An economic assessment of foot and mouth disease in Japan

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Summary

A large-scale foot and mouth disease (FMD) epidemic in Japan in 2010 caused severe economic losses for livestock and related industries. In this paper, the authors develop a clear and usable framework to estimate the economic impact of this FMD outbreak. An economic analysis is then conducted by combining this framework with an epidemiological model.

The framework estimates the direct and indirect costs to livestock and related industries by applying an input–output model, as well as by addressing expenditure on disease control. The direct cost to the livestock industry was estimated at 51.2 billion Japanese yen (JPY), engendering an indirect cost to related industries of JPY 25.5 billion. The expenditure for disease control activities was estimated at JPY 8.2 billion. The total impact of the 2010 FMD epidemic was estimated at almost JPY 85 billion.

Within the economic analysis, the authors evaluate several control measure scenarios: a baseline scenario, which assumes that the rapid disease spread observed in the early phase of the 2010 FMD epidemic would continue; prompt culling within 24 hours; early detection of the first case; and emergency vaccination within a radius of 10 km around the affected farms in either seven or 28 days. Prompt culling and early detection were superior from an economic point of view, reducing the total economic impact to 30% and 2% of that in the baseline scenario, respectively. Compared with these scenarios, vaccination was less cost effective. However, vaccination suppressed the speed of disease spread and shortened the duration of the epidemic, suggesting its potential effectiveness in curbing rapid disease spread in a densely populated area.

Keywords


Introduction

Foot and mouth disease (FMD) is a highly contagious viral disease affecting ruminants and pigs. Once FMD occurs in a previously FMD-free country, strict control measures are implemented to eradicate the disease, including culling animals on infected farms and restricting the movement of animals, animal products, and other contaminated commodities. In some cases, additional control measures, such as emergency vaccination and pre-emptive culling, are required to halt the spread of the disease. Furthermore, a restriction on international trade of livestock animals and animal products is imposed until the country contains the disease and regains its FMD-free status (1). An outbreak of FMD, therefore, causes a large economic impact on the affected countries and regions.

Economic analysis of animal infectious disease can be a useful tool in the development of future contingency plans. By combining economic and epidemiological models, we can evaluate the way in which the disease spreads and the effectiveness of different control strategies from both epidemiological and economic points of view. Economic analysis can also offer a quantitative estimation of the economic impact on livestock and livestock-related industries, other industrial sectors, expenditure on disease control activities, international trade, product prices and employment, government costs, and effects on the public. Once an FMD outbreak occurs, animal health authorities
are required to choose a cost-effective control measure quickly. Thus, based on the availability of economic analysis, a simple and appropriate economic impact estimation framework would be useful to help decision-makers apply appropriate control measures.

A large-scale FMD epidemic occurred in Japan in 2010, for the first time in over a decade. The affected area, Miyazaki Prefecture, located in the southern region of the country, is one of the major livestock farming areas in Japan, with beef and pig farming dominant in the area. In 2009, the production of beef cattle and pigs represented 51.2 billion Japanese yen (JPY) and JPY 47 billion, respectively, ranking as the third- and second-largest production values in the country. Thus, the outbreak of FMD in 2010, resulting in 292 infected farms and 290,000 culled animals, including vaccinated animals, caused devastating damage to livestock and related industries in this region.

In the current study, the authors develop a clear and applicable framework to estimate the economic impact of an FMD outbreak, based on the size of the epidemic, and then estimate the economic impact of the 2010 FMD epidemic. In addition, an economic analysis is conducted using this framework, together with an epidemiological model developed in a previous study. The authors assess the epidemiological and economic impacts of simulated outbreaks under several control strategies, such as prompt culling, early detection and vaccination.

Materials and methods

**Estimation framework for the economic impact of an outbreak of foot and mouth disease**

This estimation framework for the economic impact of an FMD outbreak is composed of two parts: the first estimates the direct and indirect costs to livestock and livestock-related industries, and the second estimates the expenditure on disease control activities. In this framework, the economic impacts related to market instability caused by consumer or producer reaction are not considered.

Using this framework, the authors estimate the economic impact of the 2010 FMD epidemic in Japan, then compare the economic impacts for several disease control strategies, using outputs from an epidemiological model.

