AN OVERVIEW OF ANALYSIS OF COSTS AND BENEFITS OF GOVERNMENT CONTROL POLICY OPTIONS

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Governments have played an important role in decision-making on animal health over the years. Early initiatives were based on principles of epidemiology — and many had success — though economists have also played a role, examining how animal diseases and health problems impact on individuals and societies. Given the relatively recent introduction of formalised processes of epidemiology and economics to assess animal disease and health, it is unsurprising that animal health economists have yet to formalise their approaches to policy making. Economic analysis of animal health is complex and disease-dependent. This complexity only increases at a policy level and requires a systems approach with interdisciplinary working. The paper aims to highlight areas where there have been advances, and to identify areas of best practices. It will also look at areas where economics may be best used to provide clarity for, and add value to, the assessment of animal health policy in the future.

Over the years, governments have played an increasingly large role in decision-making on animal health. Investigations into livestock diseases began as early as 1776, when Louis XIV established a Commission on Epidemics to assess a severe epidemic (probably rinderpest) in cattle (Harrison, 2004). It was not until nearly 100 years later (1865) that Great Britain established a veterinary service in response to growing problems with the control of rinderpest, contagious bovine pleuropneumonia and foot-and-mouth disease (Fisher, 1998). These examples mark the beginning of national-level initiatives to manage disease in animals for the benefit of society. At an international level, the World Animal Health Organisation (OIE) was created in response to global problems of managing rinderpest in 1925.

Historically, the presence of disease in animals has generated societal responses. Initially, these have spurred investigations leading to improved policies for surveillance, control and prevention of these diseases. Early initiatives were based on principles of epidemiology, and many had success; rinderpest and CBPP were controlled, and in some cases eradicated, in Europe in the late 1800s, while FMD and classical swine fever were eradicated in the United States in the early 1900s. Epidemiological principles were not formalised as a discipline until the 1960s and 1970s, and only recently have they become an accepted part of veterinary curricula. Economists have also played a role in this epidemiological movement by examining how animal disease and health impact societies; the first studies on disease control were published in the early 1970s (Ellis, 1972; Powell and Harris, 1974; Hugh-Jones, et al., 1975). These studies served as *ex post* assessments of successful disease campaigns in developed country settings — which, in turn, were based on significant investments in general agricultural research and institutional developments during the post-World War II period.

Given the recent introduction of formalised processes of epidemiology and economics to assess animal disease and health, it is unsurprising that animal health economists have yet to formalise their approaches to policy making. This paper aims to highlight areas where there have been advances, and to identify areas of best practices. It will also look at areas where economics may be best used to provide clarity for, and add value to, the assessment of animal health policy in the future.

Are livestock important?

Societal responses to animal disease stem, in part, from the importance of livestock to society. Our varied use of animals demonstrates that animals are a fundamental aspect of societies around the world. Animals feed people, provide pleasure and company, act as a store of wealth, and, in many places, provide power to till land and to transport goods and people. In their ground-breaking work on the economics of animal welfare, Norwood and Lusk (2011) go even further in stating that human evolution has unfolded alongside the evolution of animals, and that in general, “human lives are enhanced by the use of animals.” This importance is underscored by the sheer number of animals that humans have domesticated. A very rapid estimate using FAOSTAT data indicates that the nearly 7 billion people in the world have 2.65 billion livestock units.[1] A majority of these domesticated animals are cattle, sheep, goats, pigs and poultry — livestock that are kept for food production, transport and draught power and as a form of investment (Figure 1).

