

## SOCIO-ECONOMIC IMPACTS OF EPIDEMIC DISEASES OF FARM ANIMALS

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### ABSTRACT

Based on desk research and literature review, the paper identifies the effects of farm animal disease outbreaks from the economic perspective. It provides a brief overview of broad impacts of trans-boundary animal diseases such as Bovine Spongiform Encephalopathy (BSE) and Foot and Mouth Disease (FMD) on the economy and society. It also presents a synthetic summary of the results of several studies dealing with the assessment and estimation of the costs of BSE and FMD epidemics in selected countries. The two epidemics were costly, both in monetary and non-monetary terms. Assessed direct and indirect economic losses were equivalent to several billion US dollars or euro in the countries under consideration. The economies depending on the export of live animals and meat products (e.g. the UK and Canada) were particularly affected. The economic welfare losses from hypothetical FMD outbreak in the USA could exceed a hundred billion US dollars. From the political perspective, government-run policies aimed at controlling and eradicating dangerous animal diseases seem to find the justification primarily in economic rationality or international competitiveness arguments.

**Key words:** animal health economics, animal disease, FMD, BSE, economic welfare

### INTRODUCTION

In today's globalised world, farm animal diseases can spread dramatically as a result of the rapid growth in movements of goods and people, and trade liberalisation. Animal diseases of significant economic, trade and/or food security importance for a considerable number of countries which can easily spread to other countries irrespective of national borders and reach epidemic proportions, and where control or management requires cooperation between several countries are called trans-boundary animal diseases (TADs) [FAO 2016]. Zoonotic diseases among them include Bovine Spongiform Encephalopathy (BSE), West Nile Virus and Bovine Tuberculosis. Other important TADs are Foot-and-Mouth Disease (FMD) and Afri-

can Swine Fever. They cause considerable economic, social, environmental and even political implications, and can pose a risk not only to animal health but also to human wellbeing. Countries which are heavily leveraged toward exports of animals and animal products can be particularly affected by livestock disease crises since it would take several years to recover their position on international market lost due to closing their borders for trade. There is a wide consensus that indirect or longer term impacts (such as loss of market shares, disruption of trade flows, effects on tourism, and the loss of consumer confidence in food safety) are far greater than the direct or shorter term impacts for livestock keepers (such as herd destruction).

For year 2018, the list of the World Organization for Animal Health (Office International des Épidémiologies

– OIE) covers 117 animal diseases, infections and infestations [OIE 2018]. The official disease status on freedom from any of the specified six priority diseases (along with BSE and FMD) being granted to OIE member states is of great importance for international trade. For FMD only, countries or zones can be given a free status with or without vaccination. A country may either lose or improve its commercial attractiveness amongst existing or potential trading partners, depending on official recognition of its status.

Our study focuses on BSE and FMD diseases that have occurred in and outside Europe, and have aroused widespread concerns amongst producers, consumers and general public about disease-related socio-economic and ecological costs as well as government accountability. The European Union (EU) had its crisis of BSE (“mad cow disease”) that originated in the United Kingdom (UK) in the late 20th century and shook world food security and safety, and public trust. During the past decades, large events related to FMD (economically the most destructive farm disease) have taken place in different parts of the world, including Europe. Over 100 states are still not considered as free from FMD and its potential outbreak is widely regarded as a major threat to many other countries. Re-emergence of the both diseases in Europe may have implications going far beyond severe disturbances in animal production and trade.

The economic and social effects of high-impact animal diseases (transmissible to humans – such as BSE, and not directly affecting human health – such as FMD) have not attracted much attention from economists, and this topic only occasionally appears in the economic journals. Paradoxically, veterinary literature seems to be richer in studies on the economic implications of animal disease epidemics. Generally, however, scientific publications on the subject are scattered across the literature, concentrated on particular countries with different epidemic size or pattern and types of impact within specific time periods. This makes the comparison and synthesis of findings achieved by different researchers particularly difficult.

The purpose of this paper is to describe and classify costs (losses) stemming from animal disease outbreaks, and provide a synthetic summary of the empirical studies quantifying real and potential effects

of BSE and FMD on the agriculture sector and whole economy. The study would help understand the full scope of economic and social impacts from the observed and potential occurrence of animal epidemics.

