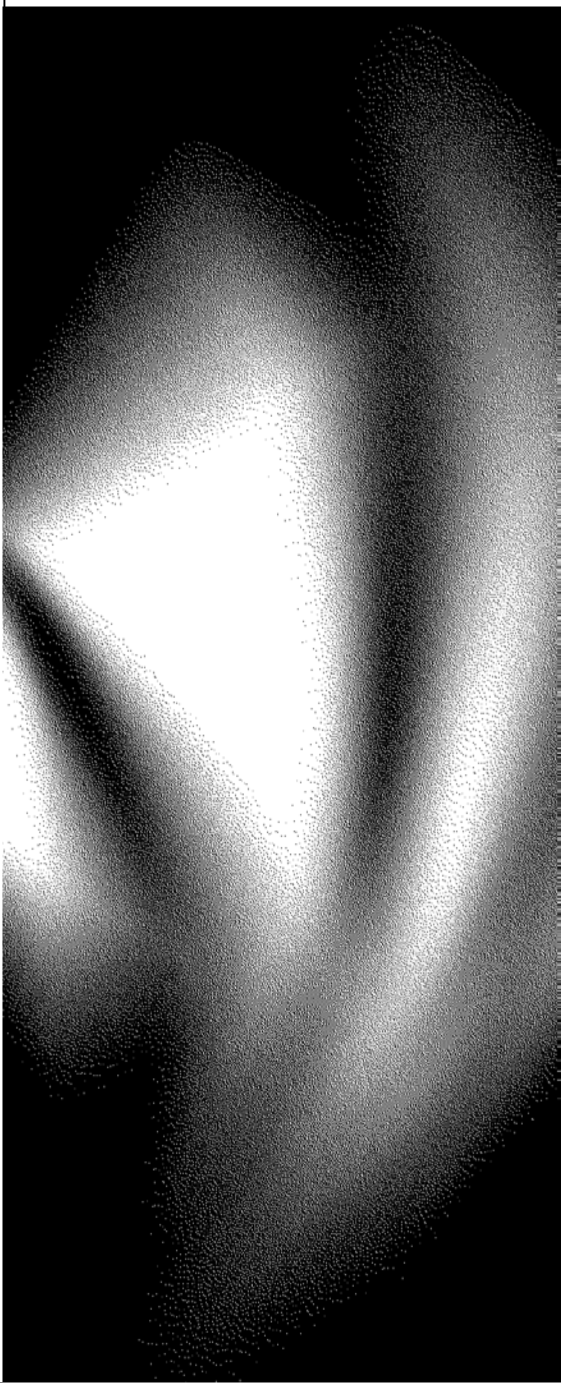
PRODUCTIVITY
COMMISSION

Impact of a Foot and Mouth Disease Outbreak on Australia

Research Report



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The Productivity Commission

The Productivity Commission, an independent Commonwealth agency, is the Government’s principal review and advisory body on microeconomic policy and regulation. It conducts public inquiries and research into a broad range of economic and social issues affecting the welfare of Australians.

The Commission’s independence is underpinned by an Act of Parliament. Its processes and outputs are open to public scrutiny and are driven by concern for the wellbeing of the community as a whole.

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Terms of reference

THE ECONOMIC AND SOCIAL COST OF AN OUTBREAK OF FOOT AND MOUTH DISEASE IN AUSTRALIA

PRODUCTIVITY COMMISSION ACT 1998

Australia is free from major exotic animal diseases such as foot and mouth disease (FMD). If an outbreak of FMD was to occur in Australia, there would be a major impact on the agricultural sector, the national economy and rural and regional Australia. Assessing the full extent of these consequences will provide important information, which will assist planning and preparedness for such an outbreak and also in managing a response.

The Productivity Commission is requested:

- To consider three scenarios:

1. A small single point outbreak;
2. A medium sized outbreak which impacts on two States and which takes up to six months to contain and eradicate; or
3. A large multi-point outbreak which takes up to twelve months to control and eradicate.

- To evaluate the full economic, social and environmental impact of an outbreak (under each of the above scenarios), including on the agricultural sector, regional Australia, and the national economy, and in any other collateral manner.
- For scenarios (2) and (3) above, consideration be given to any changes to the impact of an outbreak if:

a vaccination policy is in place; or
FMD-free geographic zones are established.

