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Risk Management of Outbreaks of Livestock Diseases

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Comments are welcome and may be sent to tad.contact@oecd.org.

Abstract

RISK MANAGEMENT OF OUTBREAKS OF LIVESTOCK DISEASES

Livestock diseases can severely harm animal and human health, and have adverse economic impacts on producer incomes, markets, trade, and consumers. This paper develops a common framework to improve information on public actions and policies to manage outbreaks of livestock diseases across countries. The main aim is to facilitate the assessment of the effectiveness and efficiency of different policy responses to disease outbreaks. A pilot database covering four livestock diseases (avian influenza, bovine spongiform encephalopathy, classical swine fever, and foot and mouth disease) in nine countries (Canada, Denmark, France, Germany, Hungary, Japan, Mexico, the Netherlands, and the United Kingdom) was constructed. It combines three layers of data: epidemiological factors; government control and compensation measures; and economic impacts of disease outbreaks. Policy responses to outbreaks were reviewed based on the information generated from the data analysis. The results show that government expenditures to destroy pathogens via slaughter and compensation policy measures were very expensive, especially in the case of large or prolonged outbreaks, and that measures compensating financial losses at the farm level generated the highest share of government expenditures in the short run.

Keywords: Agricultural policy, risk management, animal health, livestock disease, outbreak

JEL classification: Q18

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Acronyms

AI	Avian Influenza
APM	Agricultural Policies and Markets
BSE	Bovine Spongiform Encephalopathy
CSE	Consumer Support Estimate
CSF	Classical Swine Fever
FAO	Food and Agriculture Organization of the United Nations
FMD	Foot and Mouth Disease
GSSE	General Services Support Estimate
HPAI	Highly Pathogenic Avian Influenza
IMS	Information Management System
LU	Livestock Unit
OECD	Organisation for Economic Co-operation and Development
OIE	World Organisation for Animal Health (*Office International des Epizooties*)
PSE	Producer Support Estimate
PVS	Performance of Veterinary Services
PVS Tool	Tool for the Evaluation of Performance of Veterinary Services
SAGARPA	Ministry of Agriculture, Livestock, Rural Development, Fishing and Food of Mexico (Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación)
SENASICA	National Agro-Alimentary Health, Safety and Quality Service (Servicio Nacional de Sanidad, Inocuidad Y Calidad Agroalimentaria)
SPS	Sanitary and Phytosanitary Measures
TSE	Total Support Estimate
VLU	Veterinary Livestock Unit
WAHID	World Animal Health Information Database
WTO	World Trade Organization

Countries

AUS	Australia
CAN	Canada
CHL	Chile
DEU	Germany
DNK	Denmark
FRA	France
GBR	United Kingdom
HUN	Hungary
ISL	Iceland
ISR	Israel
JPN	Japan
KOR	Korea
MEX	Mexico
NLD	Netherlands
NZL	New Zealand
NOR	Norway
TUR	Turkey
USA	United States

Currencies

AUD	Australian dollar
CAD	Canadian dollar
CLP	Chilean peso
EUR	Euro
GBP	Great Britain pound
ILS	Israeli shekel
ISK	Icelandic krona
JPY	Japanese yen
KRW	Korean wong
MXN	Mexican peso
NZD	New Zealand dollar
NOK	Norwegian krone
TRY	New Turkish lira
USD	United States dollar

Executive summary

This report develops a common framework to improve information on policies for managing outbreaks of livestock diseases with the aim of assessing the effectiveness and efficiency of different policy responses to outbreaks.

A pilot database of four diseases (avian influenza, bovine spongiform encephalopathy, classical swine fever, and foot and mouth disease) has been constructed to validate the framework. The database, which combines three layers of information on epidemiological factors, control and compensation measures, and economic impacts, forms the basis of the review of policy measures for responding to outbreaks.

This policy review shows that government expenditures for the removal of pathogens using slaughter and compensation policy measures can be very expensive especially in the case of large or prolonged outbreaks. Measures to compensate financial losses at the farm level are the most important part of government expenditures in the short run. These expenditures can be very high, depending on the valuation of the animals destroyed and on the specific cost-sharing schemes used. Where follow-up costs are incurred they further increase government expenditures. Very little is known about the economic impacts of outbreaks on different sectors of the economy. The size of market losses following disease outbreaks depends on the countries' trade profile. Net exporting countries face larger and more prolonged financial impacts than importing countries.

As part of this work, challenges and opportunities of cross-country policy comparisons were identified. Data availability on economic implications of outbreaks and on economic impacts on different sectors of the economy, which are extremely limited and considerable differences between studies, remain as a continuing challenge for the scope of further analysis. For more effective and efficient disease control, governments need to consider broader and longer-term impacts that go beyond the immediate crisis management. Comparative policy analysis to learn from experience across countries and integrating economic analysis can help to improve policy responses.

The review shows that a database that combines the information in different layers would allow for a better review of policies and outcomes from past outbreaks across diseases and countries. It is concluded that the framework provides a basis for future data collection and analyses of the public actions and policies for outbreaks of livestock diseases.

1. Introduction

At the OECD international conference on "Livestock Disease Policies: Building Bridges between Animal Sciences and Economics", 3-4 June 2013,[1] experts and policy makers from different countries and international organizations shared analyses and experiences on dealing with livestock disease outbreaks. The lack of internationally comparable methods and datasets on animal health control policies and measures and their economic implications (including costs) was raised as an obstacle to designing more effective and efficient policy responses. Against this background, the objective of the study is to classify information on outbreaks into different layers (epidemiological, policy responses, and economic impacts) aiming to improve our understanding of disease outbreaks for better response, and to create frameworks capturing disease outbreaks in the future.

The OECD has been engaged in studying risk management in agriculture for several years. The OECD analysis identifies three layers of farmers' risk: normal risk, marketable risk, and catastrophic risk (OECD, 2009). The work calls for a holistic approach to risk management, focusing on the interactions between strategies undertaken by farmers, and the whole set of government policies that impact on risk management. In 2011, OECD commissioned a study on livestock diseases as part of its risk management project. The report focused on government policies relating to livestock diseases prevention, control and compensation schemes (OECD, 2012). However, these past studies did not cover some important issues such as analysing different policy responses across livestock disease outbreaks and countries. Learning from past experiences in a consistent and comparable manner is necessary to better understand and manage the risk associated with contagious livestock diseases.

This report responds to the needs identified at the conference, and fits well with the main conclusion of the risk management work: policy should focus on catastrophic risks and it should be based on rigorous risk assessment and comparative analysis of policy experiences. A database on outbreaks and policy responses and economic impacts by different diseases and countries will add transparency and improve the comparability of experiences and common understanding of policy intervention. This research complements the existing World Animal Health Information Database (WAHID) of the World Organisation for Animal Health (OIE), by including policy and economic information, and supports ongoing initiatives such as Star-IDAZ,[2] DISCONTOOLS[3] and the World Bank's work on disease impacts (World Bank et al., 2011) as well as the ongoing initiatives of the Food and Agricultural Organization of the United Nations (FAO), and the World Organisation for Animal Health (OIE) on developing the guidelines for socio-economic impact assessment of the Progressive Control Pathway for Foot and Mouth Disease.

1. The programme of the conference on livestock disease policies is available on the meeting website together with material presented at the meeting (http://www.oecd.org/tad/agricultural-policies/livestock-diseases-2013.htm).

2. STAR-IDAZ (http://www.star-idaz.net). An EU funded project that aims to establish a sustainable network to exchange research information on priority diseases and includes a process of disease prioritization albeit with limited use of economics and economic data.

3. DISCONTOOLS (http://www.discontools.eu). An initiative linking the public sector and industry and funded by the EU to establish web-based information on the major diseases including aspects of their economic impact.

Why manage risk of livestock diseases?

Livestock diseases can severely harm animal health as well as human health, and also have adverse economic impacts through their effects on producer incomes, markets, trade, and consumers. The control of animal diseases is required to invest in animal production and to reduce different economic impacts due to livestock diseases: loss of capital (mortality); reduction in the level of marketable outputs; reduction in (perceived or actual) output quality; productivity loss, including through higher level of input use; resource costs associated with disease prevention and control; human health costs associated with diseases (zoonoses) or disease control; negative animal welfare impacts (i.e. animal suffering) associated with disease; international trade restrictions due to disease and its control; and a range of other impacts such as loss of revenue from input suppliers and effects on rural economies, tourism, and the environment (OECD, 2012).

Livestock diseases such as avian influenza (AI), bovine spongiform encephalopathy (BSE), classical swine fever (CSF), and foot and mouth disease (FMD) have had the most significant impacts in OECD countries in recent years, and these impacts can vary substantially across diseases and sectors. The typical response to an exotic disease in countries that are free from outbreaks is to cull infected and potentially contagious animals. As large-scale production expands and is more geographically concentrated, the extent of such interventions could be increased particularly in the region where livestock production is concentrated (Box 1).

Box 1. Mexico's response to outbreaks of Highly Pathogenic Avian Influenza in 2012

