Economic aspects of foot and mouth disease: perspectives of a free country, Australia

M.G. Garner (1), B.S. Fisher (2) & J.G. Murray (1)

(1) Product Integrity and Animal and Plant Health, Agriculture, Fisheries and Forestry – Australia (AFFA), G.P.O. Box 858, Barton ACT 2601, Australia
(2) Australian Bureau of Agricultural and Resource Economics (ABARE), AFFA, Edmund Barton Building, Macquarie Street, Barton ACT 2600, Australia

Summary
Australia is a significant livestock producer and a major exporter of livestock, livestock products and livestock genetic material. An outbreak of foot and mouth disease (FMD) would have severe economic consequences on the economy. A recent study found that in an outbreak lasting six months, real gross domestic product in Australia would fall by an estimated 0.6% (AUS$3.5 billion), employment by 0.8%, and a depreciation of 3% would be recorded in the exchange rate in the first year. Much of this impact would be due to the loss of export markets. Given the significant consequences of an outbreak of FMD, Australia invests considerable resources in prevention and planning. These measures can be viewed at three levels, namely: pre-border, border and post-border. Australia recently further enhanced quarantine at the border to minimise the risk of entry of FMD. However, no matter how much is invested, there is no guarantee that FMD will not enter the country. Accordingly, it is important to ensure that comprehensive contingency plans are also in place. Recent outbreaks in previously free countries have shown that a large outbreak of FMD poses major problems for the animal health services of a country and a combined government and industry response is required.

Keywords

Introduction
Australia is a significant livestock producer and a major exporter of livestock, livestock products and livestock genetic material. In 2000-2001, the gross value of Australian livestock slaughterings and livestock products was AUS$16.3 billion with exports worth AUS$14.7 billion (7). The profitability of livestock production in Australia has undoubtedly been assisted by the country being free of the major epidemic diseases of livestock and relatively free of other serious animal pests and diseases (3).

Exotic diseases, such as foot and mouth disease (FMD), would give rise to costs that are currently not incurred by agriculture in Australia. These include administration and control costs, dead weight losses associated with compensation incurred in implementing a control programme and losses associated with exclusion from export markets for an uncertain period. The importance of loss of export markets has been borne out by recent outbreaks in previously free countries like the United Kingdom (UK) and Taipei China (9, 23). A recent study has estimated that Australian export revenues from affected livestock products could fall by 70% in the first year after an outbreak of FMD (6).

Defence against exotic diseases in Australia is based both on keeping diseases out and being prepared to rapidly respond in the event that an incursion occurs. The Commonwealth Government has jurisdiction over import and export regulations and is responsible for the quarantine policy. As a member of the World Trade Organization, Australia is also obliged to take into account international standards in developing animal health measures applied to imports and exports of animals and animal products. Economics is a discipline primarily concerned with decision-making and animal health economics aims at providing a framework of concepts, procedures and data to support decision-making to

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optimise animal health management (12). Thus, economics provides a rational basis for developing policies and allocating resources to manage or prevent animal diseases, can assist in developing quarantine policies and is a valuable tool for evaluating alternate control strategies.

This paper briefly reviews the livestock industries in Australia, describes the approach of Australia to FMD, examines the potential impact of FMD in Australia should the disease occur and considers the role of economics in assisting policy development before and during an outbreak.

Livestock production in
Australia

Livestock production in Australia is largely based on extensive grazing and is dominated by wool, sheep-meat, beef and dairy production. The gross values of Australian livestock production and export values for 1999-2000 to 2001-2002 are shown in Table I.

This paper focuses on those industries that would be directly affected by FMD. Populations of the major livestock species – cattle, sheep and pigs – are given in Table II. The livestock industries extend from the beef cattle areas of tropical north Queensland to the sheep areas of southern Tasmania, and from the dairy areas of coastal New South Wales to the Merino wool-producing areas of Western Australia. Figure 1 shows maps of Australian climatic zones and regions and the distributions of sheep and cattle. Australia also has smaller, intensive pig and poultry industries. In addition, there are a number of smaller, developing industries based on goats (meat, fibre and dairy goats), farmed deer, buffalo and camelids.

Beef cattle

Cattle are bred over much of Australia. Across northern Australia, cattle are raised on extensive cattle holdings, grazing native pastures at low stocking rates. Tropical breeds, which are better adapted to the harsh conditions in the north, dominate in tropical and semi-tropical Australia. The main outputs are manufacturing beef and animals for lot-feeding and live cattle exports. In southern Australia, cattle are raised on smaller holdings, grazing largely on improved pastures. Temperate breeds, either British or Continental-derived, dominate. Smaller and younger animals are produced, largely for the Australian domestic market.

