficiaries of this work are owners of animals, but indirect benefits flow to suppliers of goods and services to the agricultural sector and to the general public though animal diseases impacting on availability or price of agricultural products and through the reduction of animal diseases being passed through to the human population.

Losses from a FMD outbreak would be very large

Experience from FMD outbreaks in other countries provide an indication of the scale of the risks that Australia faces:

- In Taiwan, following the 1997 FMD outbreak, pork exports valued at $US 1.6 billion fell by over US$1.3 billion to $US 234 million with the loss of the Japanese market (Chang *et al.*, Griffith 2005). Other countries stepped in to take over Taiwan's market share. With the loss of export markets, 27 million tons of pork was diverted to the domestic market with disastrous consequences for producers.
- An outbreak of FMD in the Republic of Korea in 2000 had similar consequences.
- In 2000 Argentina's exports of beef fell 52 per cent (Rich, 2004). Outbreaks of FMD in Uruguay and Brazil in the same year resulted in loss of export markets, prices falling

below the cost of production and serious damage to the livestock industries of these countries (FAO 2006).

Given that the value of Australia's cattle and calve, sheep, lamb and pig slaughterings in 2012-13 were worth over $10 billion (including slaughter of dairy cattle and skin value for sheep and lambs), the potential losses from a significant FMD outbreak are large (ABARES, 2013a).

B.4.2 Potential future impacts

As international trade and travel increase, so does the risk of animal diseases reaching Australia from overseas sources. The benefits of AAHL's work in relation to foot and mouth disease preparedness can be determined from the estimated cost of an outbreak of this disease.

B.4.3 Cost Benefit Analysis

ACIL Allen believes that the best way to illustrate the value delivered by AAHL is to undertake a detailed analysis of the insurance value it delivers as this is the key benefit it delivers. In effect the protection that AAHL's work provides for the Australian people and industry against serious health and economic risks.

As noted in Section B.2, AAHL works on a wide range of diseases, including:

- Foot and mouth disease (FMD)
- Transmissible Spongiform Encephalopathy
- Hendra virus vaccine
- Middle Eastern respiratory syndrome
- Avian influenza
- Insect-borne diseases
- Testing capability

In examining which of these to analyse for the purposes of this case study we sought to identify for which of the above we could obtain information that was:

  - *Reliable* – i.e. information collected and analysed by reputable groups or organisations
  - *Recent* – i.e. work that had been done in the relatively recent past
  - *Relevant* - information that was applicable to Australia's circumstances.

In ACIL Allen's view the information available for FMD best met the above criteria. That is not to say that information was not available on the other research topics listed that enables us to say with confidence that the insurance value delivered by the FMD work is very much just a lower bound.

Foot and Mouth disease

ACIL Allen has estimated the potential benefits of AAHL's disease surveillance and vaccine R&D activities in attenuating the adverse economic impacts of a potential foot-and-mouth disease (FMD) outbreak in Australia, drawing on the findings of a 2005 ABARE report and a 2013 ABARES report.

Economic impact of FMD outbreaks

ABARES has modelled FMD disease control strategies

In 2013 ABARES modelled FMD disease control strategies for three scenarios (ABARES, 2013):

- a *small outbreak in North Queensland*, where most cattle are raised on extensive rangelands
- a *small outbreak in Victoria's Goulburn Valley*, which has a high density of livestock and intensive dairy farms
- a *large multi-state outbreak* that, by the time of detection, has spread from Victoria to all eastern states (New South Wales, Queensland, South Australia, Victoria and Tasmania).

The following disease control strategies were examined:

- for the small and large outbreaks
- **stamping out**, which involves destruction and disposal of animals in infected and dangerous contact premises
- **stamping out with extensive vaccination**, which requires vaccination of all FMD-susceptible animals within a designated ring surrounding infected and dangerous contact premises; and removal of vaccinated animals once the disease is contained
- for the large multi-state outbreak (in addition to the above)
- **stamping out with targeted vaccination**, which includes the vaccination of all cattle and sheep on mixed cattle and sheep farms within a designated ring surrounding infected and dangerous contact premises. In outbreak areas outside the high-risk ring, stamping out (without vaccination) is undertaken.

A national livestock standstill is a key element of any response

All strategies would be preceded by a national livestock standstill which would have a significant economic impact on day 1, before the implementation of any of the above strategies.

Historically, stamping out has been used to manage FMD outbreaks. It ensures disease eradication and a swift return to disease-free status and access to international markets. However, it involves the rapid destruction and disposal of large numbers of stock. This can be highly resource intensive and can also lead to criticism within the community.