**Direct and indirect costs to the livestock and related sectors**

Direct cost is defined here as ‘the value of animals culled for the purpose of disease control’. Farmers were compensated for these animals by the government, based on market prices (with the national government contributing four-fifths and the prefectural government one-fifth), according to the Animal Infectious Disease Prevention Act. Compensation for culled animals on vaccinated farms was paid by the national government under the Special Law for Countermeasures Against Foot-and-Mouth Disease, which was temporarily established to deal with the FMD epidemic. Government expenditure on this compensation was reported.

Indirect cost is defined here as ‘the economic loss that extends to related sectors due to the loss of animals’. This cost was estimated using an input–output model (I–O model), which specifies the flow of inputs and outputs among sectors in the economy. That is, the I–O model enables us to estimate which sectors will receive spillover effects and how large these effects will be if the livestock industry is damaged by an FMD outbreak. In Japan, each prefecture has developed its own I–O model for economic analysis. The authors employ the I–O model developed by the Miyazaki Prefecture to estimate the indirect costs due to the FMD epidemic.

**Expenditure on disease control activities**

Disease control expenditure includes the costs of implementing control measures, such as culling and disposing of animals, vaccination, disinfection, and cleaning. These costs are divided into four categories:

1. The cost of materials and equipment used on farms or burial sites (e.g. personal protective clothing, injecting equipment and needles, disinfectants, heavy machinery and waterproof sheets)
2. The cost of setting up and operating disinfection stations, which are established on major roads to disinfect vehicles in and around the movement-restriction zone; this mainly includes the cost of disinfectants, power sprayers, automobile sprinklers and an operation consignment fee
3. The cost of human resources – during the epidemic, a large number of staff were dispatched from all over the country to help in disease control measures, including veterinarians from the prefectural and national government and the private sector, livestock technicians, construction workers, members of the Self-Defence Force (Japan’s armed personnel), police officers, and other support staff
4. The cost of vaccination.

These four categories of expenditure for disease control activities were collected from various national, prefectural and municipal government reports. The I–O model was not used here, to avoid the complexity of the indirect-
cost estimation, which involves a variety of industrial sectors.

**Economic analysis**

To evaluate alternative disease control strategies, an economic analysis was conducted, using outputs from an epidemiological model. An FMD transmission model developed for the 2010 FMD epidemic in Japan (4) was adapted as an epidemiological model for the present study. The FMD transmission model is a farm-based, spatial stochastic model, which estimates the size of the epidemic in the simulated area under movement restrictions. The details of this transmission model have been described in a previous study (4). In this study, the actual outbreak area of the 2010 FMD epidemic was selected as the simulation area. This area contains 1,210 farms (1,080 cattle farms and 130 pig farms).

Five control measure scenarios are evaluated in this study as follows:
- the baseline scenario
- the prompt culling scenario
- the early detection scenario
- two separate emergency vaccination scenarios.

**The baseline scenario**

The baseline scenario assumes that the disease-spread pattern observed in the early phase of the 2010 epidemic continues during the simulation period, without any additional intervention measures. The number of farms infected when the first case was detected in the 2010 epidemic and the duration of culling operations on infected farms are also both reflected in this baseline scenario. Thus, in this scenario, the simulation of the disease spread starts from 11 farms (4). This scenario assumes that 3–16 days are required after detection of the virus to cull all animals on infected farms (4).

**The prompt culling scenario**

In this scenario, animals on infected farms are assumed to be culled within 24 hours of detection, as this is the principal policy of all major FMD-free countries, including Japan (11, 12, 13, 14).

**The early detection scenario**

In the early detection scenario, it is assumed that the detection of the first case takes place two weeks earlier, reducing the number of farms that begin the disease spread simulation from eleven to three.

**Emergency vaccination scenarios**

The first vaccination scenario assumes that vaccinations are conducted within a radius of 10 km of the infected farms on day 7 after the first detection of the virus. The second scenario assumes that vaccination takes place on day 28. In each scenario, vaccinated farms are assumed to be fully protected seven days after the vaccination of cattle and 14 days after the vaccination of pigs (15, 16, 17, 18). Farms that are infected before being protected by vaccination are assumed to be equally infectious as non-vaccinated infected farms. In the vaccination scenarios, all vaccinated animals are assumed to be culled after the successful containment of the disease (vaccine-to-kill strategy).