Cattle are bred and produced on a range of farm enterprises, from specialist beef producers to mixed farm operations that may include sheep and/or cropping. Specialist beef enterprises range from an average of 250 hectares in Victoria, to more than 350,000 hectares in the Northern Territory. Queensland has the most beef cattle (47%), followed by New South Wales (22%) and Victoria (10%).
Table I
Value of Australian livestock industries

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<thead>
<tr>
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<tbody>
<tr>
<td><strong>Gross value of production</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Livestock slaughters</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle and calves</td>
<td>4,616</td>
<td>5,900</td>
<td>6,682</td>
</tr>
<tr>
<td>Cattle exported live</td>
<td>433</td>
<td>482</td>
<td>500</td>
</tr>
<tr>
<td>Sheep</td>
<td>204</td>
<td>360</td>
<td>392</td>
</tr>
<tr>
<td>Lambs</td>
<td>669</td>
<td>760</td>
<td>816</td>
</tr>
<tr>
<td>Sheep exported live</td>
<td>180</td>
<td>258</td>
<td>348</td>
</tr>
<tr>
<td>Pigs</td>
<td>792</td>
<td>855</td>
<td>983</td>
</tr>
<tr>
<td>Poultry</td>
<td>1,031</td>
<td>1,085</td>
<td>1,167</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>7,925</td>
<td>9,699</td>
<td>10,888</td>
</tr>
<tr>
<td>Livestock products</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wool</td>
<td>2,175</td>
<td>3,096</td>
<td>2,783</td>
</tr>
<tr>
<td>Milk</td>
<td>2,853</td>
<td>2,977</td>
<td>3,395</td>
</tr>
<tr>
<td>Other livestock products</td>
<td>392</td>
<td>462</td>
<td>501</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>5,420</td>
<td>6,535</td>
<td>6,680</td>
</tr>
<tr>
<td><strong>Value of exports</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meat and live animals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beef and veal</td>
<td>3,119</td>
<td>4,007</td>
<td>4,127</td>
</tr>
<tr>
<td>Live cattle</td>
<td>433</td>
<td>482</td>
<td>500</td>
</tr>
<tr>
<td>Mutton</td>
<td>326</td>
<td>416</td>
<td>434</td>
</tr>
<tr>
<td>Lamb</td>
<td>376</td>
<td>504</td>
<td>524</td>
</tr>
<tr>
<td>Live sheep</td>
<td>180</td>
<td>258</td>
<td>348</td>
</tr>
<tr>
<td>Pig meat</td>
<td>159</td>
<td>186</td>
<td>262</td>
</tr>
<tr>
<td>Poultry meat</td>
<td>21</td>
<td>26</td>
<td>30</td>
</tr>
<tr>
<td>Canned meat</td>
<td>50</td>
<td>16</td>
<td>44</td>
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<tr>
<td><strong>Total</strong></td>
<td>4,663</td>
<td>5,894</td>
<td>6,271</td>
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<tr>
<td>Wool</td>
<td>1,796</td>
<td>2,305</td>
<td>2,160</td>
</tr>
<tr>
<td>Semiprocessed</td>
<td>1,031</td>
<td>1,289</td>
<td>1,146</td>
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<tr>
<td>Skins</td>
<td>136</td>
<td>298</td>
<td>199</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2,963</td>
<td>3,892</td>
<td>3,505</td>
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<tr>
<td>Dairy products</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Butter</td>
<td>291</td>
<td>291</td>
<td>289</td>
</tr>
<tr>
<td>Cheese</td>
<td>807</td>
<td>950</td>
<td>1,271</td>
</tr>
<tr>
<td>Casein</td>
<td>81</td>
<td>89</td>
<td>74</td>
</tr>
<tr>
<td>Skim milk powder</td>
<td>478</td>
<td>694</td>
<td>877</td>
</tr>
<tr>
<td>Whey milk powder</td>
<td>403</td>
<td>580</td>
<td>763</td>
</tr>
<tr>
<td>Other dairy products</td>
<td>380</td>
<td>442</td>
<td>457</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2,439</td>
<td>3,047</td>
<td>2,731</td>
</tr>
<tr>
<td>Other livestock exports</td>
<td>1,452</td>
<td>1,883</td>
<td>1,941</td>
</tr>
<tr>
<td><strong>Total livestock exports</strong></td>
<td>11,517</td>
<td>14,716</td>
<td>15,447</td>
</tr>
</tbody>
</table>