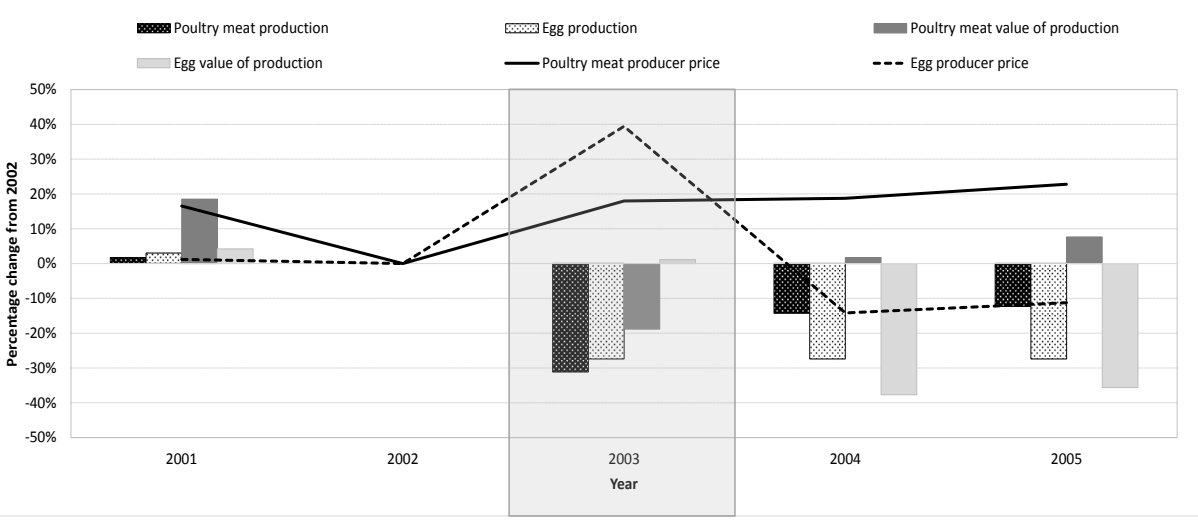
Highly Pathogenic Avian Influenza (HPAI) was reported in the eastern part of the Mexican state of Jalisco (Los Altos), between June and September 2012. Before the outbreak was eradicated in November, twenty-two million birds were culled in the state where more than 40% of national production volume was produced in 2011. During the outbreaks, a set of measures such as prevention and control, and compensations was implemented by the National Agro-Alimentary Health, Safety and Quality Service (SENASICA). SENASICA is responsible for regulating animal health issues under the Ministry of Agriculture, Livestock, Rural Development, Fishing and Food (SAGARPA). Since 2011, SENASICA has implemented the *Prevention and Risk Management Program* to support agricultural producers from outbreaks and natural disasters. While the programme covers preventive measures in broad areas, including animal, plant, and fisheries and aquaculture in general, though not specifically adapted to animal and the outbreaks, the programme applied to animal health includes various activities such as campaigns on animal health, epidemiological surveillance, and training for farmers. Budgets for SENASICA in 2013 and 2014 were MXN 974.4 million (USD 76.3 million) and MXN 1 004.2 million (USD 76.1 million) respectively; however the amount allocated to each activity of the programme is unknown. The outbreaks resulted in the implementation of emergency response programmes (the National Device for Animal Health Emergencies "DINESA") by SENASICA to control diseases and to protect livestock and public health. The duration of the programme was six months and various control measures were provided during the outbreaks. The measures of this programme were: (i) education on animal health for poultry farmers, individuals, and companies in the area of outbreaks; (ii) movement control of birds and their products and by-products as well as other animal species risking poultry farming; (iii) zoning; (iv) disposal of birds, their products and by-products; (v) immunization to protect and prevent the spread of the disease; (vi) quarantine; (vii) diagnosis and identification of virus; (viii) disinfection; (ix) culling of birds; (x) stamping out of infected birds; and (xi) epidemiological monitoring. Similar to the prevention measures, the total cost of control measures spent for the outbreaks is unknown. Compensations were provided to farmers for several control measures such as stamping out and disposal of birds. The total of

MXN 200 million (USD 15 million) was compensated to producers from the joint fund of the Ministry, the State of Jalisco, and the National Poultry Farmers Union. The Government also removed a tariff of 45% for imports and imposed a tariff quota for 211 000 tons of eggs for human consumption in order to make up a loss in the domestic production caused by the outbreaks. In August 2012, economic impacts from 2012 HPAI event in Mexico were estimated by GEA (Economists and Associates Group) using data from the National Union of Poultry Farmers. The study estimated economic impacts on: production losses; the sector and wider economy; producers; consumers; and jobs. According to the scenario, a loss of 20 million birds, the highest economic impact was on the consumers, which was MXN 16 billion (USD 1.2 billion) due to an increase in the price. Estimated producer losses were MXN 5.8 billion (USD 433 million) and losses to the sector and wider economy were 2.8 billion (USD 205 million). In October 2012, the National Poultry Farmers Union informed that the economic impacts from the HPAI event in Mexico were around MXN 10 billion (USD 760 million) for the sector. These estimates, however, did not take into account the impacts caused by international trade restrictions due to disease such as temporary imports ban by several countries. The temporary ban was notified to the Committee on Sanitary and Phytosanitary Measures at WTO in 2012. In 2013, a new event was reported in the same region. The outbreak has not yet been eradicated and there have been a further 64 outbreaks reported to date.

*Source*s: Ministry of Agriculture, Livestock, Rural Development, Fishing and Food of Mexico, Ministry of Finance and Public Credit, Economists and Associates Group (2012) and National Council of Evaluation for Policy Development (CONEVAL).

These outbreaks can impose significant effects on production, price and value of livestock products domestically. One example of such effects is the change in the production, the price and the value of poultry meat and eggs in the Netherlands in 2003. This was caused by the culling of over 30 million birds due to an AI outbreak. The changes of meat and egg outputs from the previous year were reported at: -31% and -27% for production volume; +18% and +39% for price; and -19% and +1% for production value, respectively (Figure 1).

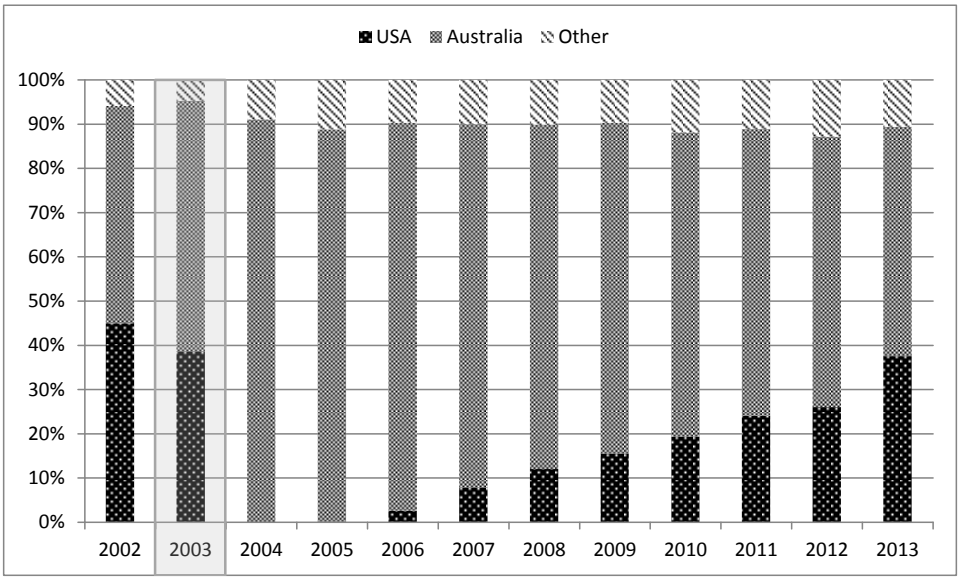
Figure 1. Change in the poultry meat and egg production of the Netherlands (from 2002)



Source: OECD (2014), "Producer and Consumer Support Estimates", OECD Agriculture Statistics Database, http://dx.doi.org/10.1787/agr-pcse-data-en.

International trade with existing trade partners is negatively affected by a disease outbreak, while competing suppliers may benefit by gaining market share (Junker *et al*., 2009). Loss of export revenues can be particularly serious for net export countries, particularly if the export is the main source of income for the livestock sector (OECD/FAO, 2011). Regaining market share after trade bans are imposed by trading partners is difficult, and in some cases export markets may not entirely recover (Johnson and Stone, 2011). A single outbreak of a livestock disease in an exporting country can lead to long-term changes in market shares because importers explore new sources for the products. For example, an outbreak of BSE in the United States in 2003 led Japan to suspend US beef imports and gave Australia an opportunity to gain a market share on the Japanese beef market. The share of US beef in the Japanese market continues to recover but it remains below the pre-outbreak level (Figure 2).

Figure 2. Change in the imported beef market share of Japan (by fiscal year)



Source: Trade Statistics of Japan.

The need for cross country comparisons

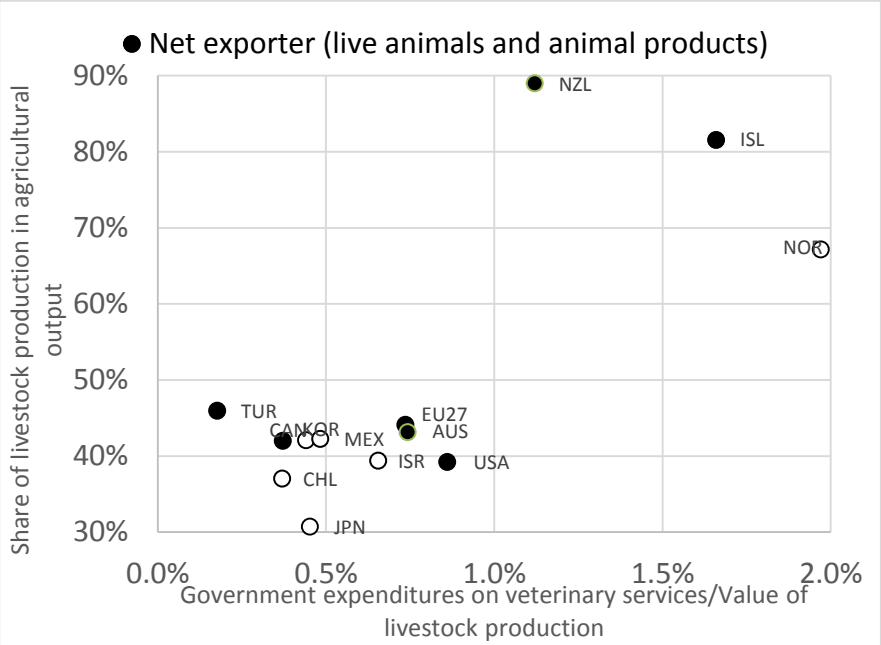
The impacts of diseases can be costly in the long term, and cross national borders. "International organisations like the OIE, FAO, the World Health Organization (WHO), and the World Trade Organization (WTO) have developed standards, codes, guidelines, recommendations and programmes designed to enhance international co-operation for efficient disease management", (OECD,2013). At the same time, many countries have implemented eradication and control programmes to combat outbreaks and prevent the reintroduction of contagious diseases. These programmes vary across countries and are often grounded in legal provisions that focus on prevention.

Governments generally implement two sets of policy measures: prevention and control, and compensation (OECD, 2013). In order to illustrate the policy measures applied in OECD countries for control of diseases, information on relevant veterinary measures contained in OECD Producer Support Estimate (PSE) and the General Services Support Estimate (GSSE) database was extracted (Annex 1). In general, on-farm services, such as those related to diseases eradication and compensation are reported under the Producer Support Estimate category B3 (payments based on on-farm services), while off-farm services, such as pest and disease control measures and public

funding of veterinary and phytosanitary services (for the farming sector) are reported under category I2 (pest and disease inspection and control).

While these measures tend to cover broad areas, both animal and plant, information regarding these measures and their total cost in each country, as well as the percentages of this spending relative to total support and the value of livestock production are useful to understand the policy context in OECD countries. Variance in relative importance of this spending is seen across countries, seen from country trade profiles and characteristics of the agricultural sector. For instance, the percentage of budget transfers for veterinary services to livestock production value is less than 1% in many countries, but fluctuates within this limit from one country to another (Figure 3). Similarly, the ratio of these expenditures to the Total Support Estimate (TSE) is generally less than 3% (New Zealand (33%) and Australia (7%) are the only exceptions), but varies significantly across the countries (Annex 2).