More recently, several countries have combined vaccination with stamping out to achieve effective control of FMD. Removal of vaccinated animals can delay the time to regain market access after eradication is achieved. However, early vaccination may assist with or be essential for effective disease control.

ABARES also examined targeted vaccination to explore the effectiveness of control in a situation where resources to undertake widespread extensive vaccination might not be available.

A FMD outbreak would have large direct and indirect economic impacts. Producers of FMD-susceptible livestock would bear most of the revenue losses as a result of countries placing restrictions on imports from Australia. Loss of exports and depressed domestic prices would significantly reduce the revenues of producers.

ABARES' estimates of the present value of direct costs of an FMD outbreak over 10 years in each scenario and under each disease control strategy is shown in Table B4. The direct cost of an outbreak is calculated by adding the estimated revenue losses to livestock producers to the costs associated with the chosen control strategy. The control costs are estimated to be $0.32-0.37 billion (depending on the control strategy) for the large multi-state outbreak, $0.09-0.10 billion for the small outbreak in Victoria and $0.06 billion for the small outbreak in North Queensland.

Table B4 **Present value of total direct costs of an FMD outbreak over 10 years by type of outbreak and control strategy ($billion)**

Type of outbreak and control strategy	Total direct costs ($billion)
Large multi-state outbreak	
Stamping out	$52.21
Stamping out with extensive vaccination	$49.89
Stamping out with targeted vaccination	$49.62
Small outbreak in Victoria	
Stamping out	$6.00
Stamping out with extensive vaccination	$6.26
Small outbreak in Queensland	
Stamping out	$5.64
Stamping out with extensive vaccination	$5.96

Source: ABARES (2013), *Potential socio-economic impacts of an outbreak of foot-and-mouth disease in Australia*

ABARES' modelling showed that the lowest cost disease eradication strategy depends on the initial conditions of the outbreak and the type of production system in the outbreak area. In the smaller outbreaks, the additional time required to remove vaccinated animals from the population (and the consequent increase in delay in regaining FMD-free status and market access) was greater than the reduction in eradication time due to vaccination (at least in the case of the small Victorian outbreak – vaccination actually had no effect on the eradication time in the small North Queensland outbreak).

Based on ABARES' modelling results, ACIL Allen has summarised the total direct costs of an FMD outbreak over 10 years with and without the vaccination option (see Table B5). The composite small outbreak is a combination of the small Victorian outbreak and the small Queensland outbreak (with equal weighting for both).

Table B5 **Present value of total direct costs of an FMD outbreak over 10 years by type of outbreak and availability of vaccination option ($billion)**

Type of outbreak and control strategy	Total direct cost ($billion)
Large multi-state outbreak	
With vaccination option	$49.62
Without vaccination option	$52.21
Small outbreak in Victoria	
With vaccination option	$6.00
Without vaccination option	$6.00
Small outbreak in Queensland	
With vaccination option	$5.64
Without vaccination option	$5.64
Composite small outbreak	
With vaccination option	$5.82
Without vaccination option	$5.82

Source: ACIL Allen Consulting analysis based on ABARES (2013)

Relative probability of FMD outbreaks by severity

In a 2005 study by ABARE[5], early detection of FMD was found to be highly significant in influencing the probability of containing the spread of the disease when vaccination is not available.

In the reference case of the 2005 ABARE study, the probability of a severe FMD outbreak under a stamping out disease control strategy was only 0.19 while the probability of a small outbreak was 0.81. Under a stamping out with vaccination strategy, the probability of a large outbreak was zero while the probability of a small outbreak was one.

However, should detection be delayed by two weeks, the probability of a severe outbreak under a stamping out only strategy rises to 0.93 (with a concomitant reduction in the probability of a small outbreak from 0.81 to 0.07). According to ABARE, the probability of a severe outbreak under a stamping out and ring vaccination strategy remains at zero even with delayed detection, as the resulting outbreaks under all scenarios would invariably be small.

In the ABARE study, a large outbreak results in over 90 per cent of the livestock in the affected region being slaughtered, compared with fewer than six per cent if the outbreak were small.