The Commission is required to report within 6 months of commencing the study.

IAN CAMPBELL
21 DECEMBER 2001

Foreword

The Commission has prepared this research report in response to a request from the Parliamentary Secretary to the Treasurer. The Council of Australian Governments meeting of June 2001 agreed to review and revise national whole-of-government frameworks for the prevention, preparedness for, and management of a major emergency disease outbreak, such as Foot and Mouth Disease (FMD). This report is intended as an input to that process.

The report assesses the economic, social and environmental impacts of a range of hypothetical FMD outbreak scenarios on the agricultural sector, rural and regional Australia, and the national economy. It also assesses how those potential impacts would change if a vaccination policy were in place, or FMD-free geographic zones were established.

The report has drawn on information contained in previous studies of the possible impact of FMD on Australia, the impacts of FMD outbreaks on other countries, and wide ranging consultations with government agencies, industry associations and academics. The Commission wishes to thank the many people who have contributed to the study.

Gary Banks
Chairman
May 2002

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Abbreviations

ABARE	Australian Bureau of Agricultural and Resource Economics
ABS	Australian Bureau of Statistics
AFFA	Department of Agriculture, Forestry and Fisheries Australia
AUSVETPLAN	Australian Veterinary Emergency Plan
CIE	Centre for International Economics
COAG	Council of Australian Governments
DEFRA	Department of Environment, Food and Rural Affairs
EADRA	Emergency Animal Disease Response Agreement
FMD	Foot and mouth disease
GDP	Gross Domestic Product
MMRF model	MONASH Multi-Regional Forecasting model
OIE	Office International Des Epizooties
PC	Productivity Commission
SPS	Sanitary and Phytosanitary
UK	United Kingdom
USA	United States of America
WTO	World Trade Organisation

Glossary

AUSVETPLAN	A nationally agreed approach for responding to exotic animal disease emergencies developed by Commonwealth and State animal health authorities and the Natural Disasters Organisation, linking Australia’s animal disease policy, strategies, implementation, coordination and counter-disaster plans.
Chief Veterinary Officer	The veterinarian of each State or Territory animal health authority who has responsibility for animal disease control in that State or Territory.
Control area	A declared area in which defined conditions apply to the movement of specified animals to reduce the chance of the disease spreading further. Conditions applying in a control area are of lesser intensity than those in a restricted area.
Dangerous contact animal	An animal showing no clinical signs of disease but which, by reason of its possible exposure to disease, will be subject to disease control measures (which may include slaughter of all or some of such animals).
Dangerous contact premises	Premises containing dangerous contact animal(s) and on which some or all susceptible animals may be slaughtered.
Declared area	A defined tract of land being subject to disease control restrictions under exotic disease legislation. Types of declared areas include restricted area, control area, infected premises and dangerous contact premises.
Decontamination	Includes all stages of cleaning and disinfection.
Emergency ring vaccination	This involves vaccination of all susceptible stock in a ring of fixed width around an outbreak to contain the disease.
Emergency Animal Disease Response Agreement	A national cost sharing agreement between Australian governments and livestock industries for emergency animal disease control.
Endemic	Disease regularly occurring in a particular region, country or population group.
Epidemiology	The study of the distribution and determinants of disease in populations.