Figure 3. Government expenditures on veterinary services (2011-13)



Source: OECD (2014), "Producer and Consumer Support Estimates", OECD Agriculture Statistics Database, http://dx.doi.org/10.1787/agr-pcse-data-en; and UN Comtrade Database.

Government expenditures during a crisis period vary across countries depending on the type of disease, the disease management timeline, and the size of the outbreak and its duration. The efficient management of livestock diseases is a complex issue. While higher spending on control can be expected to lead to lower disease losses, a more relevant question for policy-makers is how to minimise impacts and at what cost; in other words, how to best design cost-effective policies. Yet disease outbreak policy measures differ across countries, and little is known about their economic implications and efficiency. There is a general lack of broad cross-country comparisons.

The cross-country comparison of policy responses for outbreaks during a crisis period is difficult because of the diversity of diseases, differences in their epidemiology, variety of policy measures, and their economic implications. To overcome this, different types of information that take epidemiological factors as well as economic analysis into account are necessary. Learning from past experiences in a consistent and comparable manner is a way to better understand and manage risk

associated with contagious livestock diseases. Finding these opportunities, however, requires a framework to understand the pattern and scale of livestock diseases, policy responses, and economic implications across outbreaks and countries.

2. The framework for information on outbreaks of livestock diseases

This section discusses the framework for the database on outbreaks and policy measures. Three different layers of information are identified: epidemiology; policy measures; and economic impacts. A list of variables has been developed for each layer in order to identify data that can be useful for cross-country policy analysis (Annex 4).

Layer 1: Epidemiology

Variables for layer 1 have been developed to compare epidemiology of different outbreaks in different countries. These variables have been classified into three sub-groups: (i) epidemiological evidence from outbreaks; (ii) veterinary control measures implemented by governments; and (iii) contextual information on livestock sectors and veterinary systems at national level. These variables have been primarily developed based on the existing database, the OIE World Animal Health Information Database (WAHID), which provides the most comprehensive information on epidemiological data on outbreaks and contextual information on livestock.

Selection of diseases and countries

One of the problems in compiling the data for outbreaks of livestock diseases is the existence of many diseases, their epidemiological difference, and data availability. While the choice of diseases for the study is very important as government responses can be different by disease, the work focuses on the four major diseases; Foot and mouth disease (FMD), Bovine spongiform encephalopathy (BSE), Classical swine fever (CSF), and Avian influenza (AI). These are notifiable diseases reported to the OIE having different characteristics which justifies their inclusion in the database.

FMD is the most contagious animal disease and can affect cattle, pigs, sheep, goats, buffaloes, and many other species of cloven-hoofed wildlife. It causes severe production losses and thus has a significant economic impact. There is some evidence that infection in wildlife populations makes the control of this disease problematic in a number of developing countries. Most OECD members are free of FMD yet are under the risk of the disease through trade and people movements. This poses a major obstacle to the global trade in live animals and animal products (Knight-Jones and Rushton, 2013). Compared to FMD, CSF is limited to swine (pigs and wild boars), but is one of the most important viral diseases with significant impact on international trade. Similar to FMD, the existence of susceptible wildlife populations makes the eradication of the disease difficult, and CSF is found in some developed countries. While the scope of these two diseases is limited to animals or the livestock sector, BSE and AI add a dimension of the potential impacts on human health.

OIE database on epidemiological data

The pattern and scale of each outbreak varies, and therefore it is important to capture the epidemiology of each outbreak, such as location (country and year), date (start of the event and event resolved) and affected animals (species and number of animals destroyed). The information regarding different control measures (e.g. vaccination) is also important to understand how the societal and human reactions shape the outbreak and in some respects constrain disease spread. Therefore, it is necessary to have contextual information on livestock sectors and veterinary systems such as the number of farms, animals and veterinarians, and the import and export volume or the

value of live animals and animal products for assessing subsequent policy responses to complement epidemiological evidence.

Data on epidemiological evidence and contextual information are publicly available in the OIE WAHID database and the OIE portal as well as government websites. The OIE WAHID is the most comprehensive database containing information on outbreaks. The database is maintained based on the notifications by OIE members, who are committed to notify the OIE of diseases, infections and any other significant epidemiological event, including immediate notifications, weekly follow-up reports, six-monthly reports, and annual reports, stating the health status of OIE-listed diseases (e.g. FMD), (OIE, 2014). One of the main characteristics of the OIE WAHID is that epidemiological information on each outbreak such as the date of the first outbreak, number of outbreaks, report date, species and number of animals are reported in a comparable manner. The database also provides information on general control measures of outbreaks for each outbreak. The standards of these measures designed to prevent and control livestock diseases are adopted at the OIE and are reference measures for countries. If different control measures are taken, they can be reported at the OIE WAHID for each outbreak. However, other than standard measures taken during an outbreak, the database does not provide details of measures actually taken and the expenditure for these measures for each case.

Layer 2: Policy responses

Variables for layer 2 have been developed to compare policy responses in different countries. These variables have been classified into three sub-groups: (i) control measures; and (ii) compensation measures; and (iii) trade measures imposed by trading partners. Government expenditures on control and compensation measures are classified into two groups with 14 categories. Grou 1 control measures contains nine categories: Stamping out; Quarantine; Movement control inside the country; Screening; Zoning; Disinfection of infected premises and establishments; Vaccination; Surveillance; and Other. Group 2 compensation measures contain a further five categories: Direct loss of culled animals; Operational support measure; Price support measure; Consumption measures; and Other. These variables have been collected from the available evaluation and audit reports in Canada (Agriculture and Agri-Food Canada, 2011), Japan (Sugiura et al., 2001; and Miyazaki Prefecture, 2012), and the United Kingdom (NAO, 2002). The control measures from the OIE database described in layer 1 related to technical issues such as number of vaccines applied, and the number of animals slaughtered. Layer 2 collected specific information on the allocation of resources to achieve these technical outcomes, and in this particularly exercise is restricted to the actual government spending for the measures recorded. It is recognised that there are likely to be additional private costs and also changes in resource allocation across the sectors affected.

Country level information

Control measures aim at eradicating the disease as quickly as possible and can take various forms such as limiting the risk of any further spread of disease from premises through movement control; application of disinfection of infected premises; and continuing surveillance on the premises. In contrast, compensation measures aim to compensate farmers whose herds are affected by disease and are generally provided to compensate producer losses from the culled animals or to compensate the reduction of market price. As seen in the case of HPAI outbreaks in Mexico (Box 1), information on a set of measures responding to the outbreaks can be found at the national level of the respective country, and academic or government publications and reports. For example, budgetary and expenditure information on these measures, including regulations, and compensation

schemes to incentivise producers, veterinarians and other to take appropriate actions, are reported by the respective ministries (e.g. Ministry of Agriculture).

WTO database on trade measures

As access to international markets significantly affects policy responses at national level, it is necessary to have the information on trade measures imposed by countries or their trading partners. Data regarding trade measures, such as export restrictions or import bans and other trade restriction, are available at the World Trade Organization (WTO), as well as government publications and reports. The WTO Sanitary and Phytosanitary Measures Information Management System (SPS-IMS) provides access to documents and records relevant under the WTO Agreement on the Application of SPS (WTO, 1994). The database draws on the notifications provided by WTO members. One of the main characteristics of the WTO SPS-IMS is that trade measures, such as date of introduction, products covered, regions or countries likely to be affected and type of measure (e.g. suspension and lift of the suspension), are reported. However, beyond the information on trade measures, the database provides relatively little or no information on economic implications of outbreaks.

Layer 3: Economic impacts

Variables for layer 3 have been developed through collecting economic data to assess impacts from outbreaks. Economic impacts have been classified into three sub-groups: (i) production loss for livestock producers (ideally broken down in animals lost, meat, milk, egg and wool production reduction); (ii) control costs for government control and compensation measures (ideally separated into fixed and variable costs); (iii) sector and wider economy (impacts assessments on different sectors, both downstream and upstream industries, to capture consumer and producer surpluses, trade impacts and other ripple impacts in the economy). This classification has been built on a review of impact assessments of outbreaks in different studies (Table 1).

The number of studies on measuring the economic impacts of outbreaks is limited. While much time and skill is spent to predict the impacts of hypothetical outbreaks, little time is spent in examining the impacts of actual outbreaks. A majority of the available studies have been conducted as ex-ante studies which are based on hypothetical scenarios. In contrast, ex-post studies that examine the impacts of actual outbreaks are very few. While hypothetical scenarios are useful in their layout of the range of impacts and the increasing sophistication in the capture of farm-level and veterinary service aspects with the sector and wider economy aspects, they use a range of assumptions with a general trend that the more complex the models the more assumptions required.

When data are available, further complexity is also brought by the variety of definitions, scope, methodologies and activities to model the sector and the wider economy. Different terms such as "visible", "invisible", "direct", "indirect", and "consequential" are used for different types of costs. In sum, definitions, quantifications and measurements have not been standardised and this adds complexity. The lack of data and the lack of data comparability on economic impacts entail a great risk when comparing policy responses across countries and diseases. For instance, Saatkamp et al. (2014) developed a framework for the categorization of economic impacts of outbreaks, and identified four cost categories (virus control-related direct costs, spread prevention and zoning-related direct consequential costs, market and price disruption-related costs during (indirect consequential costs) and after the outbreak (aftermath costs). When the framework is used to review existing literature on cost estimation, it shows considerable differences across studies, which make the comparison of results difficult.

With this in mind, the classification of layer 3 has been built on a review of impact assessments for the selected diseases in order to include all available information for the selected diseases and countries. The classifications identify different sectors of the economy, starting with those that are at the core of the economic first incidence, livestock producers directly and indirectly affected by an outbreak. It expands the scope of analysis to other sectors in successive concentric areas to include the downstream sectors, other sectors and the public sector, including control and compensation costs. The data captured in the impact assessment classification described will provide a basis to examine a number of different levels of impact of different diseases. An accurate reporting of economic impact assessments based on the framework developed would allow more of an understanding of outbreaks, thus allowing better policy comparisons and analyses.