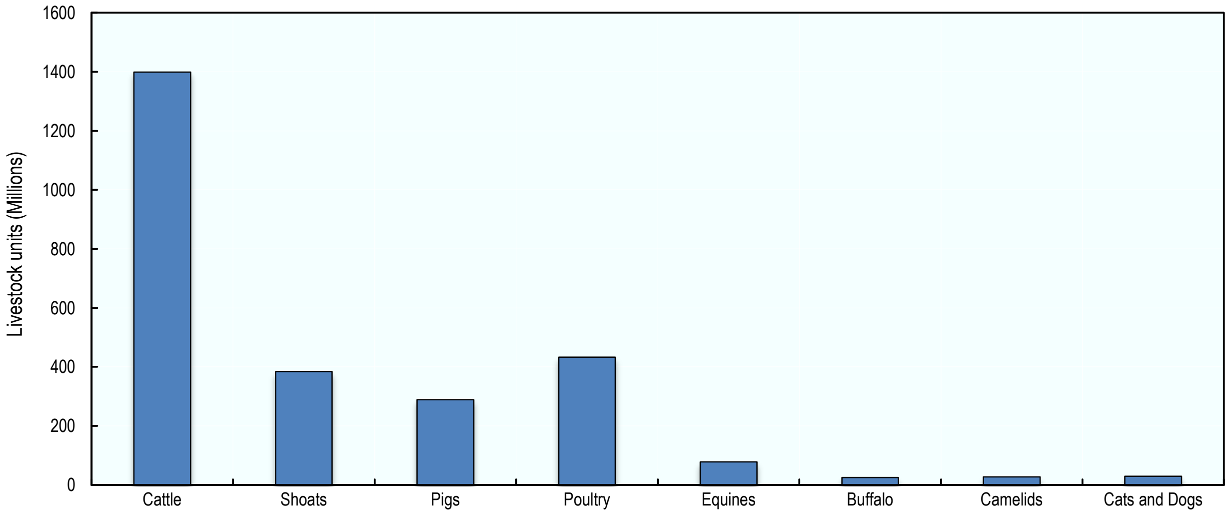
For every person in the world therefore there are approximately 0.38 livestock units, or an estimated 190 kilos of live animals. This means that for every person in the world, there are three chickens, a third of a sheep or goat, a fifth of a cow, a seventh of a pig and a tenth of a cat or dog. There has not been enough time to determine whether these proportions are changing, though it is likely that poultry and pigs are becoming more important based on

1. Livestock Unit = 500 kg liveweight.

increasing populations — particularly of poultry — and increased consumption of meat from these species.

It is therefore clear that animals are important and that livestock, in particular, are critical to food systems. Animals are involved in everything we do; they compete for resources such as land and water, and they pose risks because the diseases they contract can be transferred to humans. Thus, policies to manage animals and the diseases they suffer from remain critical.

Figure 1. Global livestock units by species



Note: Camel = 1.2; Cattle and Buffalo = 1; Equines = 0.7; Pigs and other camelids = 0.3; Sheep and Goats = 0.2; Turkeys and Dogs = 0.05; Chickens, Ducks, other Poultry, Cats = 0.01.

Source: FAOSTAT, 2011 data author analysis.

Economic analysis of animal disease mitigation

Maintaining animal health has led to policies that reflect the importance of livestock in society. Such policies and responses are dynamic, changing as society evolves and advances. As things change, available resources, demand and supply will change as well, which necessitates changes in policies. Susan Jones (2003) explains these changes in her book, *Valuing Animals*. For the United States, she identifies three phases:

- Until the late 1800s and early 1900s, early veterinary science was dominated by horses.
- From the early 1900s to the 1970s, there was a strong focus on food animals.
- More recently, veterinary science has seen an increased awareness of and investment in pet animals.

The ways in which animals are used can vary according to the phase of development for a given society. Many developing countries, for example, still rely on cattle, buffalo, camels and equines for transportation and draught power. This affects the way animals are valued, as well as the products they produce. Countries and regions that use cattle for draught power have lower offtake rates and hence lower meat production, reducing the availability of meat on urban markets (Barrett, 1992). At the extremes, some argue that the importance of draught animals has become entwined with cultural rules, pointing to the as religious taboo of eating beef in India or the meat abstinence observed during Lent in Europe (Crotty, 1980).

The general development of a society and its use of animals influence governmental responses to livestock disease, animal health and welfare. These responses reflect the importance of animals in each society. Key differences are as follows.