Free zone	Part of a country that is free of a disease. To obtain recognition of a disease-free zone, countries must demonstrate that they have a reliable system of disease control, the disease is compulsorily notifiable, and that they have an effective veterinary organisation.
Infected premises	A defined area (which may be all or part of a property) in which exotic disease exists, is believed to exist, or in which the infective agent of that exotic disease exists or is believed to exist. An infected premises is subject to quarantine served by notice and to eradication or control procedures.
Infected zone	A zone where disease is present in an otherwise disease-free country.
Infectious units (IU)	Measure of the amount of virus (1 IU = 1.4 $TCID_{50}$ or Tissue culture infectious dose)
Local disease control centre	An emergency operations centre responsible for the command and control of field operations in a defined area.
Movement controls	Restrictions placed on movement of animals, people and things to prevent the spread of disease.
Outbreak	Usually defined as a small epidemic — the occurrence of disease in a particular region, country or population group at a level clearly in excess of that normally expected.
Quarantine	Legal restrictions imposed on a place or tract of land, limiting access or movement of specified animals, persons, vehicles or things.
Rendering	Destruction of the crushed carcass or animal by-products by heating.
Restricted area	A defined area around infected and dangerous contact premises, which will be subject to a high level of quarantine, movement control and surveillance.
Serological survey	The blood testing of herds to determine the extent of antibodies against a specific pathogen.
Serotype	The range of antibodies in an individual's blood, from which one can infer the individual's history of infection.
Stamping out	Control of disease outbreaks by slaughtering infected animals and animals exposed to infection plus quarantine and disinfection of infected premises.
Strain	A group of organisms closely related to one another and possessing a common characteristic.

Surveillance	A systematic program of inspection and examination of animals or things to determine the presence or absence of a disease.
Suspect animal	An animal which is under suspicion of having been exposed to an exotic disease such that quarantine and intensive surveillance, but not pre-emptive slaughter, are warranted; or an animal not known to have been exposed to the disease agent but showing suspicious clinical signs.
Suspect premises	Premises containing suspect animals which will be subject to quarantine and intensive surveillance.
Tracing	The process of locating animals, persons or things which may be implicated in the spread of disease.
Zoning	Dividing a country into defined infected and disease-free areas. A high level of movement control between zones apply.

OVERVIEW

Key messages

- A range of measures are in place to prevent a Foot and Mouth Disease (FMD) outbreak in Australia. All Governments and the livestock industries are also reviewing their preparedness to deal with an outbreak should it occur.
- An FMD outbreak would result in the immediate closure of many of Australia's major export markets for livestock products. Key beef and lamb markets would not reopen until at least three months after the disease was eradicated, and it could then take some time to rebuild those markets.
  - The Commission estimates that the cumulative losses of export revenue would range from over $3 billion for a short outbreak to over $9 billion for a 12 month outbreak. The majority of losses would be in the beef industry.
- The resulting oversupply of meat on the domestic market would result in a large drop in price in Australia and a further decline in industry revenue.
  - The cumulative decline in revenue from domestic sales is estimated to be over $2 billion for a short outbreak to over $3 billion for an outbreak that takes 12 months to control.
- Control and compensation costs are estimated to be around $30 million for a short outbreak rising to $450 million for a 12 month outbreak.
- There would be significant flow-on losses to the economy, including to many businesses reliant on livestock industry revenue in rural and regional Australia.
  - Overall, the cumulative loss to the national economy is estimated to be around $2 billion to $3 billion in Gross Domestic Product for a short outbreak, rising to between $8 billion and $13 billion for a 12 month outbreak.
- All jurisdictions would suffer losses but, because of the size of its beef industry, Queensland would be particularly affected.
- Establishing FMD-free trade zones could reduce the costs of an outbreak to Australia by up to two-thirds.
- Emergency ring vaccination of livestock is likely to be an appropriate policy option whenever it could materially reduce the length of an outbreak.
- There would be significant social costs associated with any FMD outbreak. In addition to the disruption and distress caused by the control and eradication measures in the infected areas, the widespread financial losses arising from the trade costs of an outbreak would result in significant social costs to individuals and communities throughout rural Australia.
- Environmental costs, which stem mainly from the disposal of animal carcasses, could be minimised with good preparation and site selection.

Overview

Geographical isolation and sound quarantine procedures have protected Australia's agricultural industries from major animal diseases, such as Foot and Mouth Disease (FMD). Nevertheless, with FMD endemic in many parts of the world, and becoming more prevalent in our region, Australia needs to be well prepared to control an outbreak should it occur.

The Commonwealth Government, as part of its planning and preparedness for a possible FMD outbreak, has asked the Productivity Commission to assess the potential economic, social and environmental impacts on Australia of a range of hypothetical FMD outbreaks.

