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# Preparing for animal health emergencies: considerations for economic evaluation

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**Summary**

Livestock production systems and the societies in which they are embedded face a set of risks presented by infectious diseases and natural and human-made disasters which compromise animal health. Within this set, threats are posed by natural, deliberate and accidental actions that can cause sudden changes in animal health status, requiring the allocation of additional resources to manage animal health. Determining the benefit of preparing for such emergencies is a challenge when the total set of risks includes the unknown. Any method for analysing the economic costs and benefits of animal health emergencies must not only accommodate this uncertainty, but make it a central feature of the analysis.

Cost–benefit analysis is a key approach to economically evaluating animal health interventions. However, the value of this approach in dealing with uncertainty is often called into question. This paper makes the case that, by restricting the outcomes of an emergency event to specified states of nature, boundaries can be placed on the uncertainty space, allowing cost–benefit analysis to be performed. This method, which merges state-contingent analysis with cost–benefit analysis, is presented here. Further discussion on the economic characteristics of emergency events, and the nature of the threats posed to animal health systems, is also provided.

**Keywords**

Agroterrorism – Cost–benefit analysis – Emergency – Risk – State-contingent analysis – Uncertainty.

## Introduction

In the wake of the Al-Qaeda attack on the United States of America (USA) on 11 September 2001, the risk of biological agents being used for terrorist purposes was identified as a present and credible threat to the public. Agroterrorism is defined as a deliberate attack on agriculture that may include the deliberate release of pathogens into animal or plant populations, with the objective of destroying agriculture and disrupting food supplies. While deemed to be a low-probability event, the potential impacts may be significant. Consequently, governments have sought to identify high-risk pathogens and to review their investment in risk mitigation and emergency preparation measures (1).

Agroterrorism is just one of a series of natural or human-made animal health events that may require an emergency response. Agroterrorism is considered a low-probability and high-impact event since, while a single act may cause devastating outcomes, it may equally never take place. These events pose complex problems for evaluation, making it difficult to justify investment into preparation to combat or prevent such outcomes.

This paper will explore the conceptual basis for evaluating investment into preparing for high-impact, low-probability events. To do this, we must not only be able to separate the costs and benefits from alternative investments, as well as deal with risk and uncertainty, but also separate fear from logic to help us make rational decisions. There is no guarantee that unlimited funding will prevent every future incident of agroterrorism. Equally, there is no guarantee that a single agroterrorist incident will ever occur. Based on experience, however, it can be guaranteed that there will be a significant emergency (natural or human-made) response needed from animal health services somewhere in the world, sooner rather than later.

Thus, it is necessary to define what constitutes an emergency in the context of animal health. If we consider the set of all pests (diseases, weeds, vertebrate pests, pathogens, etc.) that may affect a given production system in a given location at a given time, we can define the 'background pest load' (2). This background pest load then defines the endemic pests that shape production system investments. We can define the frequency (i.e. how often they occur), the management approach (i.e. the costs used to control the pest) and the outcome of that management (i.e. yield and price). The background pest load identifies the known risk and determines the returns from alternative livestock production systems.

The risk posed by pests is not static over time. Changes in climate, land use and trade patterns can introduce new pathogens or induce changes in the background pest load (3, 4). Such changes can be gradual or sudden, deliberate or accidental, and have the potential to alter the rate of return from existing livestock production systems. An animal health emergency occurs when a sudden change in the background pest load necessitates the allocation of additional resources to protect capital investment in livestock production.

For this paper, the authors define:

– animal health management (AHM) as the impact of the background pest load in an area in a given time period

– emergency animal health management (EAHM) as the impact of a sudden shock to the background pest load, causing additional private or public resources to be allocated to protect existing capital investment in livestock production.

We can then consider the difference between AHM and EAHM as the difference between the management of known risks to production choices, and the management of unknown risks or uncertainties that production systems may face. For this article, the authors limit the discussion to EAHM resulting from one of the following:

– a natural event, such as the natural movement of a disease or vector

– an accidental event, such as the introduction of disease through trade in livestock or livestock products

– a deliberate event, such as an agroterrorist attack or act of commercial sabotage.