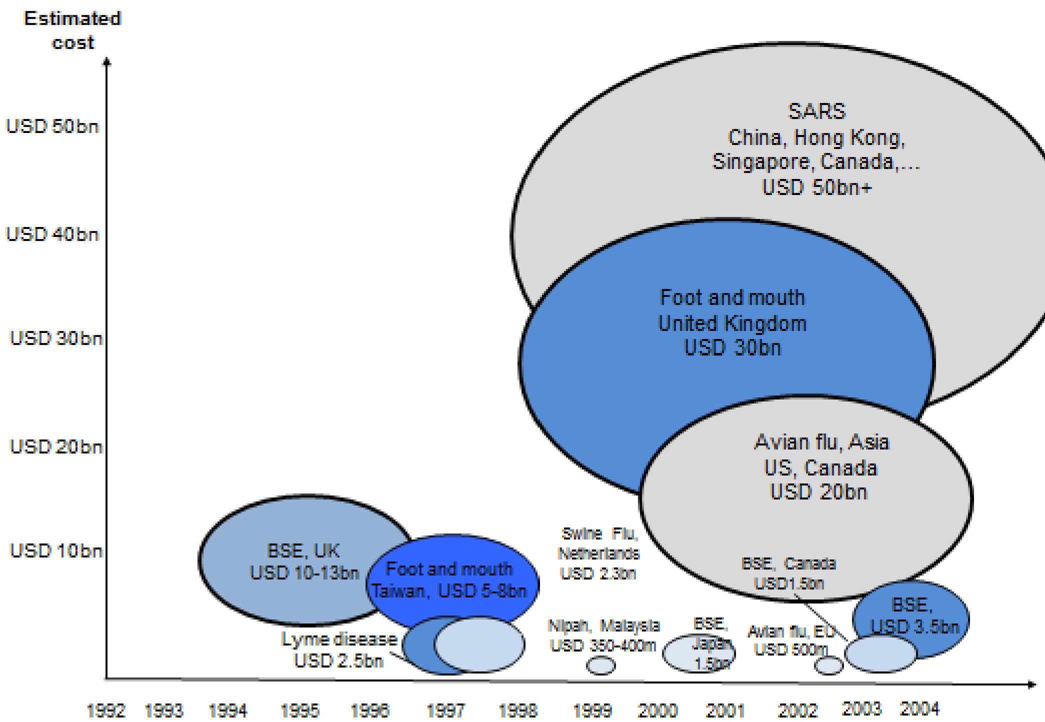
- In countries with a high animal health status and sophisticated livestock agri-food systems, surveillance is critical to limiting public liability and safeguarding private investments (Häsler, 2011).
- Disease eradication and animal health status are critical for exports in countries with emerging export livestock industries.
- Feeding people is critical in countries with food deficits and large, intensive systems.

It is clear that societies are rapidly changing, and that demand for livestock products is increasing. Historically, this has created health problems. The current rate of change has raised new challenges in terms of emerging and re-emerging diseases. Addressing these diseases with adequate investments in health education, research and institutional development remains a major challenge. This is a societal resource allocation and socio-economic challenge.

What do we know about disease impact?

Given the challenges involved with allocating resources for disease management, it is no surprise that economists are working to assess the magnitude of these challenges, while developing stronger tools, methods and data collection procedures. Assessing disease impact remains one of the most important aspects to this economic analysis. Figure 2 presents some examples that are frequently used in presentations.

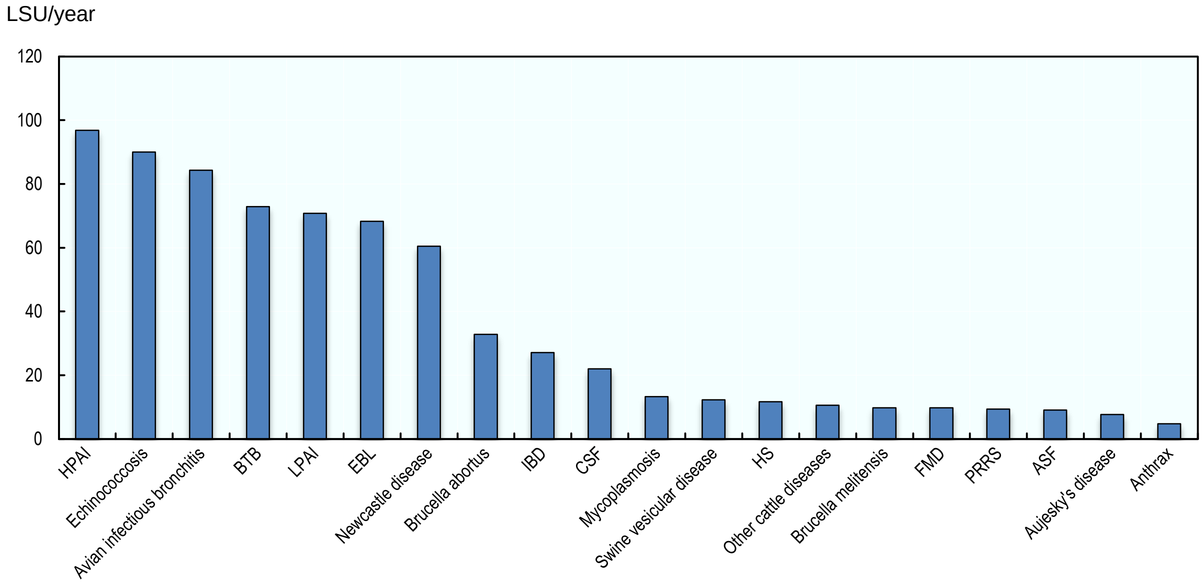
Figure 2. Estimated global impacts of the major panzootics since the early 1990s