a) preliminary  
b) Australian Bureau of Agricultural and Resource Economics estimate  
c) includes dairy cattle slaughtered  
d) excludes animals exported for breeding purposes  
e) excludes skin values  
f) shorn, dead and fellmongered wool and wool exported on skins  
g) milk intake by factories and valued at farm gate  
h) mainly egg production, honey and beeswax  
i) based on quantity data, from Agriculture, Fisheries and Forestry – Australia, and export price data, from the Australian Bureau of Statistics (ABS)  
j) excludes breeding stock  
k) on a balance of payments basis. ABS recorded trade data adjusted for changes in stock levels held overseas by Wool International

Note: the gross value of production is the value placed on recorded production at the wholesale prices realised in the market place. The point of measurement can vary between commodities. Generally, the market place is the metropolitan market in each State and Territory. However, where commodities are consumed locally or where they become raw material for a secondary industry, these points are presumed to be the market place.

Prices used in these calculations exclude Goods and Services Tax

Sources: Australian Bureau of Statistics, Australian Bureau of Agricultural and Resource Economics
In 2000-2001, Australia produced 2,054 kt of beef and veal (Table I). In addition, 846,000 live cattle were exported, with most going to feedlots in South-East Asian countries.

**Sheep**

Australia is the largest supplier of apparel wool in the world. Sheep are bred over a wide range of conditions, from the arid and semi-arid inland to the higher rainfall areas of south-eastern Australia. Most sheep in Australia are produced as part of a mixed farming enterprise, often for lamb production and frequently with crops, beef and dairy cattle. Sheep numbers fluctuate according to seasonal conditions, movements in wool prices and the relative profitability of other enterprises.

The sheep-meat industry has developed along with the wool industry and is an important individual industry rather than a by-product of fibre production. Although wool and mutton production is distributed throughout the sheep-raising areas, prime lamb production is generally confined to higher rainfall areas with good pasture conditions.

Live sheep exports are also an important part of the industry, with 5.7 million sheep exported in 2000-2001 (Table I).

**Dairy cattle**

The dairy industry is the third largest rural industry in terms of wholesale value of production in Australia. The industry operates in all States. Victoria has some 61% of dairy cattle, followed by New South Wales (15%) and Queensland (9%). Most dairy farms are family owned and operated. Over the past twenty years, the dairy industry has been extensively restructured as a result of changes in Government regulation and changes to both domestic and export markets for dairy products. As a result, the number of dairy farms has decreased by more than half and cow numbers have fallen by 20%. However, production per cow has increased markedly over the same period. The trend is to larger herds. Milk production has continued to grow in Australia, as reflected by higher export volumes for all major dairy products.

**Pigs**

From an historical basis as an adjunct to the dairy industry, pig farming is now highly specialised in Australia. New South Wales is the largest producer of pigs (29%), followed by Queensland (25%) and Victoria (19%). Most pigs are housed indoors. Extensive pig-keeping systems are expanding slowly. The number of establishments with pigs has shown a steady decline over the years, although the number of sows has remained relatively stable. This reflects industry adjustments as smaller producers leave the industry and existing producers increase the size of their operations. Many of the larger establishments are vertically integrated companies and the largest 2% of farms account for about 40% of the total sow population. The pig industry is a large user of feed grain and pig numbers tend to fluctuate with grain prices.

From a predominantly domestic production base, the Australian pig industry has become more export-focused in recent years, with 12.1% of production exported in 2000-2001. Recent expansion of Australian pig meat exports is expected to continue in response to the demand for chilled pork in Asia.

**Other industries**

Australia has a rapidly growing goat industry, producing angora and cashmere fibres, as well as milk, meat and live goat exports. There is also a small, farmed deer industry, comprising about 1,500 farmers breeding mainly fallow deer (*Dama dama*) and red deer (*Cervus elaphus*), producing both venison and velvet. Australia also possesses many other small, developing livestock industries, including buffalo and alpaca farms.

**The approach of Australia to foot and mouth disease**

Australia has never had a major outbreak of FMD, the last recorded case being in 1872 (10). However, as a major producer and exporter of livestock and livestock products, Australia has always had a strong interest in FMD, the most serious disease affecting such trade.