To begin assessing the economic value of emergency preparedness, it is necessary to quantify the costs of preparing for emergencies, and the economic impact of livestock disease. The impact of disease is likely to be shown as a combination of direct costs, that is, the effects of the disease itself, and the response costs incurred in reaction to it (Fig. 1). These costs will not necessarily be limited to the livestock sector or consumers of livestock products,

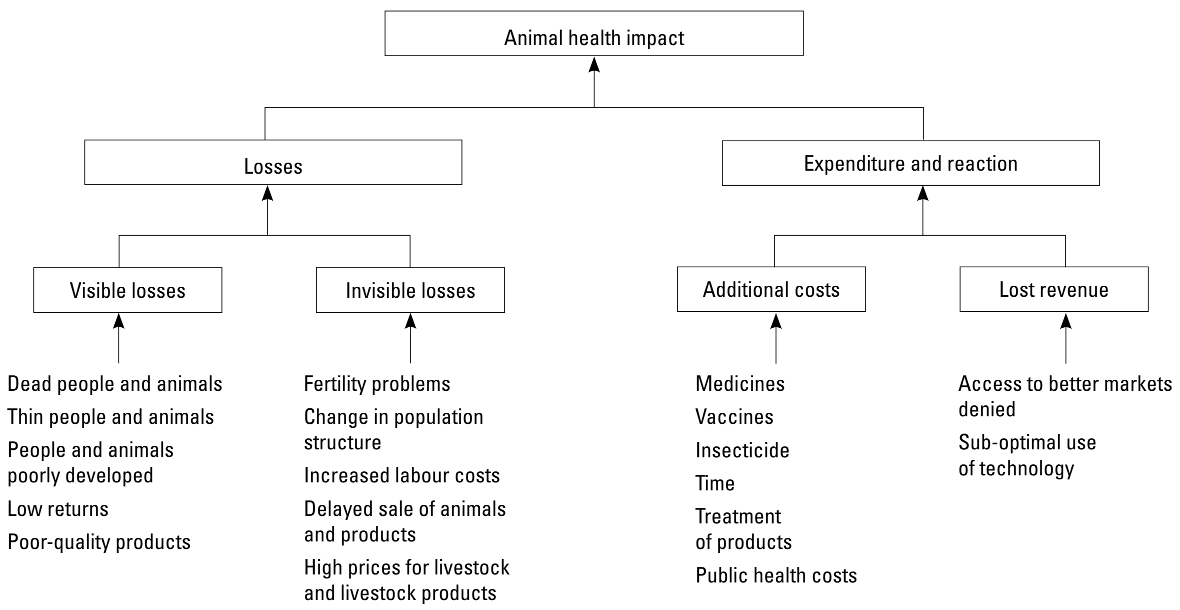


**Fig. 1**
**The economic impacts of livestock disease** (5, 6)

but can reach into other sectors of the economy, such as tourism, leisure and human healthcare. The economic case for preparedness hinges on whether the magnitude of these impacts in the future can be reduced by investing in Veterinary Services in the present.

# Investing in emergency preparedness

Emergency preparedness and response are public goods. Public goods are those goods and services which benefit everyone, in that those who do not pay cannot be excluded from using them or benefiting from their provision. As a result, markets do not provide incentives for private institutions to supply public goods at the level needed for society to operate at its optimum level. Public goods are therefore funded by government institutions and some benevolent non-governmental agencies to improve public welfare.

Governments allocate resources to manage both the existing background pest load (AHM) and new risks (EAHM). Emergency animal health management funding may take various forms: reducing the risk of an outbreak occurring (e.g. monitoring), or reducing the severity of an outbreak (e.g. research and development, and having resources ready to combat the first signs of an outbreak). With limited public budgets, the quantity of resources allocated to AHM and EAHM needs to be justified. Cost–benefit analysis (CBA) is a process of evaluating the returns from allocating economic inputs (land, labour and capital) into different investment options over time. It permits the incorporation of risk and uncertainty into evaluation. In this paper, the authors will explore the application of CBA to emergency preparedness in animal health. State-contingent analysis (SCA) will be presented as a way of conceptualising the uncertainty related to the diversity of potential changes in the background pest load. Although CBA can be undertaken from an individual (private) or institutional (public) perspective, this paper will limit the discussion to institutions.