Source: Bio-Era. Courtesy of Dr. Will Hueston, Center for Animal Health and Food Safety, UM.

Figure 2 is based on animal disease crises that the world has experienced in the last 20 years. It does not provide information on insidious animal diseases. These estimates are not based on empirical datasets, and in many cases have not been published in peer-reviewed papers. The World Bank and TAFS forum (2011) have attempted to fill this void with a study that looks at the losses of animals (measured as livestock units) by disease. Their work is based on disease incidence data collected by OIE combined with FAOSTAT data on livestock populations (Figure 3).

Figure 3. Estimated global losses of livestock units by major diseases



Source: World Bank, 2010; author analysis.

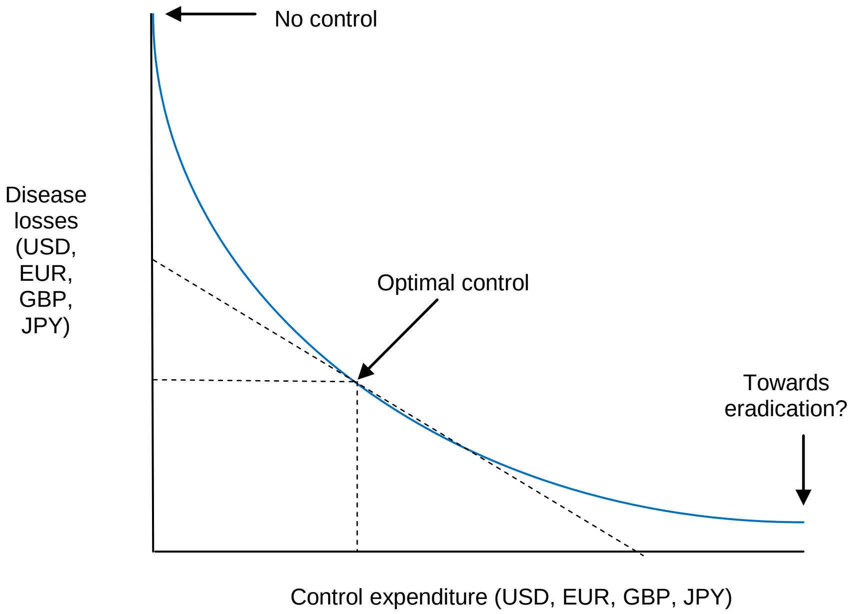
The World Bank/Tufts study (2011) focuses only on animal losses measured as livestock units and therefore follows a logic similar to that underpinning WHO work on human diseases. A livestock unit (LSU) is a standard weight of animal biomass, with one livestock unit usually being an animal of 500 kilos liveweight. WHO work tends to prioritise diseases based on their impact on humans, and measures this impact in daily life-adjusted years (DALYs). This approach ignores other impacts relating to responses to disease presence, including investments in disease surveillance, control and prevention, as well as market-based responses and shocks. Neither of the two highlighted works disaggregate animal disease impact into losses due to production and reactions from societies, businesses and individuals to the presence and/or risk of disease. The only study that has systematically done this was carried out for a list of endemic diseases in Great Britain (Bennett, 2003). This study was later updated to include welfare measures (Bennett and Ijplaar, 2005). Bennett describes and explains the methods he used in the recent special edition of *Eurochoices* (Bennett, 2012), while Perry and Randolph (1999) present a framework for looking at parasites in animal production.