Table 1. Summary of the main studies reviewed

Reference	Disease	Country	*Ex ante ex post*	Impacts included		
				Production losses	Control costs	Sector and Wider economy
Berentsen et al., 1992	FMD	NLD	Ex ante	X	X (government)	PS, CS through sector models
Garner & Lack, 1995	FMD	AUS	Ex ante	X	X	Employment in the sector through sector models
Buetre et al., 2013	FMD	AUS	Ex ante	X	X	Sector and economy through sector and economy models
Paarlberg et al., 2008	FMD case study	USA	Ex ante	X		PS, CS, Trade through economy models
Longworth et al., 2012	HPAI	NLD	Ex ante	X	X includes consequential costs	Captures trade impacts
Longworth et al. 2007	HPAI	NLD	Ex ante	X	X	PS, CS through economy models
Mahul & Durand 2000	FMD	FRA	Ex ante	X	X	
Gohin & Rault, 2013	FMD	FRA	Ex ante	X		Labour and financial markets through economy models
Hubbard & Philippidis, 2001; Philippidis & Hubbard, 2005	BSE (plus 2001 FMD)	GBR	Mixed	X		Employment, prices, output through sector models
Mangen et al., 2004	CSF	NLD	Mixed	X	X	PS, CS through economy models
Thompson et al., 2002	FMD	GBR	Ex post	X	X	Downstream industries, Tourist sector through surveys
DTZ 1998	BSE	GBR	Ex post	X	X	Downstream sectors through surveys
Miyazaki Prefecture, 2012	FMD	JPN	Ex post	X	X	Downstream sectors

Key: X = inclusion; PS = Producer Surplus; CS = Consumer Surplus; FMD=Foot and Mouth Disease, HPAI=Highly Pathogenic Avian Influenza; BSE= Bovine Spongiform Encephalopathy; CSF=Classical Swine Fever.

The relationship between layers

The layers and associated variables have been developed from existing databases for epidemiological data (Layer 1), from government reports for policy measures (Layer 2), and from available studies and data for economic impacts (Layer 3). The variables differ from each other in terms of the nature of the information to be collected, the source of the data and the time dimension. Some variables are interrelated on the different layers: control measures in layers 1 and 2; compensation measures in layers 2 and 3; and trade measures in layers 2 and 3 are interrelated. In fact, most control measures in layer 1 have a counterpart in policy measures in layer 2, including how they are financed through the budget or through contributions from livestock growers or the industry. While most policy measures in layer 2 also have a counterpart in the economic implications for different groups in layer 3, trade measures in layer 2 also have a counterpart in the trade implications in layer 3. On the other hand, the time dimension is different among the layers. While layer 1 contains weekly or each outbreak basis data, layer 2 is based on data that is published annually or on an individual outbreak basis. Data and information for layer 3 is annual or each event basis data. In general the economic layer draws on the data around the biological aspects of the disease (layer 1) and the reaction to the presence of disease (layer 2), in essence it is a umbrella for the layers.

3. Pilot database

A pilot database of four major diseases (avian influenza, bovine spongiform encephalopathy, classical swine fever, and foot and mouth disease) in nine countries (Canada, Denmark, France, Germany, Hungary, Japan, Mexico, the Netherlands, and the United Kingdom) was constructed to validate the framework developed (Table 2). Separate paths for data collection for each layer were taken.

Table 2. List of selected countries and diseases

Foot and Mouth Disease (FMD)	Classical Swine Fever (CSF)
France	Hungary
Japan	Mexico
United Kingdom	
Bovine Spongiform Encephalopathy (BSE)	**Avian Influenza (AI)**
Canada	Canada
Denmark	Denmark
France	Germany
Netherlands	Mexico
United Kingdom	Netherlands

Source: OECD Livestock diseases outbreaks dataset.

Data on epidemiology (Layer 1) were collected from WAHID and WTO SPS-IMS for the selected countries and diseases. Information on epidemiologic evidence for each outbreak (year, country, disease, starting date, resolved date, affected animal (species), number of cases infected by each outbreak, number of susceptible, deaths, destroyed and slaughtered animals of each outbreak, and control measures) were collected from WAHID and put together in a comparable manner. Information on trade measures due to outbreaks (country imposing measures, type of measure (e.g. suspension, starting date, ending date) were collected from WTO SPS-IMS and stored in the database. In addition, contextual information such as import and export (volume and value) of live animals and animal products, livestock population, number of livestock farms and farmers, livestock

share in total agricultural production, livestock share in GDP, value of production at farm gate, level of production, and number of veterinarians, were collected from government websites, WAHID, and the UN COMTRADE, and stored in the database.

Data on policy measures (Layer 2) were collected from government and academic websites to capture readily available policy information. Information on policy measures for each event, such as country, disease, type of measure, programme name, payment source, description of measure, species, year, unit price (per species), payment currency, volume, expenditure, legal framework, and data source were collected from government reports and put together in a comparable manner. Simultaneously, a questionnaire on policy measures was sent out to the selected countries, containing a request for additional information on policy measures during outbreaks and the contact persons in a country. Canada, Denmark, Japan, Mexico, and the United Kingdom responded to the questionnaire. In addition, the EU provided information on the measures co-financed by the EU for several countries (Denmark, France, Germany, Hungary, the Netherlands, and the United Kingdom). Such information was compared with national data when possible. Verification of the policy information, as well as clarifications and requests for further inputs were dealt with through bilateral contacts. The requests for additional information aimed to fill data gaps in the pilot database and to verify whether the data collected for each of the policy measures was accurate. This includes the information regarding policy measures at subnational level, where the search of websites found no mention about these.

Data on economic impacts (Layer 3) were collected from academic and government publications and reports. Information on economic impacts (reference, disease, country, *ex ante/ ex post*, method, time period, descriptions of measurement and output, economic impacts, economic components) was collected and fed into the database. For selected countries and diseases, the secretariat was able to gather data for two events in the United Kingdom and Japan, which provide estimates of the economic costs to agriculture producers, control costs and downstream industries, with different components, definitions and methodologies.

4. Results and discussions

Table 3 summarizes the dataset coverage of each layer for the selected countries and diseases. The pilot database contains information on Layer 1 (epidemiology evidence, veterinary measures, and contextual information), Layer 2 (control and compensation measures), and Layer 3 (economic impacts).

The data collection exercise found that the amount and quality of information varies substantially across layers and countries. Overall, data availability on layer 1 is relatively good across countries and diseases. On the other hand, the quantity and quality of data in layer 2 vary across countries and diseases. In many cases, data are available only at national level. While many governments responded that several programmes are also implemented at sub-national level, sub-national data are often unavailable, limited or partial. In addition, data are limited to aggregated figures over several years or budgeted amounts which were not reflecting actual spending for some countries. When annual figures are unknown, government spending across different years is not always clear and is difficult to compare with other countries. In addition, some countries are unable to provide government expenditures or their detail due to confidentiality. In contrast, very little is known about the economic impacts on different sectors in each country. Data availability, as well as differences in coverage, measurement, and definitions, is the major obstacle to comparability of economic impacts. Shifting government's focus from collecting data on government expenditures at national level to economic impacts may be necessary to have a more complete picture of livestock disease outbreaks.

Table 2. Livestock diseases outbreaks dataset coverage

Source			Layer 1 (Epidemiology)			Layer 2 (Policy responses)			Layer 3 (Economic impacts)		
Disease	Country	Year	Evidence	Veterinary measures	Contextual information	Control measures	Compensation measures	Trade measures	Production losses	Control costs	Sector and wider economy
FMD	JPN	2010	X	X	X	X	X	X	X		X
FMD	JPN	2000	X	X	X	X	X	X			
FMD	GBR	2007	X	X	X	X	X	X			
FMD	GBR	2001	X	X	X	X	X	X	X	X	X
FMD	FRA	2001	X	X	X	X	X	X			
BSE	NLD	2011	X	X	X	X	X	X			
BSE	NLD	2010	X	X	X	X	X				
BSE	GBR	2011			X	X	X				
BSE	GBR	2010			X	X	X	X			
BSE	FRA	2010			X	X	X	X			
BSE	FRA	2009			X	X	X				
BSE	DNK	2009			X	X	X				
BSE	CAN	2003	X	X	X	X	X	X			
AI	DNK	2013	X	X	X	X	X	X			
AI	DNK	2010	X	X	X	X	X				
AI	DNK	2008	X	X	X	X	X	X			
AI	DNK	2006	X	X	X	X	X	X			
AI	DEU	2008	X	X	X	X	X	X			
AI	DEU	2007	X	X	X	X	X	X			
AI	CAN	2004	X	X	X	X	X	X			
AI	NLD	2003	X	X	X	X	X	X			
AI	MEX	2013	X	X	X	X	X	X			
AI	MEX	2012	X	X	X	X	X	X			
CSF	HUN	2010			X	X	X				
CSF	HUN	2009			X	X	X				
CSF	MEX	2009	X	X	X	X	X				

Source: Livestock diseases outbreaks dataset, OECD as of April 2015.

Table 4 shows the size, duration and amount of government expenditures on a single year basis for four events in which the governments had to spend more than USD 100 million (FMD/2001/GBR[4]; BSE/2003/CAN, FMD/2010/JPN, and AI/2003/NLD). It is based on the different variables of layers 1 (date of start of the outbreak, outbreak status (resolved date), number of outbreaks, value of livestock production) and 2 (control and compensation measures). The percentage of total cost to the value of livestock production ranges from 2% to 31% for these events. This is in comparison to

4. FMD/2001/GBR: FMD event in 2001 in the United Kingdom.

below 2% for each country in 2011-13 (Figure 3). The expenditures on control and compensation measures were less than 0.2% for other events (Annex 3).

Table 3. Top four events with large government expenditures

Source			Layer 1			Layer 2		
Disease	Country	Year (a)	Number of days	Number of out-breaks	Number of animals destroyed in millions	Value of livestock production (USD million) in year (a), b	Government expenditures (USD million) in year (a), c	c/b (%)
FMD	GBR	2001	222	2 030	4.2	10 302	3 241	31.5
BSE	CAN	2003	-	1	<0.1	11 486	774	6.7
FMD	JPN	2010	101	292	0.3	29 085	584	2.1
AI	NLD	2003	68	241	30.6	8 361	183	2.2

Source: Livestock diseases outbreaks dataset, OECD as of April 2015.

The above table provides data on a single year basis, and there is a possibility that the government cost for these events increase further due to follow-up measures taken place in subsequent years. For example, in the case of the BSE outbreak in Canada in 2003, a set of measures was also provided 2004 onward (Box 2). This reveals a subsequent refocussing of government policy (and costs) from direct outbreak management to price stabilization to restoration of the livestock sector in subsequent years. Thus, there are also follow-up measures to disease outbreaks which must not be overlooked.