Application of sound quarantine procedures has successfully prevented the entry of major diseases with imported livestock, genetic material and products. Australia has developed comprehensive contingency plans for dealing with an incursion of the disease (see below) and maintains a high awareness of changes to the disease status of countries with which it has commercial, cultural and tourist links. Priority has been placed on new knowledge of the FMD virus, such as the emergence and spread of new strains, the various modes of transmission of the disease, improved methods of detection and the most efficient and practical ways to control and eradicate outbreaks.
Prevention and preparedness

The potential economic impact of FMD on Australia dictates the investment level in protection. Strong protection measures have been implemented to prevent introduction of FMD, particularly over the past 25 years. Notwithstanding this, the severe UK epidemic this year and spread of FMD in recent times (notably due to the type O pan-Asian strain) has necessitated a re-evaluation of these protection measures.

Protection can be viewed at three levels – pre-border, border and post-border. Pre-border activities have involved working with the Office International des Epizooties (OIE: World organisation for animal health) to develop international standards to meet contemporary animal health, consumer and trade needs – such as vaccination, safe disposal, endangered species, country classification, zoning and compartmentalisation and laboratory methods. This has generally been aimed at developing practical codes and standards to facilitate trade. At the same time, Australia has worked with countries, particularly those in South-East Asia, through Australian aid projects and joint laboratory activities, to assist with local FMD control and diagnosis (3, 22). Australia has supported OIE regional efforts in FMD control by providing financial and in-kind support to help co-ordinate the South-East Asian Foot and Mouth Disease Control and Eradication Campaign.

Australia has made efforts to learn from the experiences of countries that have experienced FMD and at the same time participate in control and eradication programmes. In recent years, this has involved work in the Philippines and with the Governments of Japan and Taipei China. A senior epidemiologist from the Commonwealth Government of Australia assisted the Republic of Korea during the recent outbreak of FMD in that country and approximately 180 veterinarians and animal health field staff worked in the UK during the 2001 epidemic.

Several other pre-border activities are considered particularly critical. These include membership of the International Vaccine Bank (IVB) based in Pirbright in the UK and ongoing work with vaccine manufacturers to identify alternative sources of supply of vaccines should an emergency occur in Australia. From a surveillance and monitoring perspective, joint activities are undertaken with Indonesia, East Timor and Papua New Guinea through the Northern Australia Quarantine Strategy (3).

The scale and impacts of the FMD epidemic that took place in the UK have resulted in a re-appraisal of quarantine measures at Australian borders. Given the threat of FMD, an additional investment of almost half a billion Australian dollars over four years has been made to enhance border inspection. These additional resources will ensure 100% inspection at airports in parallel with developments in technology, including enhanced detector dog support. External inspection of all aircraft containers and inspection of all material of quarantine concern in air cargo has been introduced. At sea ports, 100% of ships are inspected and all passengers are screened and general surveillance, including quarantine waste management, has been increased. All sea cargo containers are inspected externally and material of quarantine concern is more minutely inspected. At mail exchanges, all postal articles are screened by X-ray or subjected to surveillance by detector dogs. Despite massive investment, these quarantine protection measures, while reducing the risk, cannot guarantee that FMD will not enter the country. Hence, post-border preparedness and planning to deal with an incursion are essential.

In addition to contingency planning (see below), other post-border activities undertaken in Australia include legislative bans on swill-feeding and audits of these bans, enhanced communications and surveillance capacity to promote awareness and early reporting of suspect cases and specific training of staff in emergency disease management. Livestock producers have also been encouraged to adopt improved biosecurity measures as part of quality assurance programmes.

Contingency planning

Effective responses to outbreaks of serious animal diseases, such as FMD, require emergency disease planning at National, State/Territory and District levels and the involvement of both animal health authorities and emergency management organisations. Pre-planning is especially important for a continent like Australia. Given the size of Australia, the country possesses a varying mixture of industries in different areas and a wide range of production systems and agro-climatic zones – including dry and wet tropics, temperate, arid and Mediterranean. The Australian Constitution gives States and Territories a key role in providing animal health services and it is important that consistent programmes and policies be implemented at both the Commonwealth and State/Territory levels.

In Australia, contingency plans are based on a comprehensive approach to emergency management. The approach covers a range of prevention, preparedness, response and recovery actions that can be applied in a generic sense to an outbreak of an unknown disease or, alternatively, in a narrower context such as response to a specific disease like FMD. The approach has previously been described in detail (20). The response of Australia to outbreaks of major exotic diseases is described in the Australian Veterinary Emergency plan, AUSVETPLAN (2). AUSVETPLAN comprises a series of technical response plans that describe the proposed Australian approach to an exotic disease incursion. The documents provide guidance based on sound analysis, linking policy, strategies, implementation, co-ordination and emergency-management plans.