The problem and some solutions

Estimating the overall impact of a disease event is useful in raising the profile of animal health governance and highlighting the need for investments in animal health organisations and institutional environments. Yet it provides little useful information on where scarce disease management resources may be best placed, or how public policy can address important issues of externalities and market failure. See Wolf (2013) for a comprehensive explanation of these issues. If estimates highlight the impact of major crises and look at only a limited spectrum of overall disease impact, significant public funding may be used in reaction to short-term crises such as major outbreaks or diseases. This underscores the need for a more rational use of economics in animal health policy making, which should include better frameworks to assess impact and evaluate change. The results from such work must also be presented in ways that are socially acceptable and politically palatable.

Fortunately, there is no need to start from the beginning. Professor John McInerney examined this problem with Keith Howe and other colleagues over many years. Much of his thinking was summarised in a paper he presented to the Agricultural Economics Society (McInerney, 1996). Through a theoretical application of production economics to animal disease, McInerney identified an area where impacts of disease relate to disease losses and control expenditure. These impacts are connected: higher spending on control leads to lower disease losses. If this relationship can be established, then optimal and sub-optimal points of expenditure can be identified. Figure 4 indicates some of the main points underpinning such a relationship.

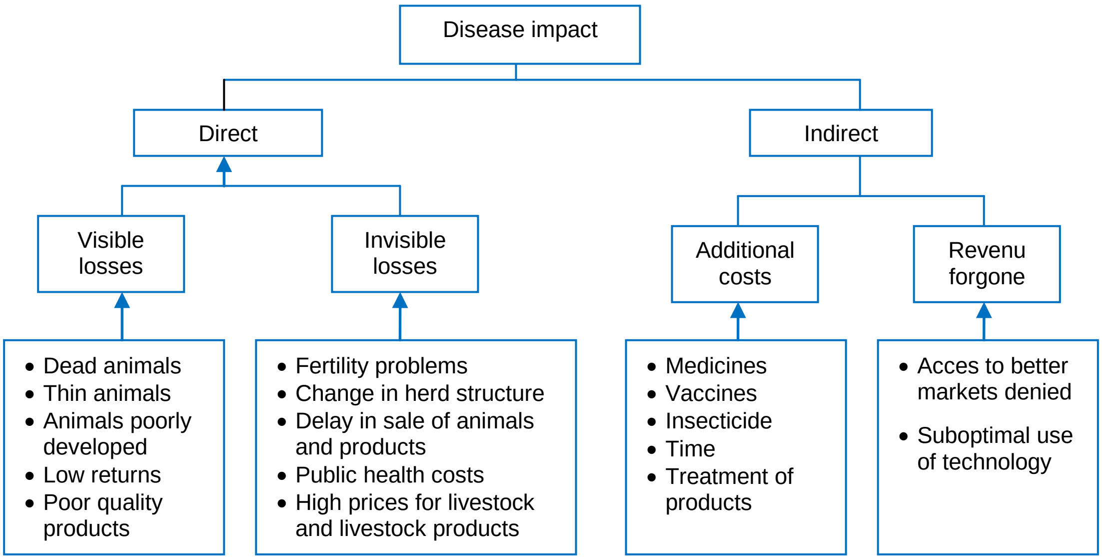
Figure 4. Disease loss – expenditure frontier



In a less theoretical framework, Rushton, et al. (1999) disaggregate animal disease impacts (Figure 5). They identify direct and indirect impacts — the former relating to McInerney's disease losses and the latter being control expenditures related to human reaction to disease presence and risk. They separate the direct impact into visible losses that have immediate impacts (e.g. animal deaths) and invisible losses that usually go unnoticed and often relate to fertility management issues. Among indirect impacts, a distinction can be made between the control measures (additional costs) and foregone revenue. Revenue foregone relates to opportunities that are lost due to the presence or risk of disease. For example limited or no market access, and the selection of technologies, such as breeds by farmers and people along the food system. Knight-Jones and Rushton (2013) present a practical application of this method for FMD at a global level.