## MATERIAL AND METHODS

The basis for the article was desk research (identification of relevant literature/data) and literature review (content analysis of available literature/data). The literature search covered scientific journal articles and official reports. It was performed using online (Google and Google Scholar) search for papers with key words “animal diseases”, “animal epidemics”, “FMD”, “BSE”, “economic impact”, “social effects”, “welfare loss”, “direct costs” and so on. The references of interest in identified articles were also reviewed. The literature was considered from the perspective of an economist. Additionally, statistics of the World Organization for Animal Health (OIE) was used. The BSE and FMD were chosen for an analysis because they are unique in the extent of their socio-economic implications. Therefore, they have been studied by economists more extensively than any other animal diseases. Both diseases are at the forefront of disruptions in livestock industry and meat trade in the EU and on the global scale. In addition, they affect a number of seemingly unrelated economic sectors such as tourism for example.

## RESULTS AND DISCUSSION

This section first provides characteristics of the two diseases (BSE and FMD) under investigation. Then, it briefly overviews the spectrum of impacts generated by animal diseases by applying the economic analysis framework. Afterwards, it presents the empirical results on BSE and FMD costs/losses in certain countries already and potentially affected by them.

Although the detailed characteristics of both diseases and their epidemic developments goes beyond the scope of this study, their short description would allow readers a better understanding of effects they cause.

The BSE – a novel progressive and degenerative neurologic disease in cattle [Wells et al. 1987] was first diagnosed (recognized) in the UK thirty years ago (the case reported in November 1987) but the disease may

have started two years before its official confirmation [Meikle 2012]. An initial incident resulted in a common source epidemic that peaked in the UK in 1992–1993. According to veterinary scientists, the spread of BSE among cattle was caused by feeding rendered material (meat and bone meal) from infected cattle or sheep back to other cattle [BSE... 2011]. At the EU level, a ruminant feed ban had been introduced in 1994, followed by a total ban on the feeding of meat and bone meal to all farm animals in 2001. The “mad cow disease” has occurred not only in Europe but also in Asia, North America and the Middle East. Its subsequent international spread had been facilitated by British exports of BSE-contaminated feed and infected cows. Outside the UK, the first BSE events were reported in the following years: Ireland – 1989; France – 1991; Germany – 2000; Japan – 2001; the Czech Republic – 2001; Poland – 2002; Canada and the United States – 2003; France – 2005 [OIE 2018, Zawojka and Horbowiec-Janucik 2018]. According to the OIE [2018], 97% of all BSE cases reported throughout the world from 1987 to 2007 were those in the UK (184,105 cases). The number of BSE cases reported each year in the UK has dropped drastically from 37,300 in 1992 to only 2 in 2015. The present epidemiological situation is characterised by noticeable decrease of the BSE annual incidences also in the world. Nevertheless, millions of animals had been destroyed (euthanized or slaughtered) in an effort to control the BSE spreading. From the public health impact perspective, the BSE-connected brain disease in humans – variant Creutzfeldt-Jakob disease or “the British disease”<sup>1</sup> has caused deaths of 177 Britons and nearly 50 others around the world [Meikle 2012, Greener 2015].

The FMD is considered to be a highly contagious viral epizootic disease of cloven-footed animals, firstly discovered by Loeffler and Frosch in 1898 [Loeffler and Frosch 1898, Chakraborty et al. 2014]. The disease is of relatively low mortality among animals but of very high morbidity which in a susceptible population approaches 100%. Its global impact is enormous due to the huge numbers of animals affected. FMD virus is readily transmitted in live animals and products of animal origin. FMD was once found worldwide.

Since the nineties of the last century a number of outbreaks have occurred in previously FMD-free states. In Europe, the largest and very devastating epidemic appeared in the UK in the early 2001, and was followed by outbreaks in neighbouring states (France, the Netherlands). The disease has been eradicated by many countries (e.g. EU, USA, Japan) but still remains endemic in most of the world. To avoid the trade consequences of being categorized as “FMD free with vaccination” as opposed to “FMD free without vaccination”, the governments are ready to adopt the policy of culling or slaughtering vaccinated animals along with infected and exposed animals. Countries that are FMD-free will likely not accept livestock and fresh meat products from FMD infected areas. Opposite to BSE, FMD is not a public health risk.