Examining the costs and benefits of EAHM from an institutional perspective requires us to explore a number of questions, including:

1. What are the costs of emergency preparedness?

2. What is the potential impact of an animal health emergency?

These questions each present challenges to empirical analysis. First, examining the costs of emergency preparedness requires an assessment of Veterinary Services budgets and identification of those activities relevant to EAHM. Within those budgets, fixed-cost investments are often multi-purpose, such as salaried staff and infrastructure. While these can be diverted in case of an animal health emergency, the opportunity cost of this investment is only captured by evaluations after the event, and these are not often performed.

Second, Veterinary Services themselves are often subsumed within a larger Ministry, such as the Ministry of Agriculture or Food, and compete for funding with other executive agencies. As a result, forecast expenditure does not always translate to actual expenditure, as resources may be reallocated to other departments in the budget period. Funds may be misappropriated, or accidentally allocated against different accounting line items, and the costs of animal health services may also be supported by donor aid or other non-governmental organisations. Furthermore, effective emergency plans may require the coordination of other Ministries, such as Health and Security, which would not be visible by examining only Veterinary Services budgets. In summary, significant uncertainty is present when trying to assess current spending on emergency preparedness.

Third, in order to understand the potential benefits of emergency preparedness, it is also necessary to identify a range of potential impacts that can be mitigated by an effective response. If we begin with the category of pathogens, various classification systems developed by national and international institutions provide listings of candidate organisms with the potential to cause an animal health emergency. Dual-use biological agents are those which are considered to exist naturally but which also have potential application as a biological weapon (e.g. anthrax). Examining the dual-use listings of the USA (7), the People's Republic of China (8), and the Australia Group of countries (9) produces a list of 83 agents. Of these, 40 have a direct impact on livestock (including horses) and more than half are zoonotic (Table I). As can clearly be seen, these pathogens are highly variable in their taxonomy, host specificity, virulence, zoonotic potential, pathology and transmission modes, and therefore also in their potential impact.

Fourth, in addition to the broad group of organisms that make up the set of known threats, there is also the possibility of new and emerging pathogens, which pose an unknown set of threats. Calculating the impact of the unknown relies on making assumptions, each parcelled with an additional degree of uncertainty.

In recent years, changes in land use are thought to have driven the emergence of a number of newly identified viral zoonotic pathogens, such as severe acute respiratory syndrome-associated coronaviruses (SARS-CoV, SARS-CoV-2), Middle East respiratory syndrome coronavirus (MERS-CoV),

**Table I**
**Pathogens identified as biological warfare or bioterrorist threats to livestock or horse populations, including zoonotic pathogens**

| Affecting livestock or horses | Affecting livestock or horses, and humans |
|---|---|
| African horse sickness virus | Avian influenza virus |
| African swine fever virus | *Bacillus anthracis* |
| Bluetongue virus | *Brucella abortus* |
| Classical swine fever virus | *Brucella melitensis* |
| Foot and mouth disease virus | *Brucella suis* |
| Goat pox virus | *Burkholderia mallei* |
| Lumpy skin disease virus | *Burkholderia pseudomallei* |
| *Mycoplasma capricolum* | *Chlamydia psittaci* |
| *Mycoplasma mycoides* | *Clostridium botulinum* |
| Peste des petits ruminants virus | *Coxiella burnetti* |
| Swine vesicular disease virus | Eastern equine encephalitis virus |
| Rinderpest virus | *Francisella tularensis* |
| Sheep pox virus | Hendra virus |
| Suid herpesvirus 1 (Aujeszky's disease or pseudorabies) | Japanese encephalitis virus |
| Swine vesicular disease virus | Louping ill virus |
| Teschen disease virus | Lyssavirus |
| | Murray Valley encephalitis virus |
| | Newcastle disease virus |
| | Nipah virus |
| | Rift Valley fever virus |
| | Venezuelan equine encephalitis virus |
| | Vesicular stomatitis virus |
| | Western equine encephalitis virus |
| | *Yersinia pseudotuberculosis* |