**Estimation of economic impact**

A total of 10,000 iterations were run for each control measure scenario. Every iteration ran for 180 days from the initial detection of disease, with a discrete time step of one day for each. The total numbers of infected farms and animals, the total numbers of culled or vaccinated farms and animals, and the duration of the epidemic were the model outputs. These outputs were used to calculate the economic impact. In estimating this impact, unit costs were calculated based on the economic impact of the 2010 FMD outbreak. For the direct cost, the value per animal was calculated. For expenditure on disease control activities, the cost of materials and equipment per animal and the running cost of a disinfection station per day were calculated. As for the cost of human resources, the costs of culling and disposing of the animals, and of cleaning and disinfecting farms, were estimated per animal. In the vaccination scenarios, human resource costs were calculated for vaccinating the animals, as well as the vaccination cost per animal. Based on the experiences of the 2010 FMD outbreak, a vaccination team was assumed to visit six cattle farms or two pig farms per day. Vaccination teams visiting cattle farms included three staff members and those visiting pig farms included five.

**Results**

**Economic impact of the foot and mouth disease outbreak**

**Direct and indirect costs**

The results summarised in Table I show that the total direct cost of the 2010 FMD epidemic was JPY 51.18 billion or 563 million United States dollars (USD).

The average exchange rate in 2010 was USD 1 = JPY 88 and 1 Euro (EUR) = JPY 116. The compensation payment per animal was estimated at JPY 640,000 for cattle and JPY 31,000 for pigs. According to the estimation using
the I–O model, the total direct cost engendered a further indirect cost of JPY 25.51 billion (USD 281 million) to other industries, affecting principally: the feed and organic fertiliser sector (17.8%); the agricultural service sector (including Veterinary Services) (14.6%); and the crop-farming sector (10.5%).

Expenditure on disease control activities

The total cost for materials and equipment used in disease control activities was JPY 2.4 billion (USD 26 million), resulting in JPY 8,000 per animal. A total of 403 disinfection stations were established in Miyazaki Prefecture during the epidemic at a cost of JPY 3.3 billion (USD 36 million). Based on the duration of the epidemic (almost 90 days), the running cost of one disinfection station per day was JPY 90,000. A total of 158,000 person-days were involved in conducting disease control activities. The total staff cost was JPY 2.5 billion (USD 28 million), representing JPY 9,000 per animal. During the epidemic, stockpiled FMD vaccines were used. A total of 140,000 doses of vaccine inoculated almost 87,000 animals (32,000 cattle and 55,000 pigs). The cost of the vaccines was JPY 11 million (USD 110 thousand), representing almost JPY 100 per dose.

In total, the economic impact of the 2010 FMD epidemic was estimated at JPY 85 billion (USD 934 million).

Results of the economic analysis

The epidemiological and economic impacts of each simulated scenario are summarised in Tables II and III, respectively.

In the baseline scenario, based on the median value, a total of 253,000 animals were culled on 650 infected farms; the direct cost of culling these animals was JPY 38.7 billion (USD 426 million) and the indirect cost was JPY 19.2 billion (USD 212 million). The expenditure for disease control activities was JPY 8.6 billion (USD 95 million), and the total cost in the baseline scenario was JPY 66.5 billion (USD 732 million).

When the prompt culling policy (culling within 24 h after detection) was simulated, the epidemic size and economic impact were reduced to almost 30% of those in the baseline scenario. The total cost was JPY 21.3 billion (USD 235 million). The direct cost was JPY 10.8 billion (USD 119 million) and the control cost JPY 5.1 billion (USD 56 million).

The early detection scenario generated the smallest epidemic size, which ceased within 16 days in the median value. In this case, the total cost was JPY 1.4 billion (USD 15 million) in the median value (2% of the baseline scenario). However, in this scenario, larger epidemics occurred and the epidemic size was almost as large as in the baseline scenario. These larger epidemics reflected the 95th percentile of the total cost, reaching almost JPY 70 billion (USD 777 million).