Considering theoretical methodological basis for assessing economic effects (impacts) of particular animal disease, its related costs or losses are often split into direct and indirect ones. The concepts of direct and indirect effects are, however, diverse. According to Knight-Jones and Rushton [2013], direct impacts (losses) are attributable to on-farm production and changes in herd structure while indirect ones are connected with the disease control, poor access to markets and limited use of improved production technologies. In another conceptual framework, proposed by McInerney et al. [1992], direct economic costs due to livestock disease are explained in terms of two distinct components:

1. *L* – disease losses (i.e. reduction in output value) following disease occurrence or outbreak (for example: animal deaths, impaired fertility of stock, declined rates of liveweight gain, depressed yields, reduction in product quality).
2. *E* – disease expenditures made to treat disease or prevent its occurrence (extra resources as a result of disease such as: veterinary services, drugs, medication, vaccination, prevention measures etc.).

The total direct economic costs (*C*) can be then expressed as the sum of the two components ( $C = L + E$ ). In this case, the trade-off between losses and expenditures offers a powerful basic model for economic analysis. *Ceteris paribus*, higher (lower) control expenditures are associated with lower (higher) disease losses.

<sup>1</sup> Transmission of BSE prions from cattle to man probably occurred via consumption of BSE tainted meat and meat products.

The economic benefits (*B*) from the disease controlling can be measured by considering the reduction in economic losses from the disease corresponding to different levels of expenditure on its control [McInerney 1991].

Therefore, based on the above approach, indirect effects associated with animal disease can include: human health costs (e.g. due to BSE transmission to humans in the form of variant Creutzfeldt–Jakob disease – vCJD or psychological damage to animal owners and veterinarians involved in the culling activities), negative animal welfare impacts (animal suffering, stress prior to slaughter), trade restrictions due to disease and its control, ecological damage, and others. The problems of animal epidemics arise not only from the disease itself but also from disease-related activities of public authorities and institutions. The country’s disease-free status, public health, food safety and security, protection of environment and rural livelihoods (pov-

erty alleviation) and national security are regarded as public goods [Czyżewski and Brelik 2013, Zalewski and Skawińska 2016]. This provides a basis for the government intervention (through controlling, limiting and stopping animal epidemics) as well as for public policy to alleviate negative effects of the diseases. Such interferences require increased public expenditure, usually at the expense of taxpayers. The proposed classification of costs arising from outbreak of animal diseases (such as BSE and FMD) is shown in Table 1.

In an alternative approach, animal disease-related effects can be divided into:

- on-farm effects;
- market supply effects (reduced animal production/ /increased production costs → reduced volume of domestic supply → increased prices → farm incomes);
- market demand effects (ban or tightened controls by importing states → reduced exports → drop in domestic prices → forgone farm incomes);

**Table 1.** Outbreak costs classified by their types

Direct production costs/losses		Indirect costs	
Direct losses	number of animals lost (died from the disease or culled)	Ripple effects	denied access to domestic and foreign markets
	average market value per head of animal (pre-outbreak)		fall in domestic animal prices
	culling and disposal costs per head of animal		fall in domestic sales
	control costs per animal		fall in world animal prices
	loss of production per animal		loss of exports
replacement costs (purchasing or raising extra heifers)	costs on upstream/downstream or affiliated industries	lost employment	duration of the above impacts
Consequential on-farm losses	forgone farm income from activity (receipts/ /income per animal)	Spillover effects	loss in tourism income value
	costs due to the restriction on livestock movements		loss in other services’ income
	duration of farm business disruption (number of days)		duration of the above impact
	lost employment	Wider society	loss in GDP and economic welfare
	consumer fear, food insecurity		
		health concerns	
		environmental pollution (e.g. due to animal burning and burial)	
		loss in tax revenue due to reduced output; government expenditure	

Source: Authors’ own compilation.

- externalities (e.g. environmental degradation, food insecurity);
- financial consequences (private extra financial costs/expenditures, reduced income of farm businesses, farm solvency and liquidity, government outlays, increased taxes);
- hidden transaction costs incurred in the supply chain (e.g. greater need for monitoring, control measures and product traceability, information collection).

It is obvious that animal-keepers must suffer large losses since their production is curtailed as animals die or are preventively slaughtered (stamped out). Loss of production and productivity is likely to influence the domestic market price of sensitive animal products (limited supply can result in increase in their market price). On the other side of market relationships, public health concern associated with certain disease may also decrease the demand. In the case of epidemic diseases, output market prices will depend primarily on whether or not foreign trade restrictions are used. Without export bans, the market prices may temporarily raise dependent on the outbreak spread and duration. If exports are restricted, however, prices in countries with large export markets will drop substantially due to an oversupply of the domestic market.