and the Nipah and Hendra viruses (10). Changes in climate can introduce existing pathogens and vectors into new geographical ranges, as happened with the Chikungunya and West Nile viruses (11), while human actions can accidentally produce the same result, as happened with the introduction of African swine fever to the Caucasus in 2007 (12). In addition, antigenic drift and shift, horizontal gene transfer, and the application of selective pressures, such as antibiotic therapies, can produce new variants of existing pathogens, such as the H5N1 strain of highly pathogenic avian influenza (13), and methicillin-resistant *Staphylococcus aureus* (14). As in the case of bovine spongiform encephalopathy (BSE), there is always the potential for human actions to produce consequences which are totally unanticipated (15), while deliberate manipulation of pathogens to create new variants is becoming increasingly possible with the advent of technologies such as clustered regularly interspaced short palindromic repeat (CRISPR)-associated protein 9 (Cas9) genetic editing (16). The release or manufacture of weapons based on pathogens which have been previously eradicated is also acknowledged to be a real threat (17).

The interplay of all these factors makes identifying the entire set of animal health emergencies that may occur an impossibility. What can be done, however, is to explore the literature to determine a set of emergencies for which economic impact analysis has been performed, thus determining a range within which future events are likely to occur, while still acknowledging a certain level of uncertainty.

The literature on the economic impact of animal health emergencies in itself presents challenges to meta-analysis. Any economic analysis has four key issues to consider (18) and animal health emergencies are no different.

1. What is the scale of the analysis?

The scale defines the institutional level at which the animal health event is managed. Should the impact be analysed at a farm level, a local level, a regional level, an industry level, a national level or an international level?

2. What is the scope of the analysis?

The scope refers to the number of different issues that the analysis should consider. In the case of animal health emergencies, should the analysis consider certain groups (e.g. farmers, export markets, etc.) where market values are easily found? Or should the analysis also include those goods and services for which non-market analysis is required (e.g. environmental impact, the effects on animal welfare, etc.)?

3. What is the timing of the analysis?

Economic analysis can be performed before events occur, to assist in allocating resources to prepare for animal health emergencies and to establish essential metrics to monitor the situation. At the beginning of the event, economic metrics can be used to assess whether an emergency response is warranted. Review points during the event can be used to determine whether the emergency event has progressed to a stage where it changes from an emergency response to an eradication or management phase. After the event, reviews of its economic impact can be used to identify improvements for the future. Determining at which point published analyses have been performed is therefore a necessary part of any meta-analysis.

Is the analysis being conducted before the event (e.g. to invest in funds to have resources ready to combat any future adverse event) or at the beginning of the event (e.g. does the event meet the metrics required to initiate an emergency response)? Does it take place at a review point during the event (e.g. has the emergency event progressed to a stage where it changes from an emergency response to an eradication or management phase) or after the event (e.g. to determine improvements for the future)?

4. What is the space over which the analysis will occur?

The space is the geographical range encompassed by the analysis. When evaluating an EAHM, this can combine both the area in which the outbreak occurs, and the area which feels the economic impact. Collaboration with epidemiologists is therefore important for exploring spatial spread.

Within the domain of animal health economics, there is no agreed position on these four axes that is applied in all studies of disease impact. This issue was identified by Pritchett *et al.* (19) in 2005, and ten years later by Inamura *et al.* (20), indicating that progress has been slow in forming a consensus on how economic analyses of livestock disease emergencies should be carried out. The result is that there are relatively few studies which are sufficiently methodologically consistent to allow meta-analysis of all dimensions of economic impact. However, the commencement of the Global Burden of Animal Diseases project may herald the beginning of harmonised data collection and analysis processes across the animal health sector (21).

# Cost–benefit analysis and dealing with uncertainty

Cost–benefit analysis provides a helpful framework for analysing the known costs and benefits of alternative investments. It typically models economic outcomes based on scenarios 'with' and 'without' the intervention in question. However, the role of CBA in dealing with uncertain future events has been questioned in the literature, for several reasons.