Most events included a relatively low number of outbreaks and were contained over a short period of time (<150 days). This is true also for events that involved a relatively large number of outbreaks and animals such as AI/2003NLD and FMD/2010/JPN. The former event ended with 241 AI outbreaks in the Netherlands in 2003 destroying over 30 million birds, and the latter resulted in 292 FMD outbreaks in Japan in 2010 destroying nearly 29 thousand animals. One exception is FMD/2001/GBR that lasted for more than 200 days. At the same time, government spending varies across countries and diseases depending on disease-type, and outbreak size and duration, while differences in price of species and in cost of measures between bovine, swine, and avian, for example, make AI outbreaks less costly than outbreaks of other diseases. Differences in cost per animal and cost per day are also seen for the same disease. They arise from variability of policy measures and implementation details in across countries and years.

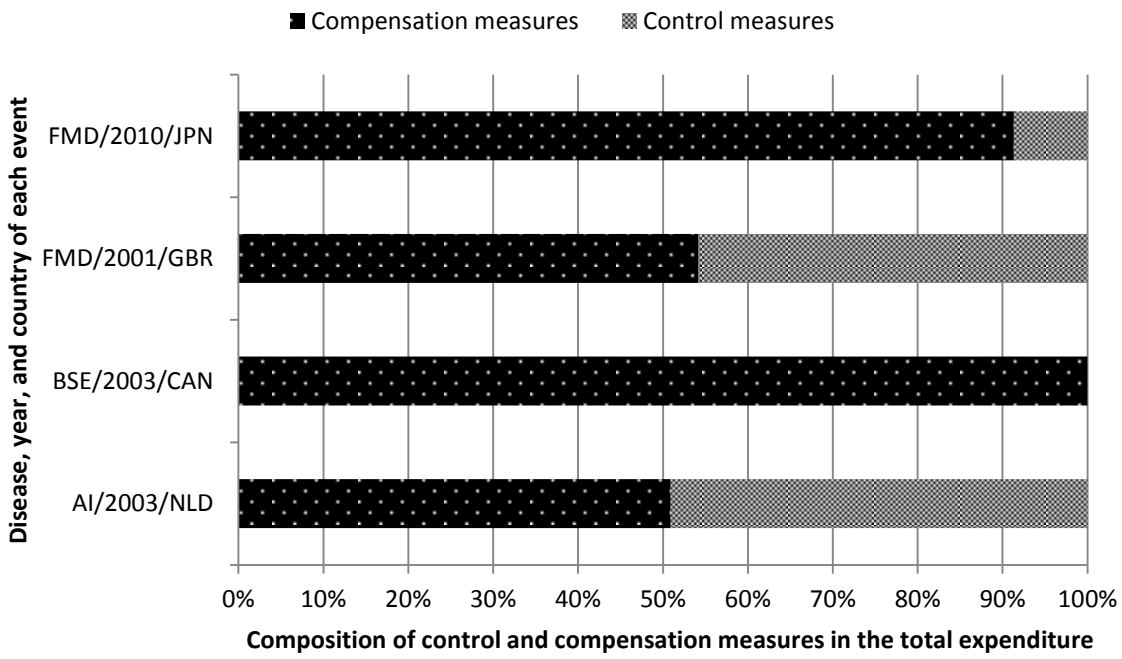
Figure 4 shows the different control and policy measures reported for each event in which the government spent more than USD 100 million in a single year basis. A significant increase in government expenditures occurred for compensation measures for these events, accounting for the majority of the total expenditures, with variations across diseases. For example, measures, such as stamping out, disinfection, and compensation of culled animals are provided for AI/2003/NLD. These measures are provided for culling animals and compensating farmers. Similarly, measures, such as stamping out and compensation of culled animals, are applied in FMD/2001/GBR and FMD/2010/JPN. In contrast, BSE/2003/CAN, a majority of the budget was used for price support measure and other type of measures such as assisting processing plants to increase the culling of animals or to slow the marketing of products.

Box 2. Canada's response to BSE outbreaks in 2003

After one Canadian cow in the province of Alberta tested positive for BSE in 2003, more than 40 countries closed their borders to imports of Canadian cattle, beef and other ruminants (e.g. sheep). Economic impacts due to the border closures were significant for Canada, as its dependency on export markets was high, particularly to the US accounting for 80% of Canadian beef exports and almost 100% of cattle exports. According to the estimation of the industry, the loss was CAN 11 million (USD 8 million) a day in exports, and another CAN 7 million (USD 5 million) a day due to depressed beef prices. A total of CAN 2.1 billion (USD 1.5 million) in federal funding was allocated over a five-year period from 2003-07 for BSE response-related programme. It was provided against the backdrop of the loss of exports due to border closures by trading partners, the reduction of slaughter capacity, and the delay in marketing of cattle. Initially, the main focus was to help sustain the industry by providing market price support and compensations to producers for revenue decline until exports resumed. These industry sustaining programmes took place in 2004-06 and CAN 2 billion (USD 1.4 billion) was funded by the Federal government and CAN 243.8 million (USD 174 million) by the Provincial governments. While the programmes were in force, there were two new BSE events in 2004 and 2005. As time passed but partners kept trade ban, governments shifted to focus on industry repositioning programmes to reduce Canada's reliance on the international market. Several programmes were provided to help reposition the industry by increasing slaughter capacity, improving tracking and tracing, and developing new market. These industry repositioning programmes took place in 2004-07 and CAN 131.8 million (USD 94.12 million) was funded by the Federal government. While most programmes ended in 2007, when Canada was categorized by the OIE as a BSE controlled country, Canadian Cattlemen's Association Legacy Fund, which is a public-private fund created in 2005, funded more than CAN 170 million (USD 121.4 million) until 2015 to support long-term market development. The main objectives of the Fund are to maintain consumer confidence, implement innovative market strategies, and increase sales in markets of Canadian beef and cattle genetics.

Sources: Based on information available on the website of OIE (www.oie.int), Evaluation of AAFC's Program Response to the BSE Crisis, Agriculture and Agri-Food Canada (2011), Farm Credit Canada, Library of Parliament of Canada, Canadian Cattleman Association and Canadian Food Inspection Agency Performance Report (2007).

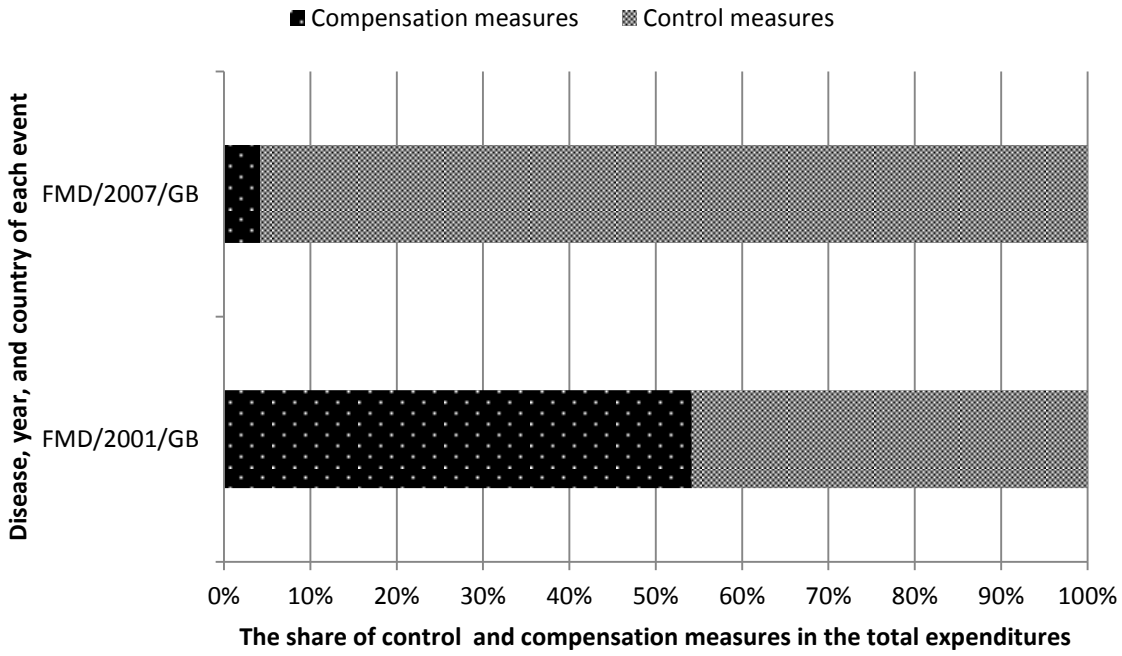
Figure 4. Control and compensation measures (FMD/2010/JPN, FMD/2001/GBR, BSE/2003/CAN, and AI/2003/NLD)



Source: OECD livestock diseases outbreaks dataset, adapted from the Canadian Food Inspection Agency (CFAI) for data for Canada. The data is limited to compensation measures as CFIA does not report control measure expenditures.

Figure 5 shows government measures taken in the United Kingdom for FMD events in 2001 and 2007. The two events lasted for more than 100 days with significant differences in the number of animals destroyed. In the case of FMD/2007/GBR, which resulted in 8 outbreaks destroying 1 578 animals, control costs far outweigh compensation costs. This is in comparison to the case of FMD/2001/GBR, which resulted in 2 030 outbreaks destroying more than six million animals: over four million for disease control purposes; and over two million for social measures. In general, events other than those four tended to have a higher share of control costs in total costs due to the low number of animals involved in their compensations.

Figure 5. Control and compensation measures (FMD/2007/GBR and FMD/2001/GBR)



Source: OECD livestock diseases outbreaks dataset.

As the size of outbreaks increases, a snowball effect on government expenditures is typically observed where compensation costs far outweigh control costs, and a variety of measures other than stamping out and compensation for culled animals are necessary to implement at national and sub-national levels. This can take a long period of time and lead to increasing government expenditures, which can be very high, especially in the case of large or prolonged outbreaks, and could therefore put a strain on public budgets for both short and long term. While the data collected are limited to a crisis period, further analysis can be possible to compare other types of measures using the data collected. For example, a study on the cost of national prevention systems for animal diseases and zoonoses in developing and transition countries was commissioned by the OIE (Civic Consulting, 2009; and Alleweldt et al., 2012). The current PSE/GSSE dataset do not provide such detail, but when data on the cost of national prevention systems for animal diseases can be collected from the countries, a quantitative comparison between disease prevention costs and the costs arising from disease outbreaks (e.g. control and compensation costs and production losses) will be possible.