Managing an incursion of foot and mouth disease

The preferred approach is to eradicate incursions of exotic diseases where this is feasible. Control will generally be based
on quarantine of infected premises, movement restrictions in the area and slaughter of stock on affected premises (stamping-out), followed by cleaning and disinfection. For FMD, the policy is to eradicate the disease as rapidly as possible, the preferred option being eradication by stamping-out. Under some circumstances, emergency vaccination might be considered. Once an outbreak was under control, consideration would be given to adopting zoning. Zoning is particularly relevant for a country like Australia because of the size and environmental diversity of the country. This would involve declaring a major part of Australia free from the disease. The free area would be based on geographical boundaries and would comply with OIE requirements. These responses are described in detail in the AUSVETPLAN disease strategy for FMD (1).

Plans made by Australia have largely been developed to cope with the perception that any incursion of FMD would probably involve a relatively small number of outbreaks. However, recent outbreaks in previously disease-free countries in north Asia and Europe suggest that this may not necessarily be the case and a different approach is necessary. Animal health services cannot be expected to manage all aspects of the response, as may have been the case in the past. Emergency services, logistics experts, economists, legal and communications experts must be included. A ‘whole-of-government’ and industry response is required – those organisations or people with different specialist skills, regardless from where they come, need to have their roles and responsibilities clearly defined in advance and to be trained to carry out their respective functions.

Assessing the consequences of an incursion of foot and mouth disease

Through quarantine policies, community awareness and, to a lesser extent, through the management practices of industry participants, Australia has the discretion to exert a degree of control over exotic diseases entering the national livestock population. Implicitly, the option or opportunity exists to maintain the current health status and associated levels of production and economic value. Presuming the opportunity to avoid exotic diseases exists, the cost of an outbreak of FMD is given by the difference between the current level of gross national product (GNP) and the level of GNP consequential to FMD entering one or more areas and then either being eradicated or becoming endemic. Changes in GNP can be decomposed into three main effects, as follows:

\[ \text{GNP effect} = \text{output effect} + \text{terms of trade effect} + \text{net foreign income}. \]

The overall impact, or opportunity cost, can be estimated using modelling techniques. In a country in which agriculture represents a small part of the national economy and only a small share of exports, the output effect will dominate and the terms of trade and net foreign income effects will be small. However, for an economy such as that in Australia where agriculture contributes a large share of exports and the exchange rate is likely to depreciate as a consequence of a serious outbreak of FMD, the external effects cannot be ignored in the analysis of a disease outbreak.

The range of issues presented below should be considered in estimating the economic impact of an FMD incursion.

**Epidemic versus endemic**

An exotic disease may be eradicated after some time following a successful control programme, or may become endemic. One approach is to develop ‘realistic scenarios’ that could unfold in practice. A likely scenario will relate to introduction of infection, via some carrier such as imported animal or product, followed by establishment and spread of the disease. The incursion might be contained and eradicated, and the effects of the disease geographically confined. Alternatively, the disease could establish, spread and, in the worst case, become endemic. To cover the spectrum of possibilities, an economic assessment should consider both the range of outcomes and the probabilities of these outcomes occurring.

Australia has developed a sophisticated simulation modelling capacity to assist in understanding how FMD might behave under the conditions prevailing in the country and to provide outbreak scenarios for estimating potential economic impacts (11, 13, 14, 15). Figure 2 shows an example of an epidemic curve of a simulated outbreak of FMD in northern New South Wales, controlled by stamping-out infected and dangerous contact flocks and herds.

**Direct costs**

The costs of eradicating FMD depend on both the severity of the outbreak and the type of management strategy applied to control the disease. Most strategies for dealing with an outbreak involve the slaughter of all infected stock and all stock in direct contact with any infected animals, as well as the quarantining of affected properties.

A direct economic loss would be incurred by producers through the loss of animals that had some value and through the loss of future productive capacity. Producers may be compensated to some degree for the loss of stock, the funding for this being shared by Commonwealth Government and State/Territory Governments. Governments may also bear the operating costs associated with implementing a disease control strategy.