In the vaccination scenarios, on average, the total number of culled or vaccinated animals (250,000 animals) was estimated to be similar to that of the baseline scenario when vaccination was conducted within a 10-km radius, seven days after the first detection of the disease. The figure was a little higher in the 28-day-vaccination scenario (280,000 animals). The total costs of the vaccination scenarios were: JPY 58.2 billion (USD 640 million) for vaccination within a 10-km radius at 7 days, and JPY 78.6 billion (USD 865 million) for vaccination at 28 days. The duration of the epidemic in the vaccination scenarios was shorter than that in either the baseline or prompt culling scenarios. However, the total cost of the 28-day-vaccination scenario was the largest cost among the control measure scenarios.

Discussion

In this study, the authors developed a framework for estimating the economic impact of an FMD outbreak. Clarity and usability were the goal in the development of the framework, so that decision-makers could use it with
### Table II
Epidemiological outputs for different control strategies using the foot and mouth disease transmission model

<table>
<thead>
<tr>
<th>Control measure</th>
<th>Duration (days)</th>
<th>Number of infected farms</th>
<th>Number of culled or vaccinated animals (× 1,000)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Median 5% 95%</td>
<td>Median 5% 95%</td>
<td>Cattle Pigs Cattle Pigs</td>
</tr>
<tr>
<td>Baseline[^a^]</td>
<td>120 106 138</td>
<td>530 488 566</td>
<td>121 115 125 51 45 54 203 190 211</td>
</tr>
<tr>
<td>Prompt culling (24 h)</td>
<td>85 59 124</td>
<td>131 79 170</td>
<td>60 35 77 12 7 19 109 59 141</td>
</tr>
<tr>
<td>Early detection</td>
<td>16 8 157</td>
<td>3 552 0 124</td>
<td>0.85 0.79 53 0 0 209</td>
</tr>
<tr>
<td>Vaccination[^b^] (day 7)</td>
<td>47 34 79</td>
<td>36 18 72</td>
<td>36 14 57 44 43 48 206 174 238</td>
</tr>
<tr>
<td>Vaccination[^b^] (day 28)</td>
<td>58 57 77</td>
<td>153 89 230</td>
<td>88 56 117 64 53 70 214 139 288</td>
</tr>
</tbody>
</table>

[^a^]: The baseline scenario assumes that the disease spread observed in the early phase of the 2010 epidemic continues without additional interventions during the simulation period.
[^b^]: A vaccine-to-kill strategy is assumed for vaccination scenarios. In both scenarios the vaccination radius was 10 km.

### Table III
Economic outputs for different foot and mouth disease control strategies

<table>
<thead>
<tr>
<th>Control measure</th>
<th>Direct cost of culled animals</th>
<th>Indirect cost induced by culling animals</th>
<th>Expenditure for control activities</th>
<th>Total cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Median 5% 95%</td>
<td>Median 5% 95%</td>
<td>Median 5% 95%</td>
<td>Median 5% 95%</td>
</tr>
<tr>
<td>Baseline[^a^]</td>
<td>38.7 34.5 41.3</td>
<td>19.2 17.2 20.5</td>
<td>8.6 7.8 9.5</td>
<td>66.5 59.5 71.3</td>
</tr>
<tr>
<td></td>
<td>426 380 464</td>
<td>212 189 226</td>
<td>95 86 104</td>
<td>732 655 784</td>
</tr>
<tr>
<td>Prompt culling (24 h)</td>
<td>10.8 6.3 16.3</td>
<td>5.4 3.1 8.1</td>
<td>5.1 3.3 7.2</td>
<td>21.3 12.7 31.5</td>
</tr>
<tr>
<td></td>
<td>119 70 179</td>
<td>59 35 89</td>
<td>56 36 79</td>
<td>235 140 347</td>
</tr>
<tr>
<td>Early detection</td>
<td>0.5 0.5 40.4</td>
<td>0.2 0.2 20.1</td>
<td>0.6 0.3 10.1</td>
<td>1.4 1.1 7.07</td>
</tr>
<tr>
<td></td>
<td>6.0 5.5 445</td>
<td>2.7 2.7 221</td>
<td>6.5 3.3 111</td>
<td>15 12 777</td>
</tr>
<tr>
<td>Vaccination (day 7)[^b^]</td>
<td>34.9 33.0 38.1</td>
<td>17.3 16.4 19.0</td>
<td>6.0 4.9 7.7</td>
<td>58.2 54.3 64.8</td>
</tr>
<tr>
<td></td>
<td>384 363 419</td>
<td>191 180 209</td>
<td>66 54 85</td>
<td>640 597 713</td>
</tr>
<tr>
<td>Vaccination (day 28)[^b^]</td>
<td>47.9 37.9 53.7</td>
<td>23.9 18.9 26.7</td>
<td>6.9 5.3 8.9</td>
<td>78.6 62.2 89.3</td>
</tr>
<tr>
<td></td>
<td>527 417 580</td>
<td>263 208 294</td>
<td>75 59 98</td>
<td>865 684 982</td>
</tr>
</tbody>
</table>