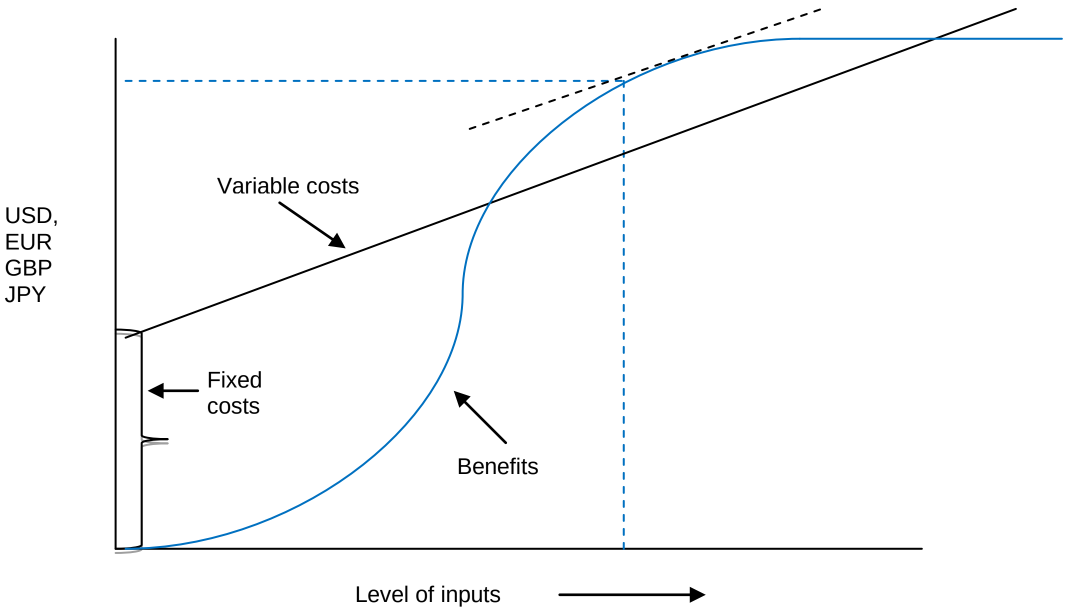
When developing a framework, one must recognise that not all costs are equal. Some relate directly to an animal disease management process and could be defined as variable costs. Others cannot be so easily assigned, and relate to the development of infrastructure, training, and organisational capacity in general. These can be defined as fixed costs. Professor Clem Tisdell examined this issue more carefully during his work on FMD in Thailand, and proposed that countries that do not invest in fixed cost elements of their animal health systems would find it difficult to incorporate and succeed with individual disease management campaigns. Tisdell (2009) developed a theoretical framework around his arguments (Figure 6).

Figure 5. Elements required for disease impact assessment



Source: (adapted from Rushton et al., 1999).

Figure 6. Cost-benefit model for livestock disease control with fixed costs



Source: (adapted from Tisdell, 2009).

Once these weaknesses are identified, policy changes (e.g. legislation and/or direct interventions) need to be assessed using a classic cost-benefit analysis framework. This framework examines marginal changes in costs and benefits over time and assesses the economic profitability of a given change.

Costs and benefits of animal health policies

When assessing the costs and benefits of animal health policies, one must identify additional costs and new benefit streams. Mitchell, et al. (2012), present a very understandable and clear approach to this problem. This approach can be used as a framework for incorporating more complex methods of examining market impacts and possible price changes.

As mentioned above, fixed costs for animal health include investments in coordination, research, information and key infrastructure — areas that have traditionally been under governmental control. Yet in some countries, private sector skills and investment are making government involvement less important, particularly in contexts where power is concentrated in agri-food systems. In such situations, private organisations are large enough to invest in infrastructure for animal health, and in some cases may be powerful enough to coordinate and manage disease control processes. This is increasingly the case in sectors such as the poultry industry, where some companies act as quasi state-like organisations. From a public policy perspective, it is important that animal health investments create synergies with on-going private investments.

The variable costs described above are specific to a disease campaign, and will vary with the level of a campaign's activity. They include the use of vaccines, anti-parasitic drugs, medicines and diagnostics, with state support ideally being dependent on whether the benefits derived from medicines can be captured by the individual (public *vs* private goods as explained in Wolf, 2013, and Hennessey, 2013). Questions concerning the state's role usually hinge upon whether a market failure has arisen.

If economics is used as described above, cost estimates for animal health interventions should guide policy on allocating public investments, and can be used for financial and social cost-benefit analyses of proposed policy changes.