Estimation of AAHL benefits

AAHL's activities in relation to FMD are expected to assist in the control of a FMD outbreak in Australia in three ways:

- AAHL's disease surveillance activities, in conjunction with those of other relevant State/Territory and Commonwealth government agencies, ensures that the possibility of delayed detection of a FMD outbreak is reduced and that the response to an outbreak is optimised (thereby preventing a small outbreak from becoming a severe one).
- Australia maintains a vaccine bank with a private company in Europe and AAHL is involved in testing these vaccines and developing knowledge on how effectively these work for the strains of FMD that are currently circulating in South East Asia and internationally.
- AAHL works closely with the World Organisation for Animal Health (OIE) and the UN Food and Agriculture Organisation (FAO) to improve FMD surveillance and response capacity across SE Asia to decrease the potential likelihood of FMD spreading from Asia into Australia.

The impact of AAHL's activities (both surveillance-related and vaccine-related) on the economic impact of a FMD outbreak is summarised in Table B6. The expected direct economic costs for each type of outbreak is equal to the product of its relative probability and its direct economic costs.

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5 Abdalla, A. et al. (2005), *Foot and Mouth Disease: Evaluating alternatives for controlling a possible outbreak in Australia*, ABARE eReport 05.6, April.

Table B6 **Expected cost of a FMD outbreak in Australia with and without AAHL (in present value terms over 10 years)**

Type of outbreak	Relative probability	Direct economic costs	Expected direct economic costs
With AAHL (vaccine and timely disease detection)			
Severe outbreak	0.00	$49.62	$0.00 billion
Composite small outbreak	1.00	$5.82	$5.82 billion
Aggregate			**$5.82 billion**
Without AAHL			
Severe outbreak	0.93	$52.21	$48.56 billion
Composite small outbreak	0.07	$5.82	$0.41 billion
Aggregate			**$48.96 billion**

Source: ACIL Allen Consulting

AAHL helps reduce the expected costs of a FMD outbreak in Australia by $43.14 billion

ACIL Allen's analysis suggests that the presence of AAHL helps reduce the expected total direct economic costs of a FMD outbreak in Australia by $43.14 billion in present value terms over 10 years, from $48.96 billion without the AAHL to $5.82 billion with AAHL. It does so by preventing a small outbreak from becoming a severe one.

It is difficult to estimate the probability of an FMD outbreak occurring in Australia – minor outbreaks are believed to have occurred in 1801, 1804, 1871 and 1872. CSIRO estimates that likelihood of an outbreak in any given year is currently in the order of 1 in 50 years (that is, a probability of 2 per cent), due to an increase in international travel, selective (rather than 100 per cent) testing of luggage at custom checkpoints and the threat of bioterrorism.

While AAHL is an important link in the Australia-wide FMD surveillance system, it also plays a critical role in ensuring an effective national response once an outbreak has occurred. Assuming a 2 per cent annual probability of a FMD outbreak and that AAHL contributes 50 per cent to the effectiveness of the FMD surveillance system once an outbreak has occurred, ACIL Allen estimates that AAHL's benefits (its "insurance value") in relation to FMD is approximately $431 million a year.

Sensitivity analysis

As there is considerable uncertainty about the probability of a FMD outbreak in Australia in any given year and about the magnitude of AAHL's contribution to the national disease surveillance system, sensitivity analysis has been undertaken to assess the impact of these uncertainties on the estimate of AAHL's benefits in relation to FMD. The results of this analysis are shown in Table B7.

Table B7 **Estimate of AAHL's annual benefits in relation to FMD under alternative assumptions**

Contribution of AAHL to effectiveness of national animal disease surveillance system	FMD outbreak probability = 0.01	FMB Outbreak probability = 0.04	FMB Outbreak probability = 0.04
AAHL contribution = 25%	$108 million	$216 million	$431 million
AAHL contribution = 50%	$216 million	$431 million	$863 million
AAHL contribution = 75%	$324 million	$647 million	$1,294 million

Source: ACIL Allen Consulting

It could be argued that an effective FMD vaccine would be made available in Australia even in the absence of AAHL. Table B8 shows the impact of AAHL's disease surveillance activities (but not its vaccine-related activities) on the economic impact of a FMD outbreak in Australia.

Table B8 **Expected cost of a FMD outbreak in Australia with and without AAHL – no vaccine (in present value terms over 10 years)**

Type of outbreak	Relative probability	Direct economic costs	Expected direct economic costs
With AAHL (timely disease detection)			
Severe outbreak	0.19	$52.21	$9.92 billion
Composite small outbreak	0.81	$5.82	$4.71 billion
Aggregate			**$14.63 billion**
Without AAHL			
Severe outbreak	0.93	$52.21	$48.56 billion
Composite small outbreak	0.07	$5.82	$0.41 billion
Aggregate			**$48.96 billion**

Source: ACIL Allen Consulting

ACIL Allen's analysis shows that AAHL's contribution to the national disease surveillance system helps reduce the expected direct economic costs of a FMD outbreak in Australia by $34.33 billion in present value terms over 10 years, from $48.96 billion without AAHL to $14.63 billion with AAHL.