[^a^]: The baseline scenario assumes that the disease spread observed in the early phase of the 2010 epidemic continues without additional interventions during the simulation period.
[^b^]: A vaccine-to-kill strategy is assumed for vaccination scenarios. In both scenarios the vaccination radius was 10 km.

ease. Only information about the size of the epidemic was required to approximate the economic impact, including direct costs, indirect costs, and expenditure on control activities. As a result of applying the framework, the epidemic impact of the 2010 FMD epidemic in Japan was estimated at JPY 85 billion (USD 934 million) in total. The direct cost of culling 290,000 animals accounted for half the total impact. The sum of the direct and indirect costs to the livestock industries was estimated at JPY 76.7 billion (USD 844 million), which is equal to 44% of the annual livestock production in Miyazaki Prefecture. In fact, according to statistics from the Japanese Ministry of Agriculture, Forestry and Fisheries (MAFF), livestock production in 2010 decreased to JPY 45.3 billion (USD 498 million) for cattle, and JPY 39.2 billion (USD 431 million) for pigs. This was in comparison to the previous year’s figures of JPY 51.2 billion (USD 563 million) for cattle and JPY 47 billion (USD 517 million) for pigs.

A unique feature of this estimation framework is that the I–O model is used to estimate indirect costs associated with livestock industries that have been damaged by the FMD outbreak. An I–O model can accurately estimate the economic impact among related industries in an economy, based on the flow of inputs and outputs. In particular, it can produce a useful snapshot of the economic impact. However, an I–O model does not allow estimates of long-term effects (6, 7), and may miss the...
actual effect on sectors not connected in the I–O model. However, considering the major damage caused to livestock and related industries by FMD outbreaks, a simple and systematic estimation framework to capture this economic impact is important for immediate decision-making when an FMD outbreak occurs. For this reason, the authors use an I–O model here.

Nonetheless, if an FMD epidemic affects other industrial sectors beyond livestock and related industries, it would be better to conduct other investigations to estimate the impact on these sectors. As a result of differences in industrial structures among regions, the economic impact of FMD on non-livestock sectors varies. A previous study, which estimated the economic impact of the 2001 FMD epidemic in the United Kingdom, took the impact on the tourism sector into account because the epidemic had severe economic effects on tourism (20, 21). In the case of the 2010 FMD outbreak in Japan, Miyazaki Prefecture estimated that the economic impact of the epidemic on livestock and related industries was JPY 140 billion (USD 1.5 billion), assuming that the economic damage would last for some five years in the affected area (8). The prefecture also reported that the economic impact on non-livestock-related sectors was JPY 96 billion (USD 1 billion). This figure was based on a questionnaire in the affected area, which targeted 677 facilities in various business sectors, such as retailers, wholesalers, restaurants, hotels, service industries and transport (8). Such an investigation after an outbreak could provide a more accurate analysis of its economic impact in the affected area.

The economic impact of the export restrictions caused by the FMD outbreak was not included in this study, because Japan is not a major exporter of livestock products. However, the total sum of beef exports decreased from JPY 4.5 billion in 2009 (USD 50 million) to JPY 3 billion (USD 33 million) in 2010 (22). This 30% decrease suggests that the FMD outbreak could potentially have had a significant impact on international trade.

The results of this economic analysis, which combines the epidemiological model and the economic impact framework, show that early detection of the first case of FMD and prompt culling are superior strategies from the cost-effectiveness point of view. Compared to the total costs in the baseline scenario of JPY 66.5 billion (USD 732 million), costs in the prompt culling and early detection scenarios represented 30% and 2% of those of the baseline scenario in the median value, respectively. These results confirm the importance of detecting infected farms as early as possible, and promptly culling animals.