Benefit streams for future investments are predictive, not definitive. For animal health decisions, they are based on epidemiological and market models. Market models are dependent on epidemiological models, and each contain levels of uncertainty. Explanations of models used to look at market impacts and the beneficiaries of proposed changes can be found in Upton (2009), Rich, et al. (2005) and Paarlberg (2013).

Evaluating a change

Rushton (2009) gives an overview of the different methods available to assess change and differentiates these methods from individual or farm level assessment tools and from tools for wider societal issues. Upton (2009) provides an overview of the methods available to assess impacts on prices and markets. Rich, et al. (2005) also provide a summary of the main economic methods and models used in assessing livestock diseases, downplaying the central role that cost-benefit analysis has played in previous works. (Animal health has traditionally used cost-benefit analysis as the method for assessing change.) Gittinger (1980) provides an excellent explanation of cost-benefit analysis and gives a clear explanation of how to incorporate cost-benefit analyses into livestock population models. The discipline of human health has much more experience and willingness to use cost-effectiveness analysis (Drummond, et al., 2005). Neither area of research has seen a need to develop ranges of outcomes, although Carpenter (2013) explains how this can be represented.

Presenting levels of uncertainty and strategy options should be a critical aspect of decision making. However, this can create difficulties in relaying information back to a policy maker, and many often resort to simple measures of project worth such as benefit-cost ratios or net present values for single strategies. Reducing the complexity down to simple ratios for single interventions can ease communication, but such analysis cannot be described as economics because it does not search for the best resource allocation across society.

Which discount rate?

A discount rate measures the rate at which one is willing to trade present for future consumption. It remains one of the most critical inputs in cost-benefit analysis. For public projects, two different measures (Lopez, 2008) can be used: Social Opportunity Cost of capital (SOC) and Social Time Preference (STP)

SOC indicates the need to measure investments in purely economic terms of the returns of capital across the economy, whereas STP implies the need to look at longer and less quantifiable aspects of investments. Animal health decision making creates an interesting dilemma between a productive industry and the well-being of society. The choice of discount rate is dependent on the type of diseases. Diseases with a public health impact, such as the zoonoses, should use a lower discount rate (STP), whereas diseases controlled in ways that are beneficial to commercially run companies while improving economic efficiencies should use a higher rate (SOC).

Economic logic for an intervention: Is it enough?

An investment is deemed worthwhile if avoidable losses generated from a disease management process are greater than costs of a change in disease status. This is normally measured using the metrics from a cost-benefit analysis, which simply measure economic profitability. These metrics give no indication of financial feasibility, and only a limited assessment of social acceptability and political palatability.

Are the tools appropriate?

Decision making using cost-benefit and cost-effectiveness analysis would appear to have limitations. The mixing of fixed and variable costs in the analysis may not allow for an examination of where activities are adding value to the overall animal health system. A complete ground zero cost-benefit analysis does not help in this regard. Lessons could be learned from other areas, such as farm management or business. A suggestion for further exploration would be to separate the fixed costs of the system — including infrastructure, salaries and maintenance — and identify all the activities that are part of the system. Each discrete activity would be associated with the specific resources it uses and its variability with activity levels. These would be akin to the variable costs identified in a gross margin analysis. The benefit streams could be estimated in terms of the disease reduction achieved where a disease is endemic. If a disease, health or welfare problem has been eradicated, benefit streams could be estimated in terms of the re-entry costs of that problem along with an estimation of the likelihood of re-entry. The suggestions from Paarlberg (2013) and the work presented by Carpenter (2013) would contribute to such work, as they use complex modelling approaches to examine the impact of disease.