It is now appropriate to ask whether market price values and cost-sharing schemes that were employed in these four events have different characteristics from others. In order to assess how the compensation is calculated and provided, the expenditures to compensate producer losses from the

culled animals are compared against the unit price and the cost-sharing scheme for each event. However, when outbreaks affect multiple species, particularly in the case of FMD outbreaks, the comparison across outbreaks faces difficulty. One way to overcome such difficulty is to estimate livestock units (LU) on a comparable basis to describe livestock numbers of various species as a single figure that expresses the total amount of livestock involved in each outbreak. For instance, data on compensation of producer losses by LU[5] for the FMD events show the highest figure for FMD/2010/JPN (USD 4 566 per LU) with large variances between events: FMD/2000/JPN (3827), FMD/2001/GBR (2262), FMD/2007/GBR (1152) and FMD/2001/FRA (763).

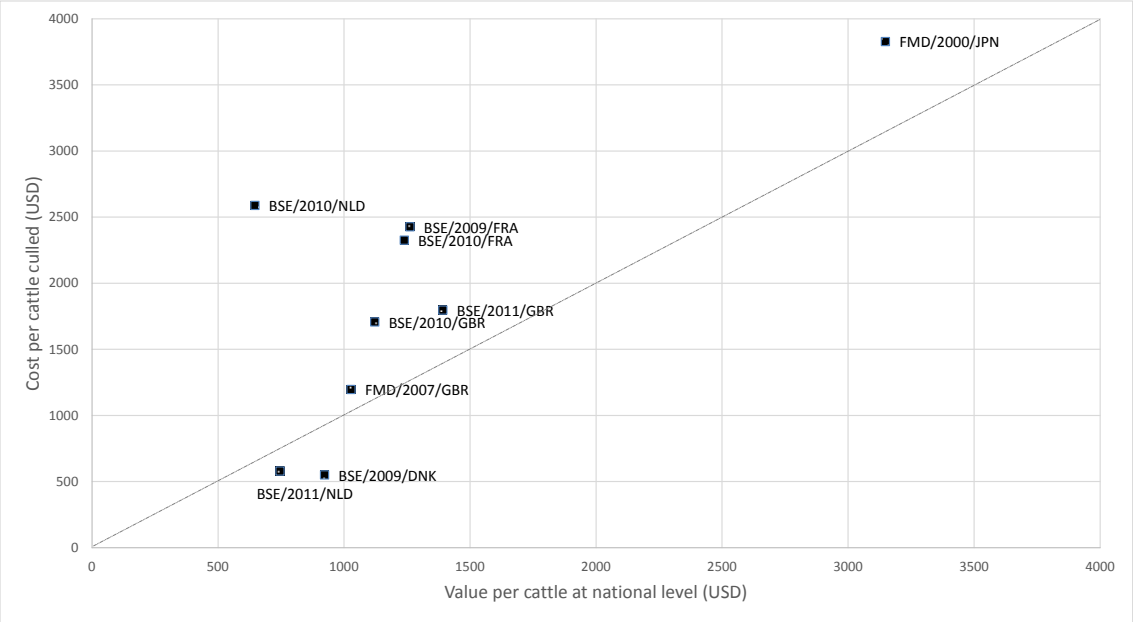
The differences are caused by the price of each animal compensated, and the composition of species or breeds involved in each event. Therefore, understanding the details of the market value of animals destroyed, the cross-reference of the number of animals with compensation paid, and the number of animals destroyed, is necessary for this analysis. Collected data so far suggest that the values of these animals depend on species or breeds, age, sex, and type (e.g. beef or dairy, pedigree or non-pedigree) of each breed. For instance, average unit prices per species in the 2001 FMD event in the UK for cattle, sheep and pigs were 45%-116% higher than those in the 2001 FMD event in France. Such differences in value can be found for the same disease in the same country. For example, an average payment per bird in Germany in 2008 was 5 times higher than in 2007 for the same disease as the 2008 event mostly involved turkey, whereas the 2007 event was mainly chicken.

Figure 6 shows the average value of cattle estimated at national level and the actual cost of cattle compensated for different outbreaks that involved same species. It is based on the variables in layers 1 and 2. Variance is seen across events with some countries paying more than the estimated value of cattle at national level while others are paying less. While the current dataset does not allow comparing such data for the four events to other events, a high market value of animals that is generated by market price support can lead to more spending on compensation as compared to a country where such support is less.

Although, many countries responded that their compensations were made based on the market value of each animal culled, the amount of compensation for culled animals at current market values is difficult to determine. As compensation values that are higher than market values may lead to a situation for a farmer with an infected herd, which is culled and compensated, to be better-off than a farmer with a healthy herd (OECD, 2013). The data collected suggest that differences in the market values of animals have a great impact on compensation of producer losses and total government expenditures, but making a comparative assessment of these values for different species, breeds, age, and type in different countries and regions is a difficult task. For instance, several rare breed populations in the UK were affected by the culling measures introduced during FMD/2001/GBR. If outbreaks involve historically and culturally rare breeds or a few highly popular animals for breeding purposes (i.e. sires), estimation and comparison of the market value of these animals are complicated. In addition, the value paid for animals may need to be sufficient to entice farmers to report animal health problems and allow them to be investigated to the point of identifying the causative agent, but appropriate valuation of each animal for each country and their comparison are complex. Nevertheless, the framework is useful to compare information on these prices used for compensation at the LU, species, and breeds levels, and further analysis is possible by crossing this information, with price details for various species and breeds in each country.

5. OIE-Veterinary Livestock Unit (OIE-VLU) was used to estimate livestock units. According to the definition, one bovine requires the same annual veterinary cost and care as five pigs, ten sheep, ten goats, or a hundred chickens (OIE, 2008).

Figure 6. Value and cost of animals by event



Sources: OECD livestock diseases outbreaks dataset; and OECD (2014), "Producer and Consumer Support Estimates", OECD Agriculture Statistics Database, http://dx.doi.org/10.1787/agr-pcse-data-en.

On the other hand, cost-sharing schemes should not be overlooked as each scheme has impacts on compensation payments. The framework includes costs for the culling and destruction of animals, the destruction of products, the cleaning and disinfection of holdings, and the destruction of contaminated feed as well as information regarding how the programme works, and how the payments are financed (e.g. cost-sharing arrangements) for each measure. Available data suggest that these rates are different by disease or measure, and that compensation can range from 50% to 100% of market values of the animals, and different fixed rates can be applied for cleaning and disinfection. In general, a rate of 100% was used for the cost of screening and surveillance, and partial coverage was used for other measures (e.g. stamping out, disinfection, and compensation of producer losses). In the case of FMD, a rate of 60% was used in the United Kingdom for compensation in FMD/2001/GBR, whereas a rate of 100% compensation of market price was used in Japan, meaning the government compensated farmers with 100% market price for culled FMD vaccinated animals and feed and other costs.

While under-compensation can lead to under-reporting, compensation schemes where the government pays the full compensation amount can create adverse incentives such as overcompensation leading to moral hazard (OECD, 2013). With this in mind, however, a situation may require a rapid intervention or culling of animals from the movement control zones to prevent the rapid spread of disease. Therefore, cost-sharing schemes during a crisis period require a careful understanding of the context of each event. The data collection exercise reveals that there is considerable scope for variants of animal disease compensation schemes, and cost-sharing across producers and between producers and government. The framework is useful to compare information on the details provided in each measure, and further analysis could be possible by comparing this information with other countries where outbreaks are not in place, and analyse the relationship between responsibility, cost-sharing arrangements and compensation across countries and diseases or during crisis periods and non-crisis periods.

As only four events exceeded the total government expenditures of USD 100 million in a single year basis, it is now worthwhile to see economic impacts of these diseases at national level. Table 5 provides an overview of the two studies presenting economic impacts for FMD outbreaks in the United Kingdom and Japan for which data are currently available in the dataset. They are sourced from layers 2 and 3. While the estimates of two studies are not comparable due to differences in definitions and measurements (Annex 5), the result indicates the size of economic impacts of these outbreaks. For example, the economic costs of the 2001 foot and mouth disease event in the United Kingdom, and the estimated loss to agriculture is approximately GBP 355 million (USD 511 million)." The majority of the costs to agriculture were met by government expenditures for compensation, disposal and clean-up costs" (Thompson et al., 2002). On the other hand, the estimated impacts of the 2010 foot and mouth disease event in Japan were JPY 27.5 billion (USD 310 million) for livestock producers and JPY 119.9 billion (USD 1.4 billion) for the food industry (Miyazaki Prefecture, 2012). The result indicates that economic impacts of these events are huge, which far outweigh the total cost of government expenditures, and impacts extend to the wide range of sectors.

Table 4. Estimates of the impact from FMD outbreaks (FMD/2001/GBR, FMD/2010/JPN)

Source			Layer 3			Layer 2
Disease	Country	Year	Production losses	Control costs	Sector and economy wide impacts	Government expenditures (control and compensation measures)
			(USD million)			(USD million)
FMD	GBR	2001	511	3 721	3 870	3 241
FMD	JPN	2010	310	NA	1 360	584

Sources: Thompson et al. (2002); Miyazaki Prefecture (2012).

As these four events led to large reactions that are associated with the removal and disposal of many animals, it is interesting to see how these impacts extend to production volume, price, production value and trade at national level. Table 6 shows in the production of animal products year. It is based on layer 1. For example, the Canadian livestock sector exported nearly USD 1.2 billion of beef and dairy products, and USD 422 million of live animals prior to the identification of a BSE-infected animal in May 2003. In 2003 alone, the value of exports declined by over USD 300 million for beef and dairy products, and USD 700 million for live animals according to the UNCOMTRADE data. The drop of 23% in production, 16% decline in the producer price and 35% decline in the production value from the previous year show how seriously the disease impacted the sector. The value of production of the entire livestock sector was reduced by 11%.

In the case of AI/2003/NLD that resulted in culling more than 30 million birds leading to the reduction of the production volume of eggs and poultry meat by nearly 30%, the value of exports declined by over USD 50 million for live animals, and the total value of livestock production reduced by 7%. This contrasts with the impact in the United Kingdom and Japan, where these countries are net importers of live animals and animal products. In these countries, although the production volumes for the sectors hit hardest by the outbreaks declined, domestic prices remained relatively high. In most events, data suggest that impacts on production volume or value could be negligible implying that outbreaks are limited to specific sectors and regions or are too small to bring a significant change at national level.