However, it is notable that even the early detection scenario may pose a small risk of inducing a large-scale epidemic, despite the fact that, in most cases, the disease is successfully contained by this scenario. This suggests that the disease spreads rapidly and widely in areas of high livestock density, like the one in the simulation, even if the first case is detected early. Therefore, especially in such high-density areas, additional control measures such as vaccination should be considered, to contain the epidemic to a smaller scale. However, the most important measures in these areas are the prevention of disease introduction and a rapid response.

The results of this economic analysis also show that the total economic impact of the 10-km vaccination strategy at seven days was a little smaller than that of the baseline scenario. However, the 10-km vaccination strategy at 28 days had a larger adverse economic effect than the baseline scenario. Compared with prompt culling or early detection, the vaccination scenarios were not cost effective when employing the vaccine-to-kill strategy. Even if the vaccine-to-live strategy were applied, it would entail other expenditure, such as the maintenance of animal surveillance, and restrictions on the movement of vaccinated animals.

However, culling alone seems unable to suppress rapid disease spread when an FMD outbreak occurs in a densely populated livestock area. Thus, if smooth containment of the disease fails, there is a potential risk that the disease will be transmitted over long distances, from area to area. From this perspective, vaccination strategies, although they may not be cost effective, enable us to reduce the speed of disease spread, shortening the duration of the epidemic, as shown in the simulation. Another benefit for farmers and staff who take control measures is a reduction in their workload, since the disease would not spread as quickly. Being prepared to implement emergency vaccination is therefore necessary, especially in a high-risk area where the disease is likely to spread.

Improving the compensation system for farmers and livestock-related industries is important to gain ready acceptance of the implementation of strategies during an outbreak. During the 2010 FMD epidemic in Japan, farmers were fully compensated for their losses from culling animals on infected farms as well as vaccinating animals on farms. This compensation was based on the market value of the animals, according to legislation. Several funding systems have also been developed to support and re-establish livestock farming and related industries. Enhancing the compensation system in advance would be key to ensuring rapid decision-making and smooth implementation of emergency control measures, contributing to reducing the negative economic impact on livestock industries in the affected region.

The decision-making process involved in effective control of an FMD outbreak largely depends on epidemiological and economic conditions and social acceptance. Combining an epidemiological model with an economic analysis enables us to evaluate the effects of disease outbreaks and control
Une évaluation économique de la fièvre aphteuse au Japon

Y. Hayama, Y. Osada, D. Oushiki & T. Tsutsui

Résumé
Une épizootie de fièvre aphteuse de grande envergure survenue au Japon en 2010 a entraîné de graves pertes économiques pour la filière de l’élevage et les secteurs connexes. Les auteurs proposent un cadre d’évaluation clair pour estimer l’impact économique de ce foyer de fièvre aphteuse. Ils effectuent ensuite une analyse économique dans laquelle ce cadre d’évaluation est relié à un modèle épidémiologique.

Les coûts directs et indirects subis par la filière de l’élevage et par les secteurs connexes sont évalués dans ce cadre en appliquant un modèle entrées-sorties (input–output) et en prenant en compte les dépenses liées à la lutte contre la maladie. Le coût direct de la maladie pour la filière de l’élevage a été estimé à 51,2 milliards de yens japonais, auxquels s’ajoute le coût indirect pour les secteurs connexes estimé à 25,5 milliards de yens japonais. Les dépenses induites par la lutte contre la maladie s’élèvent à 8,2 milliards de yens japonais. L’impact total de l’épizootie de fièvre aphteuse de 2010 est estimé à près de 85 milliards de yens japonais.

Dans leur analyse économique, les auteurs ont évalué plusieurs scénarios relatifs aux mesures de lutte appliquées : un scénario de base, qui suppose une propagation de la maladie au même rythme que durant la phase initiale de l’épidémie de 2010 ; l’abattage rapide des animaux en 24 heures ; la détection

Conclusion
This clear and usable framework proposed to estimate the economic impact of FMD outbreaks enables us to understand direct costs and expenditure for disease control activities, based on epidemic size, and indirect costs through an I-O model. By applying this framework, the authors were able to estimate the economic damage caused by the 2010 FMD epidemic in Japan at JPY 85 billion (USD 934 million). As a result of the emergency vaccination strategy, the direct costs of culling a large number of animals on infected and vaccinated farms accounted for half this damage.