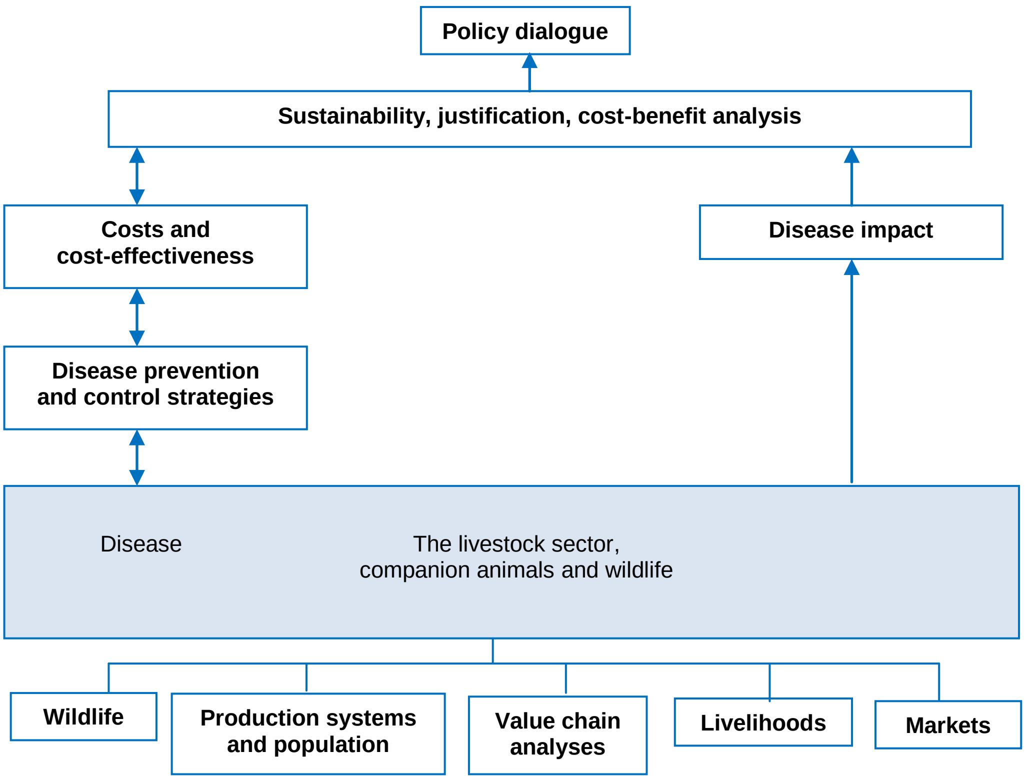
These suggestions are based on the theoretical frameworks proposed by McInerney (1996) and Tisdell (2009), which underscore the need to examine the variable application of resources to animal health problems. These frameworks could also be used to develop relationships between resource use and outcome, or to examine the switch between animal health activities under a constrained budget. The examination of resource allocations across animal health activities could be placed in a linear programming process with very narrow objectives of either cost minimisation or maximisation (if benefit streams are available) within desired constraints. For countries within the European Union, some of these constraints would be legal requirements; this approach would be useful in examining the change in outcome with the relaxation of legal constraints.

Suggestions for the future

Impact assessment frameworks are needed to identify bottlenecks in animal health and welfare management. In addition it is important that such impact assessments collect and document the public and private expenditure (see Gilbert and Rushton, 2013) on animal health and disease management in order to generate cost profiles. Many governments currently focus their work on public expenditure which is a partial and limited picture of expenditure across a society. In order to achieve a more complete picture the impact assessment frameworks need to direct national and international data collection efforts.

There must be clear information on the capacity of the private sector to manage fixed costs, and this is particularly relevant in situations where livestock sectors are becoming integrated with a small number of large companies. Economics needs to be incorporated in epidemiological models, as well as in the monitoring and evaluation of animal health projects and programs. The state's role must be better defined with regard to coordination, legislation and investment in research and information provision. One must also understand that cost-benefit analysis only provides an estimate of economic profitability. Overall, good policy dialogue needs to build on data from different areas of the economy, as well as analysis that incorporates biological, technical and economic disciplines. Figure 7 presents a summary of this approach.

Figure 7. Elements required to build a sound economic assessment of animal health and welfare problems



Conclusion

Livestock health is important to societies across the world. Economic analysis of animal health is complex and disease-dependent. This complexity only increases at a policy level and requires a systems approach with interdisciplinary working. Such analysis must account for the roles that animals play in society and the prices of resources they compete for. This implies that a realistic assessment of costs and benefits from animal health policy making will be complex. The communication of results should focus on what decisions need to be made and why, using economic principles to focus on resource allocation. Wider societal issues such as social acceptability and political palatability should also be considered and included. Once programs are established, they must be regularly reviewed with the same rigour in order to avoid institutionalisation.

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