The first is that CBA relies on converting future costs and benefits to present values. However, the selection of an appropriate method for determining values (using market versus non-market techniques) and the appropriate time scale for estimating this for emergency events can be debated. Second, where events may or may not occur, this probability assessment must be reflected in the valuation process. Finally, CBA relies on the comparison of clearly defined scenarios, and has thus been criticised as being unable to represent the unknown (22).

Discount rates provide a mechanism to bring all future benefits and costs back to a given year to compare between investment options. The further the benefits occur in the future and the higher the discount rate, the greater the bias against future returns. In the case of public goods, it is argued that a low discount rate is most appropriate, so it follows that a very low-to-zero discount rate is needed when considering investment in EAHM (23, 24, 25). Where funding is targeted to prevent a catastrophic event that will harm society (26), a low discount rate is suitable to protect social welfare.

It is hoped that the discussion to this point has illustrated the level of uncertainty present in any evaluation of emergency preparedness, partly because emergencies by their very nature are unpredictable, and partly because of the inconsistent collection of the relevant data to inform assumptions. While evaluation, monitoring and research may identify and detect known risks, it is the unknown issues that pose the true complication for emergency response. For known risks, a level of risk can be calculated, the critical entry points identified, and management responses that reduce the risk and provide the greatest net welfare benefit to society can be devised (27). While these forecasts may be imperfect, they can be upgraded over time, adding greater clarity to what is known. It is those things that take us by surprise, however, that can create the greatest strain on emergency response networks, and on the methodology used to analyse investment. To integrate this response to uncertainty into the model, the authors turn to the approach suggested by Adamson and Loch (22), which merges SCA into CBA. This method resolves both the second and third points of objection above, and the following section will articulate precisely how SCA provides a platform to model risk and uncertainty.

# State-contingent analysis

In the SCA approach, nature ($\Omega$) defines the complete uncertainty space, which can be divided into a series of real and mutually exclusive states of nature ($s$), so that ($\Omega = [1, 2, \ldots, S]$) (28). In the case of an animal health emergency, $s$ refers to the emergency state (i.e. no emergency, a small emergency, a large emergency), in which each emergency is characterised by its scale, scope, time and space. These characteristics should also describe the management approach and the outcomes from that approach for each $s$.

The decision-maker has no ability to influence which $s$ occurs, but does have a subjective understanding of the probability ($\pi$) of each $s$ occurring. For a CBA, the 'with' versus 'without' intervention scenarios have a different probability of each $s$ occurring, but the description, management solution and outcomes for each $s$ remain constant. The decision-maker then knows exactly how to allocate his or her resources to mitigate risk in the event of each $s$. The SCA approach then removes the ambiguity (29) found in other approaches for dealing with uncertainty, as both the signal of uncertainty and the response to that uncertainty can now be evaluated (30).

State-contingent analysis thus helps decision-makers to prepare for alternative states of nature. When new information becomes available, the decision-makers can update their estimation of frequency for each state of nature, and reallocate their resources appropriately. This capability can be shown by directly exploring rare states of nature (those that have a low probability but severe consequences) through a simple graphical analysis of a typical mean-variance model.

In Figure 2, a normal distribution truncated at zero is plotted, which provides a representation of outcomes of a disease event from 0 (no impact) all the way to total loss (*X*). At the first statistical division (σ), 68% of all values are encapsulated; at 2σ, 95.5% of all values are encompassed; and by 3σ, 99.7% of all values are captured. However, this representation provides no information on how management interventions should be adapted in response.

In Figure 3, EAHM is represented within an SCA framework by dividing uncertainty into states of nature (i.e. no emergency, a small emergency, a medium emergency, and a large emergency). In this case, the decision-maker can now define what the emergency would represent in each state; its range of impacts based on scale, scope, timing and space; the set of management responses to each state of nature; and the frequency of occurrence. This allows the exploration of those rare events making up the tail of the distribution. In a CBA framework, the sensitivity of the system to each state of nature can be explored, and the management solutions that fail to protect capital can be determined. Changes in policy or increased threats can then easily be represented, either by re-describing the states of nature, their inputs and outputs, or by changing their frequency. As the model solves each re-described state of nature or change in frequency, the decision-maker can determine new optimal solutions, mimicking adaptation.