The annual insurance value of FMD surveillance alone is very large.

If the probability of an outbreak in any given year is again assumed to be 0.02 and that AAHL contributes 50 per cent to the effectiveness of the Australia-wide FMD response system in the event of an outbreak, then AAHL's benefits (its "insurance value") in relation to FMD due to its role in animal disease surveillance alone is estimated to be approximately $343 million per annum.

These results suggest that AAHL's disease surveillance and response activities accounts for approximately 80 per cent of its "insurance value" against FMD, with its vaccine-related activities accounting for the remaining 20 per cent.

The insurance value of AAHL's non-FMD work is likely to also be considerable

We were also able to obtain some information about the financial implications of some of the other diseases being studied at AAHL. While the information was not of the same quality as for FMD it does provide a good indication that the insurance values associated with other work at AAHL may be considerable. That information is discussed below.

Hendra virus

Since the discovery of the Hendra virus in 1994, there have been 50 outbreaks with 4 human fatalities (out of 7 infected). More than 80 horses have succumbed to the disease or were put down as a result of it.

Over 200,000 doses of Equivac® vaccine have been used to date

The Equivac® vaccine against the Hendra virus is a world first – it is the first commercial vaccine for a Biosafety Level 4 disease agent. Since the launch of the vaccine, more than 200,000 doses of vaccine have been administered to horses. Decreasing the incidence of Hendra virus outbreaks reduces the opportunity for variant strains or mutations that could be more transmissible or lethal to emerge. AAHL is contributing to reduce the likelihood of an outbreak and to ensuring that, should one occur, its spread would be limited by the presence of vaccinated animals.

An outbreak of Hendra could have severe consequences for the horse racing industry

A major outbreak of Hendra virus could have severe consequences for the horse racing industry in Australia, making it unlikely that Australian horses could participate in events overseas, severely damaging the horse breeding industry and adversely impact on equestrian activities.

The estimated value of the racing industry was more than $6.2 billion per annum (Gordon, 2001) or more than $8 billion if volunteer labour was included.[6] A report by consulting firm IER for Racing Victoria estimated that the 2011 Melbourne Spring Racing Carnival drew a total of 78,400 out-of-state visitors to Victoria and contributed $210.37 million to Victoria's Gross State Product.

Another example of potential costs to the horse industry from disease can be found from the equine influenza outbreak in 2007. Modelling carried out by the Australian Bureau of Agricultural and Resource Economics estimated that the costs resulting from the equine influenza outbreak during the period of the initial response, involving containment and eradication through restricted movement, reached $560,000 a day for disease control and $3.35 million a day in forgone income in equine businesses, including racing, farming and recreational enterprises (Callinan, 2009).

Avian influenza

Brahmbhatt (2005) has examined the socio-economic impacts and costs of avian flu and of a potential human influenza pandemic. He has identified two distinct but closely linked levels of potential impacts and costs: animal-to-animal, and limited animal-to-human transmission of the H5N1 avian flu virus which, he predicted would increases the probability of a second stage, with human-to-human transmission and a global influenza pandemic, with enormously greater costs. Animal and human health considerations are closely linked.

Two types of economic costs arising from this were identified: the cost of increased illness and death among humans and animals, and the cost of the preventive, control and coping strategies adopted by the public and private sectors to avoid or reduce illness and death.

Brahmbhatt considered that the priority should be curbing the disease "at source", in the agricultural sector, thereby reducing the probability of a human epidemic. He noted that there are great uncertainties about the timing, virulence, and general scope of a future pandemic. The Spanish flu of 1918-19 killed 50 million, which today would translate to 150 million deaths, which, while an extreme scenario, gives an indication of the huge potential costs in a worst case scenario.

Brahmbhatt drew on experience during SARS, when people tried to avoid infection by minimizing face-to-face interactions, resulting in a severe demand shock for services sectors such as tourism, mass transportation, retail sales, hotels and restaurants, as well as a supply shock due to workplace absenteeism, disruption of production processes and shifts to more costly procedures. This led to an immediate economic loss estimated at 2 per cent of East Asian regional GDP in the second quarter of 2003, even though only about 800 people ultimately died from SARS. A two per cent loss of global GDP during a global influenza pandemic would represent around $200 billion in just one quarter (or $800 billion over a whole year), and it was considered likely that the immediate shock during a flu epidemic would be even larger than in SARS.