Much of the economic impact of BSE and FMD constitutes a direct or indirect effect of trade restrictions. Trade isolation represents one of the ripple effects (spreading result of the disease). Notably FMD affects exporters of a wide range of livestock products [FAO 2016].

From the economic perspective, the analysis of social effects (i.e. costs and benefits born by the whole community as a result of a particular event or activity) should take into account (and traditionally does) both private and external costs and benefits. They can be market and nonmarket values. Consequently, economic efficiency analysis (economics core) considers both overall economic efficiency and social welfare. In the case of animal disease management, the goal of economic efficiency implies minimising: a reduction in revenues from sales to domestic market, losses to animal-related industries, export loss, disease control costs to the government, etc.). In turn, the social welfare goal requires paying attention to minimization of human harm from animal disease and its surveillance

and control (such as disruptions to the communities caused by closed or limited public access to affected areas, emotional or psychological damage to people, limited freedom of animal keepers, burden of zoonoses, etc.). Government-run policies to control, eradicate and prevent spreading of animal diseases seem to find the justification principally in arguments of economic efficiency. An example is the policy of preventive veterinary vaccination. The prohibition of its use (e.g. the EU has banned FMD vaccines in 1990 and 2001) is of crucial importance for international trade in live animals and their products. Evidently, potential loss of economic benefits gained from country's status of being "free of FMD and infection without vaccination" is taken into consideration when strategy of animal culling/destruction (instead of vaccination-to-life) is chosen to fight highly infectious animal diseases.

To sum up, contagious animal diseases (like BSE and FMD):

- have implications on domestic trade (e.g. due to restriction on animal movement as a part of disease control) and on international trade (countries which are free from diseases tend to protect their agriculture and markets by prohibiting the import of live animals, animal products or by-products);
- disrupt both local and national economies (e.g. illegal imports of animal products, losses in tourism and supporting industries);
- threaten human health (e.g. zoonotic diseases – infective to humans);
- can lead to political and social unrest in people;
- threaten food security, proper livelihood of livestock owners and workers;
- have negative impact on consumer confidence;
- harm the environment (lost wildlife, BSE prions dispersed in the aquatic environment);
- absorb massive expenditures by the public sector (disease management, compensation or indemnity payments to producers, subsidizing disease surveillance testing, etc.);
- may generate positive effects such as prompted changes in regulatory disease control as well as increased consumer sensitivity to food safety and health issues.

Economists usually ask awkward questions about the economic burden or level of costs associated with

particular illness or disease. Thus, our question is: how much animal epidemic diseases do really cost the economy? The answers are revealed by the number of previous studies that investigated costs (losses) of BSE and FMD in the countries affected by these diseases. Their selected results are summarized in Table 2.

Both diseases are costly, either in monetary terms or in the number of livestock destroyed. The economic

losses were equivalent to several billion US dollars or euro in the particular countries under consideration. The numbers presented in Table 2 should be treated with some caution because of – among others – the possible discrepancies in data used in the reported studies. For instance, in accordance with the official announcement by the UK government, 4.07 million animals were culled in the period between the first and