**Indirect costs**

Indirect economic losses from an outbreak of FMD arise from the differences in prices received for livestock products,
particularly beef, from FMD-free areas compared with those from FMD-endemic areas. Currently, the world beef market can be divided into the Pacific Basin markets and the Atlantic Basin markets. This division occurs because major FMD-free importing countries try to protect their livestock industries from FMD. Pacific Basin importers do not allow imports of animals and animal products from supplying countries in which the FMD virus is endemic or where an outbreak of FMD has recently occurred. These limits to the supply of beef to the Pacific Basin markets mean that returns on beef sales to the Pacific Basin markets are higher than if the same product were sold in Atlantic Basin markets.

Approximately 60% of the beef and veal production of Australia is currently sold on the world market, virtually all to markets in the Pacific Basin. Should an outbreak of FMD occur in Australia, beef and veal exports from at least some regions of Australia would be precluded from entry into the Pacific Basin markets at least until the disease was eradicated (see below).

Zoning
Following international acceptance of the concept of zoning in response to a disease outbreak, as seen by the adoption of an OIE International Animal Health Code chapter on zoning and regionalisation in 1993 (21), the possibility of limiting trade impacts to those parts of the country affected by the disease exists. Thus the magnitude of the economic impacts will depend on the extent to which zones can be established in Australia that meet OIE criteria, and that are accepted by countries that import from Australia.

However, zones must be approved by the OIE FMD and Other Epizootics Commission and by the International Committee. Since the International Committee only meets once a year, there can be a long delay in approval.

Period of exclusion from international markets
Notwithstanding the adoption of zoning, the exact delay required to re-establish major export markets for the affected zones would still be uncertain. There is of course no guarantee that all markets would be regained, particularly if the outbreak were to last a long time, as other suppliers might well have moved into the market. Under the OIE International Animal Health Code (21), a country or zone cannot be considered FMD-free in less than three months after the last reported case if stamping-out is used; three months after the last vaccinate is slaughtered if stamping-out and emergency vaccination are used; twelve months after combined vaccination and stamping-out; or two years after the last case if only vaccination is used. These are the minimum periods of market exclusion that could be expected. Meeting the quarantine protocols and risk assessment procedures of premium Australian markets – such as Japan, the Republic of Korea and the United States of America – is likely to take additional time, but it is difficult to estimate how long.

Producer responses
The cost in terms of impacts on sales and production throughout Australia is complicated by responses of producers in both the affected and unaffected regions and by the time required for adjustments in production. The magnitudes of FMD impacts are sensitive to the importance of the livestock industry in the region of the outbreak and the opportunity to switch to other activities. For example, an outbreak in a region of predominantly beef specialist enterprises is likely to make changing enterprise mix towards cropping more difficult, or in some geographical regions impossible, and more expensive than for farmers in a wheat-sheep zone.

Results of economic studies
A number of studies have shown the severe consequences that an outbreak of FMD would have on the Australian economy, with trade effects due to loss of major export markets dominating these losses (4, 5, 8, 16, 19).
The studies can be divided into two principal groups, depending on whether or not they assumed acceptance of zoning disease-free areas by major trading partners. Under zoning, unaffected parts of the country would be able to resume normal exports almost immediately. The estimated economic impact of FMD in studies without zoning is large compared to subsequent studies that incorporated zoning. An outbreak of FMD would necessarily involve farmer responses to changes in relative profitability between different enterprise types, especially changes stemming from the loss of the premium meat markets in the Pacific Basin. Studies can also be differentiated depending on whether they allowed for changes in producer responses.

Lembit and Fisher (19) discussed the impact of FMD on the beef and sheep industries in Australia without zoning. This analysis assumed that FMD became endemic throughout Australia. The study drew on earlier econometric models of impacts of FMD on Australian broadacre agriculture (5) and interrelationships between Australian agriculture and Pacific Rim markets (18). Estimates showed that the farm cash income of an average broadacre farm would be reduced by AUS$25,000 during the first year of an outbreak of FMD. The beef industry was assessed as likely to be the worst affected, with cattle numbers projected to fall by 20% to 33% (depending on the time before eradication, the extent of spread throughout Australia, and different responses of major trading partners). The regional impacts were expected to be greatest in the wheat-sheep zone, where a substantial shift among farming enterprises towards cropping could be expected, due to falling absolute and relative prices of livestock products compared to crops.