A 1999 study of the United States calculated that, based on past patterns, a flu pandemic could lead to between 100,000 and 200,000 deaths in the USA, together with 700,000 or more hospitalizations, up to 40 million outpatient visits and 50 million additional illnesses. The 2004 value of the economic losses associated with this level of death and sickness was estimated at between $100 and $200 billion for the USA alone. Extrapolating from the USA to all high income countries, there could be a loss of $550 billion (in 2004 dollars).

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6 $6.2 billion (2004) is equivalent to $8.15 billion in 2014.

Economic costs that need to be considered include direct costs such as losses of poultry due to the disease and to culling, with impacts extending not only to farmers but also to upstream and downstream sectors such as poultry traders, feed mills, breeding farms etc. For an economy like Indonesia these direct costs would have been about $500 million (2004 dollars). Secondary or indirect economic costs could also arise, for example, from a fall in international tourism. In addition, the costs of prevention and control also need to be taken into account, including costs to the government of purchase of poultry vaccines, medications and other inputs, hiring workers for culling and clean-up, surveillance and diagnosis, hire of transportation etc. Governments may also face the need to pay compensation to poultry owners.

A medium level pandemic could reduce Australia's GDP by over $115 billion

Two studies from 2006 estimated that a severe global influenza pandemic would reduce Australia's GDP by approximately 10 per cent for a year (McKibbin and Sidorenko, 2006 and Kennedy *et al*., 2006). An ABARE study from the same year estimated that a medium level pandemic in Australia and globally would reduce Australia's GDP by 6.8 per cent for a year (ABARE, 2006). This means that were an influenza pandemic to occur in the near future, Australia's GDP would be reduced by $115.6-170 billion from current GDP of approximately $1.7 trillion.

B.4.4 Impact pathway diagram

Figure B1 presents the impact evaluation framework diagram for CSIRO/AAHL's work on animal health.

Figure B1 **AAHL – impact**

INPUTS

Funding from:
- CSIRO
- the Commonwealth Department of Agriculture
- NCRIS
- The Intergovernmental Hendra Virus Taskforce
- External partners.

ACTIVITIES

- Preparedness for Foot and Mouth diease
- Research on the Hendra virus
- Research into insect borne diseases
- Research into aquatic animal diseases
- Testing of samples and detection of diseases
- Research into avian influenza
- Research into Middle East Respiratory Syndrome (MERS) and other emerging zoonotic diseases

OUTPUTS

- Facitities and management arrangements in place in the event of an outbreak of Foot and Mouth and other significant diseases.
- Better public health preparedness
- A vaccine for Hendra Virus
- Diagnostic testing services
- Better targeted influenza vaccines
- Animal models for testing human treatments
- New vaccines created

OUTCOMES

- Neighbouring countries better equipped to manage FMD
- Outbreaks of Hendra Virus have been managed
- Improved diagnostic testing
- Greater confidence in agricultural industry
- Rapid implementation of appropriate disease control strategies
- Improved health outcomes

IMPACTS

- Improved biodiversity
- Costs would be reduced if there were an outbreak of Foot and Mouth or other significant diseases
- Costs and loss of life have been minimised through the use of the Equivac vaccine
- More reliable livestock trade industry
- More reliable farm income streams

Source: ACIL Allen Consulting

B.5 References

ABARE, (2006). *Avian Influenza: Potential Economic Impact of a Pandemic on Australia*, Australian Commodities, June Quarter issue, 2006.

ABARES, 2013a, Agricultural commodity statistics 2013, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra.

ABARES, 2013b, Australian Fisheries Statistocs 2012, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra.

Abdalla A, G Rodriguez and A Heaney, 2000, *The economic value of animal disease control measures in Australia*, ABARE Conference Paper 2000.27.

Abdalla A, S Beare, L Cao, G Garner and A Heaney, 2005, *Foot and mouth disease: Evaluating alternatives for controlling a possible outbreak in Australia*, ABARE eReport 05.6, April 2005.

ACIL Tasman, 2006, *Assessment of the Australian Animal Health Laboratory, prepared as an input into CSIRO's Lapsing Program Review*, October 2006.

Animal Health Australia, 2014. *Animal health in Australia 2013*, Animal Health Australia, Canberra.