**Table 2.** Costs/losses of FMD and BSE for the affected countries

Country	Outbreak year(s)	Non-monetary impacts	Costs/losses expressed in money terms
Foot-and-mouth disease (FMD)			
USA, California	1929	5 herds; 3,590 infected animals	USD 0.11 million
Canada	1951–1952	42 premises; 5,000 animals	USD 5.0 billion
Bhutan	1990–1994	111 outbreaks	USD 0.15 million per year
Taiwan	1997	6,147 premises 4 million pigs slaughtered	EUR 4.96 billion (government plus private costs – agriculture & related industries)
United Kingdom	2001	2,030 infected animals; 6.5–7.0 million slaughtered animals (5 million sheep, 0.8 million cattle, 0.4 million pigs)	GBP 3.1 billion (EUR 3.5 billion) for agriculture and food sector; GBP 3 billion – tourism; EUR 8 billion – rural economy; USD 10 billion – in total
Ireland	2001	57,000 animals culled (52,570 sheep, 1,330 cattle)	Total costs (agriculture, tourism and other sectors, government) estimated at EUR 10 million (approx. 0.2% of GDP)
South Korea	2010/2011	3.5 million cattle and pigs depopulated	USD 1.9 billion
South Korea	2000, 2002, 2010 2010/2011	from 15 outbreak farms in 2000 to 3,748 in 2010/2011	Total costs from ca. USD 23.6 million to max. USD 1.9 billion; per outbreak cost from USD 4.5 million (2010/2011) to USD 16.5 million (2000)
Turkey (mainly Anatolia)	2006–2010	1,557 outbreaks in 2006 and 1,715 in 2010; 11 million cattle (< 2 years old) infected	Average cost of each case USD 150–300 depending on production type; 3-year project for disease control – EUR 65.4 million
Bovine Spongiform Encephalopathy (BSE)			
UK	1990–2001	170,000 cases reported	over EUR 3 billion
UK	1996–2010	over 1 million cattle may have been infected; 4.4 million animals destroyed	EUR 8.5 billion
Germany	2000–2010	413 cases confirmed; 17,313 heads of cattle culled and destructed	EUR 2 billion
Canada	2003–2005	4 cases discovered in cattle	USD 4.1 billion in losses to beef sector USD 7 billion in BSE-related losses USD 11 million a day due to trade bans

Source: Authors' own compilation based on: Le Roy et al. [2006], Askaroglu [2011], DAFRD [2002], European Commission [2012], Kim et al. [2013], Knight-Jones and Rushton [2013], Probst et al. [2013], European Court of Auditors [2016], Fiebre [2017], Zawojka and Horbowiec-Janucik [2017].

last case of diagnosed FMD (20 February – 30 September 2001) but according to the British Meat and Livestock Commission, above 6 million beasts had not been included in the official slaughter toll. It means that 10 million animals could have been stamped out in foot and mouth cull, more than twice as high as official government figures [Uhlig 2002].

The results provided in Table 2 confirm that more severe impacts of animal diseases are felt in more export-dependent economies, such as the UK and Canada. Canada, having relatively small number of recorded BSE cases, experienced large economic losses in the beef industry due to import embargoes of ruminant and ruminant products originating from this country that were placed by the governments of more than 30

states, including the USA, in 2003. Some exporting countries (Ireland, for example) gained agriculture-related benefits from the FMD. Irish benefits, estimated at around EUR 107 million, resulted from FMD-related reduction in British output and this gap-filling by Irish exporters [DAFRD 2002].

Although continental Western Europe, Australia, New Zealand and Indonesia as well as Central and North America are currently (2018) free of FMD (the disease has not been found in numerous countries since many decades ago), several economic analyses have been undertaken to estimate economic impacts of its hypothetical outbreaks. Table 3 gives the simulation results for welfare effect of FMD in the USA (since 1929 there have been no FMD events on the US mainland).

**Table 3.** Simulated economic welfare losses from a hypothetical FMD outbreak in the USA

Source	Welfare losses in monetary terms	Notes/Conclusions
Ekboir [1999]	California: annual mean welfare losses USD 1.5 billion; the total costs USD 2.5– 9.3 billion depending on scenario	The loss to the US exports: USD 1.3 billion each year (optimistic scenario)
Schoenbaum and Disney [2003]	Net welfare change (producer surplus, consumer surplus and government cost): from USD 213 million to 3,443 million depending on scenario	Alternative slaughter and vaccination strategies incorporated. Increases in vaccination and slaughter infrastructure decrease costs of simulated outbreaks
Hayes et al. [2011]	Total welfare losses: USD 128.23 billion; annual welfare losses: USD 12.8 billion	National trade bans incorporated
DHS [2012]	Total losses in economic welfare range from USD 16 billion to 140 billion	Sum of producer and consumer welfare dominates the economic impacts arising from government costs and regional non-agricultural impacts. For large outbreaks, both consumers and producers welfare is large and negative
Hagerman et al. [2012]	Mean losses: Texas USD 11.2–13.5 billion; California USD 2.7–21.9 billion	Mean national economic welfare losses in Texas increase under vaccination
Lee et al. [2011]	Total economic losses range from USD 23 billion to 34 billion	Reduction in domestic and international demand is overwhelming source of the losses
Pendell et al. [2015]	Total losses for the hypothetical release of FMD virus from laboratory range from about USD 16 billion to 140 billion in damages	Producer effects (negative due to reduced output and prices) share the largest burden in losses; Consumer effects negative or positive (mainly contingent upon the outbreak size, export losses, demand shocks)
Schroeder et al. [2015]	In Midwest (8 states), producer and consumer losses would likely approach USD 188 billion; government costs would exceed USD 11 billion (without vaccination)	Vaccination program with a large vaccination zone would reduce median losses to USD 56 billion and government costs to USD 1 billion

Source: Authors' own elaboration.