FMD is a highly contagious virus that affects cloven-hoofed animals such as cattle, sheep, pigs, goats and deer. It does not generally kill otherwise healthy mature animals, but can cause the death of young animals and reduce livestock productivity. It does not pose a health risk to humans. The single greatest consequence of an outbreak of FMD in Australia would be our exclusion from premium meat markets in currently FMD-free countries such as Japan and the United States of America (USA). FMD is essentially a 'trade disease'.

The details of the outbreak scenarios used for this study were developed by the Commonwealth Department of Agriculture, Fisheries and Forestry — Australia (AFFA) in consultation with State Governments. The scenarios are:

- A small single point outbreak taking 3 months to control and eliminate, which has been modelled as occurring in the wheat-sheep zone of south west Western Australia, primarily affecting sheep. It lasts for around 3 months and results in the slaughter of 38 000 livestock to stamp out the disease.
- A medium outbreak lasting 6 months, which has been modelled as starting in north Queensland and spreading to central Queensland and the Northern Territory, primarily occurring in beef cattle. The outbreak results in the slaughter of around 50 000 animals.
- A multi-state outbreak taking 12 months to control, which has been assumed to begin in southern NSW and to spread to western Victoria and south east South Australia. It has been modelled as spreading through several regions in each of these three States and affecting high density mixed livestock, including beef and

dairy cattle, sheep and pigs. The outbreak involves the slaughter of around 750 000 animals.

Industries vulnerable to FMD — primarily the meat, livestock and dairy industries — make major contributions to the Australian economy. Annual production of these industries total around $16 billion. Exports totalled almost $10 billion in 2000-01, or 6 per cent of Australia's total exports.

To assist in understanding the economic, social and environmental impacts of an FMD outbreak, the Commission has consulted widely with industry and governments. It has also drawn on the recent United Kingdom (UK) experience with FMD and Australia's experience with other recent animal disease outbreaks.

Broadly, the impacts of an FMD outbreak arise from two sources:

- the costs of control and eradication of the disease itself; and
- to a greater extent, the costs from closure of export markets for affected livestock products.

Control and eradication costs

A nationally agreed strategy to control an FMD outbreak is set out in the Australian Veterinary Emergency Plan (AUSVETPLAN). This strategy — known as 'stamping out' — involves:

- establishing a quarantine area around the outbreak;
- slaughtering all infected herds and other herds that have been in 'dangerous contact' with them;
- disposing of animals;
- disinfecting properties;
- compensating stock owners for the livestock slaughtered; and
- carrying out clinical inspection and surveillance to ensure the disease has not spread.

As set out in the AUSVETPLAN, compensation applies only to livestock slaughtered for the purpose of eradication or prevention of the spread of FMD. It does not cover loss of income or consequential losses arising from the outbreak, such as those resulting from movement restrictions preventing the transport of stock to markets.

Significant government and industry resources would be required to 'stamp out' FMD. For example, the 1999 outbreak at Mangrove Mountain in New South Wales of a highly infectious disease affecting chickens — Newcastle disease — was confined to one local area. Nonetheless, around 5 000 people were involved in its control and the total control and compensation costs exceeded $25 million.

Based on the control costs of the UK FMD outbreak in 2001 and the cost of the Mangrove Mountain outbreak, the Commission estimates that control and compensation costs could range from around $30 million for the 3 month outbreak, to up to $450 million for 12 month outbreak. As shown in table 1, control costs for each scenario would be significantly larger than the cost of compensation for livestock destroyed.

Table 1 **Compensation and control costs for the FMD outbreak scenarios**

Outbreak	*Compensation*[a]	*Control costs*
	$m	$m
3 month outbreak — WA	4	20 – 25
6 month outbreak — Qld, NT	19	130 – 150
12 month outbreak— Vic, SA, NSW	41	360 – 420

[a] Calculated at pre-FMD-outbreak values.

Source: PC estimates.

Costs of trade restrictions

For a country such as Australia with major exports of livestock product, the economic impact of the trade restrictions resulting from an FMD outbreak would be far greater than the control costs. Trade costs would be large because countries that are free from FMD will not import meat (or a range of other agricultural products) from FMD-infected countries for fear of importing the disease. This effectively divides the world market for meat in two — an FMD-free market and an FMD-endemic market. Prices in the disease-free market are markedly higher than those in the endemic market. Currently, Australia exports over 85 per cent of its beef and around 40 per cent of its sheep meat to FMD-free countries.