In addition, the authors’ economic analysis combined an economic estimation framework and an epidemiological model. The results indicated that prompt culling and early detection strategies were superior from an epidemiological and economic point of view, whereas vaccination strategies were less cost effective. However, the vaccination strategies suppressed the speed of disease spread and shortened the duration of the epidemic, suggesting their potential effectiveness in curbing rapid disease spread, particularly in densely populated areas.

In general, decision-making when trying to control FMD outbreaks includes complex analyses of epidemiological and economic conditions and social acceptance. Combining epidemiological and economic models is useful as a decision-making tool, providing clear, quantitative consequences. The model’s outputs when comparing the cost effectiveness of various strategies are also straightforward for farmers and those concerned in the livestock industries, as well as for policy-makers, and aid considerably in fostering the necessary sense of urgency when addressing FMD outbreaks.

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This clear and usable framework proposed to estimate the economic impact of FMD outbreaks enables us to understand direct costs and expenditure for disease control activities, based on epidemic size, and indirect costs through an I-O model. By applying this framework, the authors were able to estimate the economic damage caused by the 2010 FMD epidemic in Japan at JPY 85 billion (USD 934 million). As a result of the emergency vaccination strategy, the direct costs of culling a large number of animals on infected and vaccinated farms accounted for half this damage.

In addition, the authors’ economic analysis combined an economic estimation framework and an epidemiological model. The results indicated that prompt culling and early detection strategies were superior from an epidemiological and economic point of view, whereas vaccination strategies were less cost effective. However, the vaccination strategies suppressed the speed of disease spread and shortened the duration of the epidemic, suggesting their potential effectiveness in curbing rapid disease spread, particularly in densely populated areas.

In general, decision-making when trying to control FMD outbreaks includes complex analyses of epidemiological and economic conditions and social acceptance. Combining epidemiological and economic models is useful as a decision-making tool, providing clear, quantitative consequences. The model’s outputs when comparing the cost effectiveness of various strategies are also straightforward for farmers and those concerned in the livestock industries, as well as for policy-makers, and aid considerably in fostering the necessary sense of urgency when addressing FMD outbreaks.

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Evaluación en clave económica de la fiebre aftosa en el Japón

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Resumen
En 2010 se produjo en el Japón una epidemia de fiebre aftosa de grandes proporciones, que causó graves pérdidas económicas a la industria ganadera y demás sectores conexos. Los autores describen un método claro para estimar el impacto económico de dicho brote. Acto seguido, llevan a cabo un análisis económico combinando este método con un modelo epidemiológico. El método permite estimar los costos directos e indirectos que soportan la industria ganadera y demás sectores conexos aplicando un modelo de «insumo-producto» (input–output) y teniendo también en cuenta los gastos ligados al control de la enfermedad. Según los cálculos, el costo directo para la industria ganadera fue de 51 200 millones de yenes japoneses y el costo indirecto para los sectores conexos fue de 25 500 millones de yenes. Se estimó que las actividades de lucha contra la enfermedad supusieron gastos por valor de 8 200 millones. En total, pues, según estas estimaciones, el impacto económico de la epidemia de fiebre aftosa de 2010 se cifra en casi 85 000 millones de yenes. Como parte del análisis económico, los autores evalúan varias hipótesis relativas a las medidas de control: una hipótesis básica, en la cual prosigue sin trabas la veloz propagación de la enfermedad observada en la primera fase de la epidemia de 2010; la rápida implantación, en un plazo de 24 horas, de medidas de sacrificio sanitario; la pronta detección del primer caso; y la vacunación de emergencia dentro de un radio de 10 km alrededor de las explotaciones afectadas, en un plazo de siete días o en un plazo de 28 días. Desde un punto de vista económico, el rápido sacrificio sanitario y la pronta detección ofrecían mejores resultados, pues reducían el impacto económico total hasta un 30% y un 2%, respectivamente, del registrado en la hipótesis básica. En comparación con esas dos hipótesis, la vacunación ofrecía menos eficacia en relación con el costo, aunque frenaba la rápida propagación de la enfermedad y abreviaba la epidemia, de donde se infiere que puede resultar eficaz para contener la rápida dispersión de la enfermedad en áreas densamente pobladas.

Palabras clave
Fiebre aftosa – Impacto económico – Japón – Modelo epidemiológico – Modelo de «insumo-producto».
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