Economic welfare effect is generally understood as net change in the benefit to society resulted from a change in the economy. It is usually measured as the aggregate change in consumer's surplus, producer's surplus and public expenditures.

The estimated results for potential outbreaks vary depending on: analytical framework (models employed), production conditions, epidemiological input (the epidemic duration, spread rate, number of quarantined and depopulated herds, depopulated species), trade ban duration, export loss and recovery, and consumer response. The studies are not without limitations; the welfare effects could be under- or overestimated.

## CONCLUSIONS

Transmission and spread of animal diseases (including zoonotic TADs) are driven by globalization that has increased both international trade and human mobility. The economic and social costs (expressed in monetary and non-monetary terms) associated with occurrence of BSE and FMD can be significant. Unfortunately, it is difficult to give an accurate answer to the question about their size. Even in the case of the economies affected by BSE or FMD in the near past (the UK, for instance), the reported costs or losses they faced due to these diseases very differ depending on the source of information. Looking at official statements, it seems that governments tend to underestimate the negative effects of the crisis events (such as BSE and FMD) in hope of avoiding the social unrest and the erosion of public trust.

The experience of countries not so formerly affected by FMD or BSE helps to understand how a potential outbreak situation (including that which could be caused by use of animal disease as a tool of attack on national security) may impact any country. The historical evidence shows that these diseases cause major economic and financial losses through animal (and human) mortality, reduced animal productivity, condemned products, restricted access to international markets, consumer market response, and spill-over effects on agriculture-related and other sectors (e.g. tourism). Their impacts have implications in terms of economic welfare, animal welfare, public health, food security, environment protection, poverty alleviation, social stability and national security.

Neoliberal policies of farm animal disease management driven by pure economic rather than wider societal considerations (e.g. mass destruction not only infected but also potentially healthy herds, the prohibition of animal vaccination due to its export implications, restricting the people movement within rural areas) and lack of awareness of such policy complex consequences could lead to the crisis of the entire rural economy (decline in employment, tourism collapse due to decline in overseas visitors and change in domestic tourism patterns, etc.). In view of still existing risk of a new incursion of FMD and BSE in the EU, the economists (following the veterinarians' footsteps) should study more-in-depth the potential social and economic effects associated with these diseases.

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## **SPOŁECZNO-EKONOMICZNE SKUTKI EPIDEMII CHOROÓB ZWIERZĄT HODOWLANYCH**

### **STRESZCZENIE**

Bazując na przeglądzie literatury, dokonano identyfikacji skutków wywoływanych przez wybuch epidemii chorób zwierząt gospodarskich, postrzeganych z perspektywy ekonomicznej. Na przykładzie gąbczastej encefalopatii bydła (BSE) i pryszczycy (FMD) ukazano wielopłaszczyznowe oddziaływanie trans-granicznych chorób zwierząt na gospodarkę i społeczeństwo. Zawarto syntetyczne podsumowanie wyników badań empirycznych dotyczących oceny i oszacowań kosztów epidemii BSE i FMD w wybranych krajach. Epidemie obu chorób pociągnęły za sobą wysokie koszty, zarówno w wymiarze finansowym, jak i niepieniężnym. Bezpośrednie i pośrednie straty ekonomiczne sięgały kilku miliardów dolarów lub euro w poszczególnych krajach. Szczególnie dotknięte nimi zostały gospodarki zależne od eksportu żywych zwierząt i produktów mięsnych (np. Wielka Brytania i Kanada). Straty w dobrobycie ekonomicznym spowodowane przez hipotetyczną epidemię FMD w USA mogą przekroczyć sto miliardów dolarów. Oceniając z perspektywy politycznej, prowadzone przez rządy polityki mające na celu kontrolowanie i zwalczanie groźnych chorób zwierzęcych wydają się mieć uzasadnienie głównie w argumentach natury ekonomicznej.

**Słowa kluczowe:** ekonomika zdrowia zwierząt, choroba zwierząt, FMD, BSE, dobrobyt ekonomiczny