If there were an FMD outbreak in Australia, all markets for livestock commodities would immediately close.

- Initially, FMD-endemic markets would close because of concerns about the possible introduction of a new strain of FMD virus. However, once the strain of the virus had been identified, there are good prospects of exports recommencing to FMD-endemic countries with the same strain during a medium or long outbreak. This could particularly lessen the impact of the outbreak on mutton, live sheep and live cattle exports.

- FMD-free markets would remain closed to Australian livestock commodities until at least three months after the last infected animal was eradicated. This would particularly affect beef and lamb producers as few alternative markets exist.

Because wool and dairy products can potentially also carry the virus, it is likely that there would be an initial disruption to exports of these commodities until assurances could be given that they had been treated to inactivate the virus.

The closure of export markets would have a severe effect on Australia's livestock industries, irrespective of the location of the FMD outbreak within Australia. Export prices and returns to exporters would fall dramatically. A glut of meat would cause the domestic price of all meats to fall, which would further lower returns to producers and processors. In turn, low prices would affect both farm production and domestic consumption of meat.

Impact on production

The impact of an FMD outbreak on production levels of affected livestock would differ depending on the commodity affected:

- In response to the price fall, it is likely that many beef and sheep producers reliant on grazing would initially withhold some production from the market, leading to an increase in total livestock numbers. However, feed constraints would limit the extent of holdback possible. At some point — which would differ considerably between regions — surplus stock would be dumped on the market. For sheep producers, the choice of surplus stock to dump could be influenced by the possibility of increasing wool production. Based on the Commission's assumptions about domestic and export demand for meat, it is unlikely that all livestock production could be sold, raising the spectre of some on-farm culling of animals beyond that required to eradicate the disease.
- In relation to pigmeat, the low prices for meat relative to the cost of feed would limit the holdback of production and lead to a significant temporary increase in supply as producers dumped stock. The breeding herd would be reduced to a level necessary to supply the reduced domestic demand and supply would remain subdued until the domestic prices for beef recovered and export markets for pork were re-established.

Impact on consumption

FMD does not raise human health issues. Nonetheless, because this would not be understood or accepted by all consumers, initially it is likely that consumption of red meat (including pork) would decline. However, once the initial fear of FMD receded, it is likely that low prices would lead to an increase in domestic consumption of red meat. While meat consumption would be likely to rise overall (the Commission has modelled an increase of 10 per cent), there would be a greater increase in red meats, at the expense of poultry. Indeed, competition from red meats could lead to a fall in the price of poultry and revenue losses to the poultry industry.

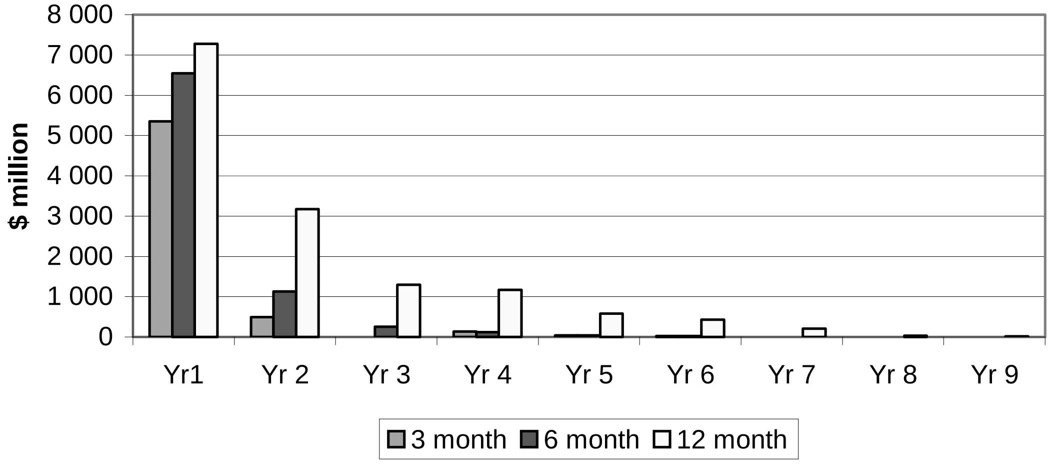
Estimates of the economic impacts

Loss of livestock industry revenue

Each of the outbreak scenarios would result in a significant loss in revenue to the livestock and meat processing industries. The Commission estimates that the cumulative loss in export and domestic market revenue to the industries would be around $5 700 million for the single point outbreak scenario, rising to around $12 800 million for an outbreak lasting 12 months. As shown in figure 1, in each scenario, revenue losses extend beyond the eradication of the disease owing to the time it would take to rebuild international markets.