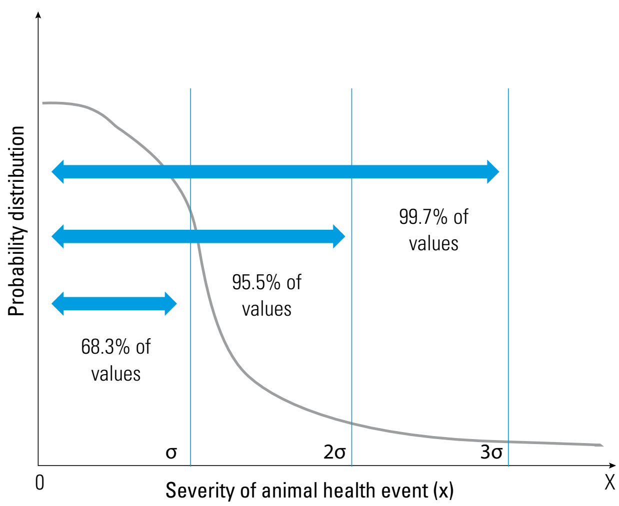


**Fig. 2**
**Normal distribution of animal health events**

In examining the economic impact of animal health emergencies, this paper has focused on describing events in terms of their scale, scope, timing and space. It is these four dimensions that determine the economic impact of an animal health emergency on society. The essential aspect of evaluating investment in emergency preparedness will be to develop a realistic 'story' that defines the differences in scale, scope, time and space between the 'with' versus 'without' investment narrative that is central to the cost–benefit analysis. The alternative 'with' and 'without' narratives define the changes in decision-making and in the resources used in dealing with a problem.

# Discussion

As SCA allows us to define states of nature and the response to those states of nature with certainty, ambiguity is removed. However, as the authors discuss above, EAHM remains fraught with uncertainty. This methodology allows restrictions to be drawn around the range of possible outcomes. However, the reality is that, during an actual event, the unpredicted can still occur. While some disease emergence and agroterrorism pathways can be described, the future is unwritten and new risks will inevitably emerge. It will be up to the individuals responsible for minimising harm to stay vigilant, maintain and improve response capacity, and be ready to deal with such emergencies.

In this respect, the set of possible agroterrorism or deliberate pathogen-release events is a relatively unexplored space. What is the objective of a deliberate act to create an emergency animal health event? Intriligator (31) treats terrorism and counter-terrorist agents as utility maximisers (i.e. those who seek to get the highest satisfaction from their economic decisions). But this goal of maximising utility is false for terrorism. In reality, terrorists can be considered

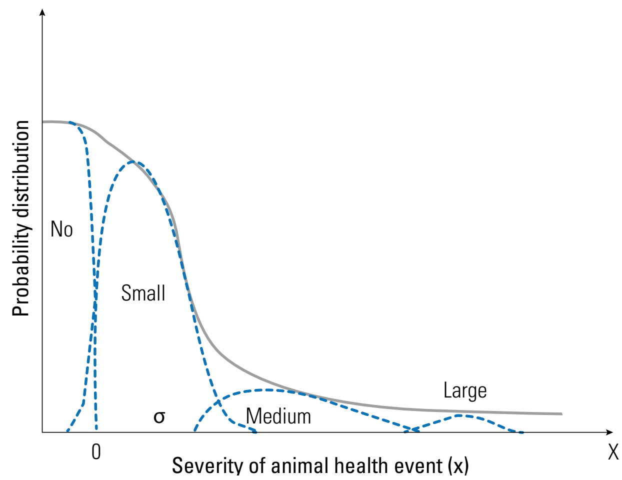


**Fig. 3**
**State-contingent analysis representation of probability of alternative events occurring**

utility satisfiers; in that a 'good enough' rather than a 'perfect' outcome is acceptable (32). There will always be a trade-off between media exposure and damage created from a deliberate act, so that any action (successful or otherwise) will have a high pay-off in CBA terms. Any deliberate release of a biological agent, even in a non-vital part of the supply chain, is likely not only to create fear, but also to gain widespread media attention. In turn, this attention may inspire other non-affiliated and unknown 'lone wolves' to act (33). For example, sending anthrax by mail (34) may not result in casualties, but the fear generated may provide a satisfactory outcome. If a critical part of the supply chain is compromised, then the impact would certainly overlap with the set of known events, leading to a reallocation of resources (35) and market share (36), reducing consumer trust for that product (37), and shattering known value chains (38, 39).