Table 5. Change in the production of animal products

Source		Layer 1			
	Event	FMD/2001/GBR	BSE/2003/CAN	FMD/2010/JPN	AI/2003/NLD
	Change	2000-2001	2002-2003	2009-2010	2002-2003
Total	Production	1%	-1%	-2%	0%
Total	Producer price	-1%	-6%	2%	9%
Total	Value of production	-5%	**-11%**	2%	-7%
Beef	Production	-9%	**-23%**	0%	-6%
Beef	Producer price	-4%	**-16%**	-3%	-1%
Beef	Value of production	**-13%**	**-35%**	-4%	-7%
Egg	Production	7%	7%	0%	**-27%**
Egg	Producer price	6%	-4%	8%	**39%**
Egg	Value of production	**14%**	3%	8%	1%
Milk	Production	2%	0%	-3%	4%
Milk	Producer price	**12%**	5%	-2%	-4%
Milk	Value of production	13%	5%	-6%	-1%
Pork	Production	**-14%**	1%	-1%	-3%
Pork	Producer price	1%	0%	5%	-4%
Pork	Value of production	**-13%**	0%	3%	-6%
Poultry meat	Production	3%	2%	2%	**-31%**
Poultry meat	Producer price	-6%	6%	**20%**	**18%**
Poultry meat	Value of production	-3%	8%	**22%**	**-19%**

Source: OECD livestock diseases outbreaks dataset.

While the market losses caused by four events (FMD/2001/GBR; BSE/2003/CAN, FMD/2010/JPN, and AI/2003/NLD) are different depending on these countries' export dependency and net trade position, quantifying economic impacts on market and trade has to take into account the elasticities of demand and supply, the trade position in the world, and the market structure of the affected country. According to the study of Junker et al. (2009), which carried out hypothetical case studies to assess the costs related to the trade ban for the US, Canada and the Netherlands, differences in the market structure of the affected country could bring a very different result for the same control strategy. Therefore, quantifying disease impacts remains a challenge and further analysis is needed to better understand how such impacts could affect different sectors and how long these impacts last.

5. Conclusions and next steps

The results indicate that the variables identified are useful to analyse policy measures across different outbreaks and across countries. Layer 1 relates to the biology of the disease and the affected host species. The associated epidemiology of the disease should be linked to the human and societal response to the disease as this changes both the availability of animals that can be infected through potential immunity change (vaccination), constraining movement and restricting contact. Such response is captured at layer 2 which collects information on the costs but is limited to public costs. Layer 3 therefore takes a wider view and tries to capture the wider societal impacts in terms of

markets, leading to changes in producer and consumer surplus. The variables and links across the layers would allow an improvement for comparative analysis.

Overall, data availability for layers 1 and 2 is relatively good across countries and diseases. However, data quality and confidentiality of policy measures such as the actual amount of compensation at the farm level does not allow a complete view of cross-country analyses. Challenges also remain with regard to economic impacts as information is rarely reported. Quantifying disease impacts on different sectors remains a challenge and more analysis is needed to better understand economic implications on outbreaks, how such impacts are allocated, and how long these impacts last.

The information gathered for the pilot database shows that government expenditures on policy measures in response to outbreaks can be considerable, especially in the case of large or prolonged outbreaks. The size and impact of outbreaks depend on the types of interventions and their policy schemes. Among the measures taken, compensation measures are the main factor to weigh on total expenditure. Compensation payments can be very high when a high price per unit of livestock is used, especially in cases where the value of livestock is driven up by market price support. Where follow-up costs are required, this may substantially increase the total government expenditures. Market losses may differ depending on countries' export profiles, with exporting countries facing larger and more prolonged impacts compared to importing countries.

The work pursued so far has faced challenges in collecting and compiling consistent information across diseases and countries. Nonetheless, the framework and the pilot database developed, which already reveal several policy insights and underscore the importance of incorporating economic analysis in the policy responses to disease outbreaks, would serve as a valuable contribution for future data collection and analysis. While, the current data on economic implications of outbreaks and economic impacts on different sectors of the economy is a limiting factor, narrowing the scope to undertake further analysis in a systematic way, it is, however, clear that for more effective disease control and sustainable resource management, governments need to consider broader and longer-term impacts, beyond short-term public expenditures. Comparative policy analysis to learn from experience can help to improve the design of more cost-effective policy responses.

The analysis of the pilot database also highlights the importance of disease prevention. Overall preparedness for an outbreak, including early detection and response, and effectiveness of the initial response will impact on the quality and cost-effectiveness of subsequent disease control efforts. The result of the present work and the dataset on outbreaks of livestock diseases could be useful inputs for the next work.

Annex 1.
List of veterinary measures[a] reported by OECD countries: 2011-13

Country	PSE/GSSE	Reported measures
AUS	PSE	Disease and pest control (State)
	PSE	National Feral Animal Control Strategy
	GSSE	Inspection services for management of pest and disease threats to plant and animal industries (SA)
	GSSE	Inspection service for management of pesticide and veterinary medicine risks in animal and plant industries (SA)
	GSSE	Inspection Services for Agriculture (Tasmania)
	GSSE	Inspection Service - Animal Health (ACT)
	GSSE	Other exotic disease preparedness programmes
	GSSE	Biosecurity protection Services (Queensland)
	GSSE	Inspection services for agriculture (WA)
	GSSE	Inspection services to minimise pest & disease risk (NT)
CAN	PSE	Pest and disease control federal expenditures
	PSE	Pest and disease control provincial expenditures
	GSSE	Federal Programmes
	GSSE	Provincial Programmes
CHL	PSE	Fund for the Improvement of Sanitary Conditions
	PSE	Livestock Development Programme/animal health programme
	PSE	Foot and Mouth Disease Control
	PSE	Brucellosis Bovine Control
	PSE	Sanitary Emergencies
EU27	PSE	Disease eradication
	PSE	Other veterinary measures
	PSE	Funds for emergency veterinary measures
	PSE	Completion of earlier veterinary and plant health measures
	PSE	Disease control national expenditures
	PSE	Pest and disease control national expenditures
	PSE	National premiums for the slaughter of cattle (disease eradication)
	PSE	National premiums for the slaughter of sheep (disease eradication)
	PSE	National premiums for the slaughter of pigs (disease eradication)
	PSE	National premiums for the slaughter of poultry (disease eradication)
	GSSE	Animal transportation controls
	GSSE	National expenditures on pest and disease inspection and control
ISL	PSE	Contagious diseases (sheep-disease control + payments to scrapie farms)
	GSSE	Pest and disease inspection and control
ISR	PSE	Flock culling (preventive measures) and Brucellosis eradication
	GSSE	Veterinary services

Country	PSE/GSSE	Reported measures
JPN	PSE	Pest and disease control
	GSSE	Pest and disease control (off farm)
KOR	PSE	Pest and disease control
	GSSE	Pest and disease inspection and control
MEX	PSE	Animal Health Programmes
	GSSE	ALIANZA - Control Cuarentenario
	GSSE	CNSA /CONASAG
NZL	PSE	Animal Health Division - disease control
	GSSE	Quarantine
	GSSE	Pest Control Regional councils
	GSSE	Meat and Dairy Inspection and Grading / Quality Assurance
NOR	PSE	Support to veterinary services
	GSSE	Veterinary institute and Bioforsk
	GSSE	Norwegian school of veterinary science
TUR	PSE	Veterinary pest and disease control
	GSSE	Pest and disease inspection and control
USA	PSE	Animal & plant health inspection service (I-E69)
	GSSE	Center for Veterinary Medicine

a. Measures of no spending for 2011-13 are not listed.

Key: PSE= Producer Support Estimate; GSSE= General Services Support Estimate

Source: OECD (2014), "Producer and Consumer Support Estimates", OECD Agriculture Statistics Database, http://dx.doi.org/10.1787/agr-pcse-data-en.

Annex 2.
Veterinary Measures Reported By OECD Countries: 2011-13

Country	Unit	Expenditures of veterinary services	Value of livestock production	Value of agricultural production	Total support estimate	a/b (%)	a/c (%)	a/d (%)	b/c (%)
		a	b	c	d				
AUS	Million AUD	156.7	21 099.9	48 945.8	2 222.5	0.74	0.32	7.05	43.11
CAN	Million CAD	77.8	20 916.3	4 9815.5	9 690.7	0.37	0.16	0.80	41.99
CHL	Million CLP	9 379.5	2 539 920.7	6 860 087.6	377 313.8	0.37	0.14	2.49	37.02
EU27	Million EUR	1 194.8	162 323.9	368 256.1	95 340.1	0.74	0.32	1.25	44.08
ISL	Million ISK	399.3	24 063.5	29 497.4	18 853.5	1.66	1.35	2.12	81.58
ISR	Million ILS	75.1	11 462.0	29 116.0	3 715.4	0.66	0.26	2.02	39.37
JPN	Million JPY	11.6	2 567.6	8 356.3	6 053.1	0.45	0.14	0.19	30.73
KOR	Billion KRW	80.6	18 283.4	44 526.5	26 666.2	0.44	0.18	0.30	41.06
MEX	Million MXN	1 397.5	289 636.4	685 397.1	106 281.3	0.48	0.20	1.31	42.26
NOR	Million NOK	339.9	17 244.0	25 668.9	24 605.1	1.97	1.32	1.38	67.18
NZL	Million NZD	208.3	18 571.5	23 174.4	627.1	1.12	0.90	33.22	80.14
TUR	Million TRY	113.0	64 151.2	139 613.9	29 698.5	0.18	0.08	0.38	45.95
USA	Million USD	1 306.0	152 560.8	388 665.5	80 032.1	0.86	0.34	1.63	39.25

Source: OECD (2014), "Producer and Consumer Support Estimates", OECD Agriculture Statistics Database, http://dx.doi.org/10.1787/agr-pcse-data-en