In 1993, with mooted OIE acceptance of a code on zoning and regionalisation of FMD, Barry et al. (8) examined scenarios that allowed particular zones to be quarantined while FMD-free zones continued exporting to premium markets. Under these conditions, regional changes in farm cash incomes immediately; after one year, and after five years, were examined for hypothetical outbreaks of FMD in two representative regions (southern New South Wales and western Queensland). With no account of the costs of disease control programmes and no compensation for losses incurred by producers, these scenarios produced discounted losses to the affected beef producers in excess of AUS$60 million over five years in each of these regions. The adoption of zoning would result in substantially smaller losses to the beef industry than those implied by the pre-zoning results of Lembit and Fisher (19). In particular, only producers in the FMD-infected regions would be restricted to the lower priced Atlantic market (where FMD is endemic). Producers in FMD-free regions would respond by increasing their turn-off (to FMD-free Pacific markets) in the year of the outbreak, so that average farm cash income in the year of the outbreak would actually increase by AUS$3,000.

Garner and Lack (14, 15) also found that acceptance of zoning would reduce the resulting economic losses to a fraction of those incurred in the absence of zoning. This study examined regional impacts of simulated outbreaks of FMD, assuming zoning arrangements, using input-output analysis. This allowed assessment of both direct and indirect costs on the beef, sheep, dairy, pig and the associated manufacturing industries. The study also examined the effectiveness of alternate control strategies for FMD control. The total costs of an outbreak of FMD varied between AUS$10 million and AUS$80 million, depending on the study region and control strategy adopted.

Garner et al. (16) undertook a more detailed evaluation of the impact of FMD under different control strategies, including vaccination. Small (10-15 infected premises) or medium (50-60 infected premises) outbreak scenarios were simulated in two regions. Costs of controlling the outbreaks ranged from AUS$1 million to AUS$4 million, and compensation costs for livestock destroyed ranged from AUS$11 million to AUS$21 million depending on the region and control strategy used. Impacts of FMD on beef production were assessed using an optimal control model. Estimates showed that if producers in the affected region were denied access to the Pacific Rim markets for one year, the sum of net beef producer revenues over the five years following the initial outbreak, discounted to the current period, would fall by about AUS$15 million to AUS$29 million. This would increase by AUS$27 million to AUS$36 million if the period of market exclusion were two years. In the first year, production in affected regions would fall by around 10% and prices by 15%. In contrast, the sum of discounted net revenues of beef producers outside the infected zones over the five years following the initial outbreak would rise because of the increase in the price of beef in the Pacific Basin due to reduced supply.

In 2001, the Australian Bureau of Agricultural and Resource Economics (ABARE) (6) studied the short run macroeconomic and intersectoral impacts on the Australian economy of an outbreak of FMD. The impacts considered were limited to the assumed direct effects on the livestock industries and their flow-on effects to other industries. Assumption was made that the trade effects would last for twelve months, based on six months to eradicate the disease and a further six months for trade effects to be resumed. Zoning was not applied. The impacts were estimated using a general equilibrium model of the Australian economy. The study showed that export revenues from affected livestock products would fall by 70%, or AUS$5.8 billion in 1999-2000 dollars in the initial year following an outbreak. Real GDP would fall by an estimated 0.6% (AUS$3.5 billion) and employment by 0.8%, and there would be a 3% depreciation in the exchange rate in the first year. The dairy and meat industries would experience the greatest losses in output and employment but some other export industries, particularly the minerals industry in Western Australia, would gain as a consequence of the devaluation of the Australian dollar.
Discussion

Australia and New Zealand are unique among Organization for Economic Co-operation and Development (OECD) countries in that a significant share of their export revenues is derived from agricultural products. Even in a modern, diversified economy such as that in Australia, an outbreak of FMD would have significant economic consequences. Much of this impact would be due to the loss of export markets.

There are a number of ways to minimise such losses. The first way is to prevent the entry and establishment of the disease. Given the significant consequences of an outbreak of FMD, Australia invests considerable resources in prevention and planning. Economics can be used to assist the development of quarantine and other policies (17). Australia has recently increased border quarantine measures to minimise the risk of introduction of FMD. However, no matter how much is invested in border prevention, there is no guarantee that FMD will not enter Australia. Accordingly, it is important to ensure that comprehensive contingency plans are also in place.