AHA, 2014, available online: <http://www.animalhealthaustralia.com.au/programs/emergency-animal-disease-preparedness/ausvetplan/fmd-response-policy-review/fmd-faqs/>, accessed September 2014

AM, 2014, available online: <http://australianmuseum.net.au/2014-Winners-Eureka-Prizes>, accessed October 2014.

Beale R, J Fairbrother, A Inglis and D Trebeck, 2008, *One Biosecurity: a working partnership*, report of the Quarantine and Biosecurity Review Panel, Canberra, October 2008.

Brahmbhatt, M, 2005, Avian Influenza: Economic and Social Impacts, an address by the World Bank Lead Economist for East Asia and the Pacific, Washington DC, September 23, 2005. A summary can be accessed at <http://web.worldbank.org/WBSITE/EXTERNAL/NEWS/0,,contentMDK:20663668~pagePK:34370~piPK:42770~theSitePK:4607,00.html>

Buetre B, S Wicks, H Kruger, N Millist, A Yainshet, G Garner, A Duncan, A Abdalla, C Trestrail, M Hyatt, L-J Thompson and M Symes, 2013, *Potential socio-economic impacts of an outbreak of foot-and-mouth disease in Australia*, ABARES Research report 13.11, October 2013, available online: <http://data.daff.gov.au/data/warehouse/research_reports/9aab/2013/RR13.11PotSocEcoImpctOfFMD/RR13.11PotSocEcoImpctOfFMD_v1.0.0.pdf>

Callinan I, 2008, *Equine influenza: The August 2007 outbreak in Australia*, April 2008

Centres for Disease Control and Prevention (CDC), 2014, *Middle East Respiratory Syndrome (MERS)*, available online: < http://www.cdc.gov/CORONAVIRUS/MERS/>, accessed 26 August 2014

Centre for International Economics (CIE), 2010, *NLIS (sheep and goats) business plan: the costs of full compliance with NLTPS*, Canberra.

Chang HS, CC Hsia and G Griffith, 2006, The FMD outbreak in the Taiwanese pig industry and the demand for beef imports into Taiwan, Australasian Agribusiness Review, 14, paper no. 15.

CSIRO undated, *CSIRO – Host pathogen interactions*, available online: <http://www.csiro.au/Organisation-Structure/National-Facilities/AAHL/Research/Host-pathogen-interactions.aspx>, accessed 13 August 2014

CSIRO undated, *Hendra virus vaccine*, available online: <http://www.csiro.au/Outcomes/Food-and-Agriculture/Hendra-Virus.aspx> accessed on 13 August 2014

Deards, B, R Leith, C Mifsud, C Murray, P Martin and T Gleeson, 2014, *Live export trade assessment*, ABARE report prepared for the Live Animal Exports Reform Taskforce, Canberra.

Department of Health and Ageing, 2009, *Australian Health Management Plan for Pandemic Influenza*, Canberra

Department of Primary Industry (NSW) *Avian Influenza* 10 January 2014 update, available online: <http://www.dpi.nsw.gov.au/agriculture/livestock/poultry/health-disease/avian-influenza>

Food and Agriculture Organisation (FAO), 2006, *Impacts of animal disease outbreaks on livestock markets*, paper presented at the 21st Session of the Inter-Governmental Group on Meat and Dairy Products, Rome, November 2006.

Gordon, J, 2001, *The Horse Industry: Contributing to the Australian economy*, a CIE report to the Rural Industries Research and Development Corporation

Kennedy *et al*., 2006, Kennedy, Steven, Jim Thomson and Petar Vujanovic. *A Primer on the Macroeocnomic Effects of an Influenza Pandemic*, Treasury Working Paper 2006-01, February (2006).

McKibbin, W J and Alexandra A S, 2006, *Global Macroeconomic Consequences of Pandemic Influenza*, Lowy Institute of International Policy, February 2006.

Matthews, K, 2011, *A review of Australia's preparedness for the threat of foot-and-mouth disease*, report to the Department of Agriculture, Fisheries and Forestry, Canberra October 2011.

Productivity Commission, 2002, *Impact of foot and mouth disease outbreaks on Australia*, Canberra.

Rich, K M, 2004, *Animal diseases and the cost of compliance with international standards and export markets: the experience of foot-and-mouth disease in the Southern Cone*, agriculture and rural development discussion paper, World Bank, Washington DC.

RIRDC, 2014, *Emerging animal and plant industries: Their value to Australia* September 2014, RIRDC Publication No. 14/069.