Taking appropriate action at the appropriate time can prevent local emergency events from spreading to a regional, national or international scale. Expertise and familiarity with local conditions can help decision-makers to identify risk creators and minimise transmission along the animal value chain, as well as contact points for human exposure to zoonotic pathogens. These features emphasise the importance of treating emergency preparedness as a system, and seeing investment in human capital as an essential component of emergency response, a component that complements capital investment in contingency plans, infrastructure or systems. Central to the implementation of any contingency plan or emergency response, therefore, are the people implementing that plan; their skills are key to any successful intervention. In addition, the relationships necessary for a multisectoral response from Veterinary Services, law enforcement, human health services and others should be strengthened in 'peace time' (i.e. when no emergency is occurring) to facilitate a swift and effective reaction when necessary.

One real advantage of investing in preparedness for EAHM is that it takes less time to deploy resources when an emergency occurs, limiting its economic impact. It is important to remember that this investment is complementary to preventative measures, such as quarantine and border inspections, which reduce the probability of an emergency event occurring in the first place. The portfolio of emergency preparedness measures, however, should include measures that specialise in the known threats, such as disease-specific contingency plans, as well as those that increase cross-cutting competencies, such as laboratory diagnostic capacity and passive surveillance systems. These cross-cutting competencies are likely to be used when facing both known and unknown threats.

In this regard, the World Organisation for Animal Health (OIE) Performance of Veterinary Services (PVS) Pathway (40) provides a route by which Veterinary Services are able to identify areas of strength and weakness, and examine resource allocations for both cross-cutting competencies and specific responses. This enables governments to target and monitor capacity-building activities for emergency preparedness in Veterinary Services. Competencies related to disease emergencies may also be valuable in other types of emergency, such as natural disasters, and this should be considered in any future analysis.

Funding is just one piece of the puzzle, and care is needed when dealing with institutional frameworks, which require both careful design in their development and rigour in carrying out their allotted duties. When institutions must multitask, the incentives offered for each task must be equal, otherwise the institution will primarily allocate resources to the activity with the greatest return (41). In countries where institutions and regulations are lax, no injection of funding for a specific goal will fix the underlying institutional weaknesses, nor will it provide a sustainable solution to the problem.

Funding to prepare for animal health emergencies and agroterrorism events faces diminishing marginal returns. It is true that the risk of agroterrorism decreases as funding increases (42), but it is impossible to guarantee sufficient funds to develop a perfectly safe system. There will always be some level of risk that society must face. If an event does occur, inevitably a lack of funding will be blamed, especially if it leads to loss of life. It is the responsibility of governments, briefed with the most up-to-date analyses, to determine the level of acceptable risk to be passed on to society. State-contingent analysis brings advantages when it comes to bridging the gap between the scientific and policy-making communities. By exploring different metrics of impact, such as disability-adjusted life year cost, jobs lost, or animals culled, acceptable risk thresholds can be set for different emergency preparedness strategies.

# Conclusions

Risk and uncertainty lie at the heart of agroterrorism and animal health emergency preparedness. A set of tools exists with which it is possible to articulate the risks and explore the uncertainties. The role of economic analysis, in this case, is to explore the uncertainty space, provide guidance, and help decision-makers to reach a conclusion by articulating the advantages and disadvantages of investment in emergency preparedness. Assessing an acceptable level of risk is not a purely economic problem, and deciding how emergency funding is apportioned is the responsibility of governments. It is their perception of risk, and the level of risk they are willing to pass on to society, that will determine funding and the manner in which it is allocated.