Annex 3.
Selected Variables of Livestock Diseases Outbreaks Dataset

Source			Layer 1				Layer 2			
Disease	Country	Year (a)	Duration	Number of outbreaks	Number of animals destroyed	Value of livestock production in year (a), b	Government expenditures in year (a), c	Control measures (2.1.A-2.1.I)	Compensation measures (2.2.A-2.2.E)	c/b
			day		million	USD million	USD million	USD million	USD million	%
BSE	GBR	2010	NA	NA	NA	16 927.0	12.9	12.5	0.4	0.08
BSE	GBR	2011	NA	NA	NA	19 781.5	15	13.8	1.2	0.08
FMD	GBR	2001	222	2 030	4.2	10 302.4	3 240.6	1 484.3	1 756.2	31.45
FMD	GBR	2007	150	8	<0.1	16 598.2	32.5	31.1	1.4	0.20
AI	DNK	2006	110 13 29 62	26 1 1 2	<0.1 <0.1 <0.1 <0.1	6 272.8	0.8	0.6	0.2	0.20
AI	DNK	2008	29	1	<0.1	7 760.4	0.6	0.3	0.4	0.01
AI	DNK	2010	42	2	<0.1	7 418.1	0.7	0.3	0.3	0.01
AI	DNK	2013	27	1	<0.1	9 706.4	0.2	0.1	0.1	0.00
BSE	DNK	2009	NA	NA	NA	7 021.4	0.003	0	0.003	0.00
CSF	HUN	2009	NA	NA	NA	2 886.5	1.0	1.0	0	0.03
CSF	HUN	2010	NA	NA	NA	2 795.8	1.3	1.3	0	0.05
AI	NLD	2003	68	241	30.6	8 360.6	183.3	90.0	93.4	2.19
BSE	NLD	2010	6 9	1 1	<0.1 <0.1	12 296.2	3.9	3.8	0.02	0.03
BSE	NLD	2011	7	1	<0.1	13 961.2	3.9	3.8	0.01	0.03
AI	DEU	2007	45 128 74	3 301 3	<0.1 <0.1 0.3	28 647.7	3.2	1.5	1.8	0.01
AI	DEU	2008	5 139	1 35	<0.1 0.4	33 727.9	19.7	7.8	11.9	0.06
FMD	FRA	2001	10	2	<0.1	20 555.9	11.0	4.5	6.5	0.05
BSE	FRA	2009	NA	NA	NA	29 918.3	42.3	40.0	2.3	0.14
BSE	FRA	2010	NA	NA	NA	29 610.1	27.3	26.6	0.7	0.09
BSE	CAN	2003	1	1	<0.1	11 486.4	773.9	0	773.9	6.74
AI	CAN	2004	92	53	13.7	13 109.0	1.8	0	1.8	0.01
FMD	JPN	2000	51	4	<0.1	21 356.8	3.1	0.3	2.8	0.01
FMD	JPN	2010	101	292	0.3	29 084.8	584.3	50.6	533.8	2.01
CSF	MEX	2009	217	2	<0.1	17 553.4	3.9	3.9	0	0.02
AI	MEX	2012	108	46	10.2	21 792.1	0.2	0.2	0	0.00
AI	MEX	2013	616	64	7	24 909.7	0.2	0.2	0	0.00

Annex 4.
List of Variables for Layers 1, 2, And 3

1	**Epidemiological data (Layer 1)**	1.3.D	Livestock share in employment.	2.3.A	Date of announcement of trade measure (e.g. suspension or lift of the suspension).
1.1	**Epidemiological evidence from outbreaks (Data source: OIE-WAHID)**	1.3.E	Livestock population density.	2.3.B	Name of country announced 2.3.A.
1.1.A	ID assigned for each event (e.g. FMD/2010/UK).	1.3.F	Livestock share in total agricultural production.	2.3.C	Regions or countries likely to be affected by 2.3.A.
1.1.B	Name of country of 1.1.A.	1.3.G	Livestock share in GDP	2.3.D	Type of measure of 2.3.A.
1.1.C	Name of disease of 1.1.A.	1.3.H	Value of production at farm gate (by product).	2.3.E	Products affected by 2.3.A.
1.1.D	Year of 1.1.A.	1.3.I	Level of consumption (by product).	2.3.F	Description of 2.3.A.
1.1.E	OIE disease status (pre-outbreak).	1.3.J	Number of veterinarians.	**3**	**Economic impacts (Layer 3)**
1.1.F	Date of loss of 1.1.E.	1.3.K	Import volume of live animals (by species).	**3.1**	**Livestock producers (Data source: Government/Academic)**
1.1.G	Date of restoration and/or recognition of 1.1.E.	1.3.L	Import volume of animal products (by product).	3.1.A	Production losses which could be broken down in animals lost, meat, milk, egg and wool production reduction
1.1.H	Date of previous occurrence of the disease.	1.3.M	Export volume of live animals (by species).	3.1.B	Other production losses to be specified.
1.1.I	Date of start of each outbreak.	1.3.N	Export volume of animal products (by product).	**3.2**	**Control costs (Data source: Government/Academic)**
1.1.J	Date of resolved date of each outbreak.	1.3.O	Import value of live animals (by species).	3.2.A	Control costs ideally separated by fixed and variable costs with a distinction between public and private sector costs.
1.1.K	Total number of outbreaks of each outbreak (=total number of affected farms).	1.3.P	Import value of animal products (by product).	3.2.B	Other control costs to be specified.
1.1.L	Affected species (e.g. buffalo, cattle, goat, sheep, swine) of 1.1.A.	1.3.Q	Export value of live animals (by species).	**3.3**	**Sector and economy wide**
1.1.M	Number of susceptible animals of each outbreak.	1.3.R	Export value of animal products (by product).	3.3.A	Sector and economy wide impact assessments to capture consumer and producer surpluses, trade impacts and other ripple impacts in the economy.
1.1.N	Number of animal affected of each outbreak.	**2**	**Policy responses (Layer 2)**	3.3.B	Other sector and economy wide impact to be specified.
1.1.O	Number of animals destroyed of each outbreak.	2.1	**Control measure (Data source: Government/Academic)**		
1.1.P	Number of animals slaughtered of each outbreak.	2.1.A	Expenditure of 1.2.A.		
1.1.Q	Number of animals vaccinated of each outbreak.	2.1.B	Expenditure of 1.2.B.		
1.2	**Veterinary control measure (Data source: OIE-WAHID)**	2.1.C	Expenditure of 1.2.C.		
1.2.A	Measures applied on stamping out of all sick and contaminated animals, with destruction of their carcases (by burying, incineration, etc.).	2.1.D	Expenditure of 1.2.D.		
1.2.B	Measures applied on quarantine of animals.	2.1.E	Expenditure of 1.2.E.		
1.2.C	Measures applied on movement control to avoid the spread of the disease within a country.	2.1.F	Expenditure of 1.2.F.		
1.2.D	Measures applied on screening of animals systematically.	2.1.G	Expenditure of 1.2.G.		
1.2.E	Measures applied on zoning for delineation (by regulatory means) of free, surveillance and/or buffer, and infected zones within the country for disease control purposes.	2.1.H	Expenditure of 1.2.H.		
1.2.F	Measures applied on disinfection of the infected premises.	2.1.I	Expenditure of 1.2.I.		
1.2.G	Measures applied on vaccination to control the disease.	**2.2**	**Compensation measure (Data source: Government/Academic)**		
1.2.H	Measures applied on surveillance.	2.2.A	Expenditure to compensate producer losses from the culled animals (e.g. compensation programme, support to movement control).		
1.2.I	Measures applied on other control measures to be specified.	2.2.B	Expenditure to compensate operation cost of farmers through fixed/variable payment (e.g. interest concession).		
1.3	**Contextual information on livestock sector (Data source: OIE/Government)**	2.2.C	Expenditure to compensate the reduction of market price (e.g. price stabilisation).		
1.3.A	Livestock population (by breed/species).	2.2.D	Expenditure to stimulate consumption through campaigns in the media.		
1.3.B	Number of livestock farms (by breed/species).	2.2.E	Expenditure for other measures to be specified.		
1.3.C	Number of livestock farmers (by breed/species).	**2.3**	**Trade measure (Data source: WTO/Government)**		

Annex 5.
Economic Impacts of FMD in the United Kingdom and Japan

FMD/2001/GBR

Sector	Definition	Economic impacts GBP million	Economic impacts USD million
1. Agricultural producer	"effects of the outbreak on agricultural producers"	-355	-511
Market prices	"a loss of revenue associated with price changes consequent to the changed pattern of marketing"	-50	-72
Export loss	"an additional effect associated with lower quality domestic uses (e.g. pet food) for supplies diverted from export"	-130	-187
Withholding costs	"an additional effect associated with lower quality associated due to holding animals on farm beyond optimum marketing dates"	-175	-252
Consequential loss	"additional losses incurred by not being able to resume livestock product production immediately or due to loss of premium payments"	-35	-50
Sheep annual premium	"sheep annual premium/over-thirty-months scheme agri-monetary aid and associated subsidy changes, some of which are co-funded by the European Union (EU) budget"	-120	-172
Agri-monetary aid	"sheep annual premium/over-thirty-months scheme agri-monetary aid and associated subsidy changes, some of which are co-funded by the European Union (EU) budget"	+155	+223
2. Food industry	"effects of the outbreak on the supply chain"	-170	-244
Auction markets	"a loss of value added due to the movement ban and export ban"	-95	-136
Abattoirs	"a loss of value added due to the movement ban and export ban"	-40	-57
Processors/hauliers	"a loss of value added due to the movement ban and export ban"	-35	-50
3. Public sector	"effects of the outbreak on the public sector which doesn't include funding from EU budget"; "comparable to those reported in Her Majesty's Treasury Pre-Budget Report excluding an adjustment for estimated budgetary savings on the sheep annual premium and over-thirty-scheme and also allowing for differences in the assumed number of animals destroyed under the welfare scheme"	-2585	-3721
Compensation	"assumed to exactly offset producer losses from the destruction of stock"	-1120	-1612
Welfare scheme payments	"welfare scheme payments on the destruction of stock"	-210	-302
Disposal costs	"costs of destruction and clean-up"	-710	-1022
Miscellaneous costs	"miscellaneous costs"	-450	-648
Agri-monetary aid	"sheep annual premium/over-thirty-months scheme agri-monetary aid and associated subsidy changes, some of which are co-funded by the European Union (EU) budget"	-155	-223
Sheep annual premium/over-thirty-months scheme	"sheep annual premium/over-thirty-months scheme agri-monetary aid and associated subsidy changes, some of which are co-funded by the European Union (EU) budget"	+185	+266
Business support measures	"largely comprises assistance to rural businesses other than farming"	-125	-179
4. Consumer	"effects of the outbreak on consumers "	-15	-21
5. Indirect impacts	"indirect effects on the industries supplying goods and services to the directly affected sectors (agriculture, the food chain industries downstream from the farm-gate and tourism)"	-85	-122
6. Tourism	"effects of the outbreak on tourism"	-2700 to -3200	-3886 to -4606

FMD/2010/JPN

Sector	Definition	Economic impacts	
		JPY billion	USD billion
1. Livestock producer	"effects of the outbreak on livestock producers and related sectors"	-43.5	-0.5
Production value	"loss of production value of culled animals"	-27.5	-0.3
Induced production value	"loss of induced production value"	-16.0	-0.2
2. Food industry	"effects of the outbreak on the supply chain"	-103.9	-1.2
Processors	"a loss of production value due to the movement ban"	-8.9	-0.1
Others (wholesalers, retailers, caterings, accommodations, hauliers)	"a loss of production value due to the movement ban"	-95.0	-1.1

Sources: FMD/2001/GBR (Thompson et al., 2002); and FMD/2010/JPN (Miyazaki Prefecture, 2012).

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