Economics can provide a framework for assessing the costs and benefits of alternate control strategies. A government/industry FMD-bovine spongiform encephalopathy (BSE) policy forum in November 2001 recognised the importance of clear policies on issues such as vaccination and zoning for FMD. The forum identified the need for further cost-benefit studies and risk analyses to evaluate conditions under which emergency vaccination should be considered in the response strategy. The Australian epidemiological model of FMD will be modified to take into account recent experience with the type O pan-Asian strain of FMD virus and will be used to provide input for economic studies by ABARE and the Australian Productivity Commission. These studies will cover a range of outbreak scenarios, from small and localised to a large epidemic involving several States.

Australia continues to refine its approach to zoning, particularly with respect to surveillance strategies to support zoning and the associated resource implications. Given the potential uncertainty over conditions under which zoning would be acceptable and the delay in implementation, there are advantages in pre-outbreak discussions on zoning with trading partners. Early discussions with trading partners and establishment of management plans with them have the potential to be just as important in minimising the overall economic impact of an outbreak of FMD as domestic contingency planning.

Finally, epidemiological and economic modelling is also important to support decision-making during an outbreak. Work is under way in Australia to develop a bio-economic decision framework to assist decision-making that can be used in evaluating alternate response strategies in an outbreak of FMD.

La fièvre aphteuse et l’économie : le point de vue d’un pays indemne, l’Australie

M.G. Garner, B.S. Fisher & J.G. Murray

Résumé

L’Australie est un important producteur et un grand exportateur de bétail, de produits d’élevage et de matériel génétique d’origine animale. Une épizootie de fièvre aphteuse y aurait des conséquences économiques désastreuses. Une étude récente a démontré qu’une épizootie qui durerait six mois entraînerait une baisse d’environ 0,6 % (3,5 milliards de dollars australiens) du produit intérieur brut réel, tandis que l’emploi reculé serait de 0,8 % ; par ailleurs, la devise nationale accuserait une dépréciation de 3 % la première année. Ses effets se feraient essentiellement ressentir au niveau des marchés d’exportation. Consciente de l’énorme impact potentiel d’une épizootie de fièvre aphteuse, l’Australie consacre des ressources considérables à la prévention et à la planification. Les diverses mesures adoptées se situent à trois niveaux : avant la frontière, à la frontière et après la frontière. L’Australie vient de renforcer les mesures de quarantaine aux frontières dans le but de réduire au minimum les risques d’introduction du virus de la fièvre aphteuse. Toutefois, l’inviolabilité du territoire ne peut être totalement
guarantee, quelle que soit l’importance des moyens déployés. Il importe donc d’envisager la mise en place de dispositifs globaux d’intervention. Les épizooties de fièvre aphteuse qui ont récemment frappé des pays jusqu’alors indemnes ont montré qu’elles constituaient un problème majeur pour les services zoosanitaires nationaux et qu’elles nécessitaient une réponse concertée de la part des pouvoirs publics et de la filière concernée.

**Mots-clés**

**Aspectos económicos de la fiebre aftosa desde la óptica de Australia como país libre de la enfermedad**

M.G. Garner, B.S. Fisher & J.G. Murray

**Resumen**
Australia es un importante productor pecuario y uno de los grandes exportadores de ganado, de productos pecuarios y de material genético de origen animal, por lo que un brote de fiebre aftosa supondría un golpe muy duro para la economía del país. En el curso de un reciente estudio se calculó que un brote de seis meses de duración provocaría una caída cercana al 0,6% del producto interior bruto real (3.500 millones de dólares australianos), así como la pérdida de un 0,8% de los puestos de trabajo. Además, el tipo de cambio sufriría una depreciación del 3% en el primer año. Tales efectos obedecerían en gran parte a la pérdida de mercados de exportación. Dada la trascendencia que tendría un hipotético brote de fiebre aftosa, Australia invierte un volumen considerable de recursos en labores de prevención y planificación, que se concretan en una serie de medidas correspondientes a tres niveles distintos de actuación: prefronterizo, fronterizo y postfronterizo. Hace poco tiempo, Australia reforzó las medidas de cuarentena en sus fronteras con el fin de minimizar el riesgo de penetración de la enfermedad. Sin embargo, por muchos recursos que se inviertan, es imposible tener la absoluta seguridad de que la fiebre aftosa no penetrará en el país. De ahí la importancia de disponer de planes de emergencia exhaustivos y listos para entrar en aplicación. Los brotes que se han producido recientemente en países hasta entonces libres de la enfermedad han demostrado que un brote importante de fiebre aftosa plantea enormes dificultades a los servicios zoosanitarios de un país y exige una respuesta concertada de las autoridades públicas y la industria agropecuaria.

**Palabras clave**
References