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# La préparation aux urgences zoosanitaires : les éléments à prendre en compte pour une évaluation économique

D. Adamson, W. Gilbert, K. Hamilton, D. Donachie & J. Rushton

**Résumé**

Les systèmes de production animale et les sociétés dans lesquelles ils s'inscrivent doivent faire face à une série de risques associés à des maladies infectieuses ou à des catastrophes d'origine naturelle ou anthropique, qui représentent une menace pour la santé animale. Parmi ces risques, certaines menaces résultant d'actions naturelles, délibérées ou accidentelles peuvent modifier de manière drastique la situation sanitaire des cheptels et imposer d'allouer des ressources supplémentaires à la gestion de la santé animale. Il est difficile de déterminer à l'avance les bénéfices apportés par la préparation aux urgences dès lors que la série complète des risques à envisager comporte des éléments inconnus. Les méthodes d'analyse des coûts et des bénéfices économiques appliquées aux urgences de santé animale doivent non seulement tenir compte de cette incertitude, mais la placer au cœur de l'analyse.

L'analyse coûts-bénéfices est une méthode clé pour évaluer les interventions de santé animale dans une perspective économique. Néanmoins, la capacité de cette méthode à traiter l'incertitude est souvent mise en cause. Les auteurs soutiennent qu'en limitant l'analyse des répercussions d'une situation d'urgence à certains états spécifiques de la nature, il devient possible de poser des bornes à l'étendue de l'incertitude, ce qui permet de réaliser une analyse couts-bénéfices. Ils présentent cette méthode, qui consiste à combiner l'analyse des incertitudes dépendantes d'un état de choses donné (*state-contingent analysis*), avec une analyse coûts-bénéfices. Ils examinent ensuite les caractéristiques économiques des situations d'urgence ainsi que la nature des menaces que ces dernières font peser sur les systèmes de santé animale.

**Mots-clés**

Agroterrorisme – Analyse coûts-bénéfices – Analyse des incertitudes dépendantes d'un état de choses donné (*state-contingent analysis*) – Incertitude – Risque – Urgence.

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# Preparación para casos de emergencia zoosanitaria: consideraciones relativas a la evaluación económica

D. Adamson, W. Gilbert, K. Hamilton, D. Donachie & J. Rushton

**Resumen**

Los sistemas de producción pecuaria y las sociedades en las que están inscritos afrontan una serie de riesgos derivados de enfermedades infecciosas y de desastres de origen natural y humano que ponen en peligro la sanidad animal. Dentro de esta panoplia de riesgos están las amenazas derivadas de sucesos naturales o actos deliberados o accidentales que puedan inducir un cambio repentino de la situación zoosanitaria y exigir recursos adicionales para gestionarla. La determinación de los beneficios que pueda traer consigo la preparación para tales emergencias no es tarea fácil, cuando «lo desconocido» forma parte del conjunto de riesgos que se afrontan. Todo método encaminado a analizar los costos económicos y eventuales beneficios en el ámbito de las

emergencias zoosanitarias debe no solo integrar esta incertidumbre, sino hacer de ella el elemento central del análisis.
El análisis de la relación costo-beneficio es un procedimiento clave para evaluar económicamente las intervenciones de sanidad animal, aunque a menudo se cuestiona su utilidad o idoneidad para manejar la incertidumbre. Los autores postulan que, restringiendo los resultados de un suceso de emergencia a un conjunto especificado de estados de la naturaleza, es posible delimitar el espacio de incertidumbre y, con ello, efectuar un análisis de costos-beneficios. Los autores presentan este método, que consiste en combinar el análisis de las incertidumbres dependientes de un determinado estado de cosas (*state-contingent analysis*) y el análisis de la relación costo-beneficio. También se detienen a examinar las características económicas de los sucesos de emergencia y el tipo de amenazas que pesan sobre los sistemas de sanidad animal.

**Palabras clave**
Agroterrorismo – Análisis costos-beneficios – Análisis de las incertidumbres dependientes de un estado de cosas (*state-contingent analysis*) – Emergencia – Incertidumbre – Riesgo.

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