Figure 1 **Estimated revenue losses to the livestock industries for each outbreak scenario**

Annual loss in export and domestic market revenue



Source: PC estimates.

These trade-related losses would continue for significantly longer under the 12 month scenario than for the shorter outbreaks. In each of the scenarios, the total value of lost exports exceeds the reduction in revenue on the domestic market (see table 2).

Table 2 **Estimated revenue losses to the livestock industries, by market**

Net present value of revenue losses at the wholesale level

Outbreak scenario	*Export market Loss of national income*	*Domestic market Transfer to consumers*	*Total revenue loss*
	$m	$m	$m
3 month	3 333	2 373	5 706
6 month	4 611	2 994	7 605
12 month	9 480	3 332	12 812

Source: PC estimates.

It is important to note that after an initial reaction by consumers, the reduction in revenue to the livestock and meat processing industries on the domestic market is primarily a transfer to meat consumers from the greater availability of lower priced meats. This would result in an increase in the consumption of other goods and services in the economy and/or to increased savings.

Impact on different commodities

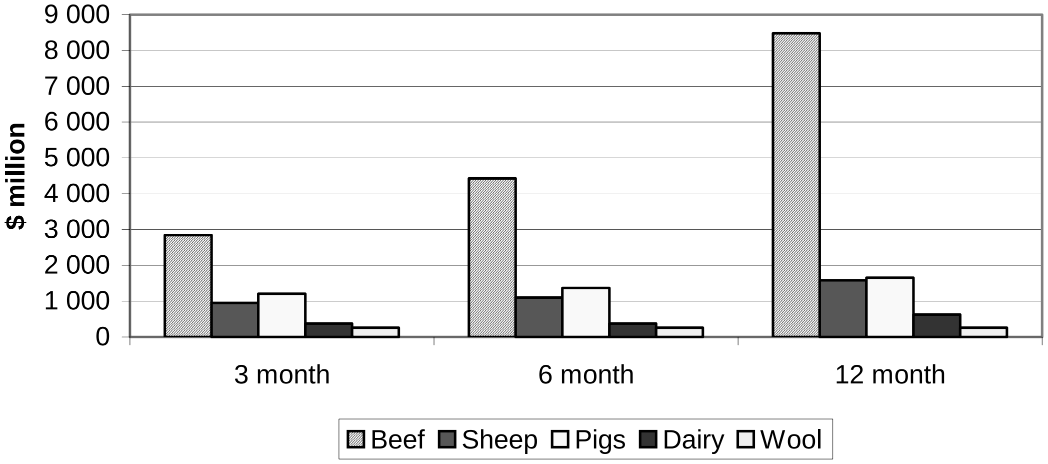
The beef industry would account for the majority of revenue losses in each of the outbreak scenarios (see figure 2). This reflects the high proportion of beef production that is exported and the FMD-free status of Australia's key beef markets in the USA and Japan. While the losses in other industries are smaller, they are significant in terms of the size of these industries.

Impact by State

The estimated losses by State, shown in figure 3, reflect the significant impact on the beef industry. As Australia's major beef producer and exporter, Queensland is more affected than other States in absolute terms. The impact on New South Wales reflects a combination of losses in the beef, sheep and pork industries. This is also the case in Victoria, where dairy losses are also overwhelmingly concentrated. While the losses in Western Australia, South Australia, Tasmania, and the Northern Territory appear smaller, relative to the level of production in those jurisdictions they are, nevertheless, significant. For example, a number of the regions likely to suffer the largest relative losses in output are in South Australia (see figure 4).

Figure 2 **Estimated revenue losses to the livestock industries by product**

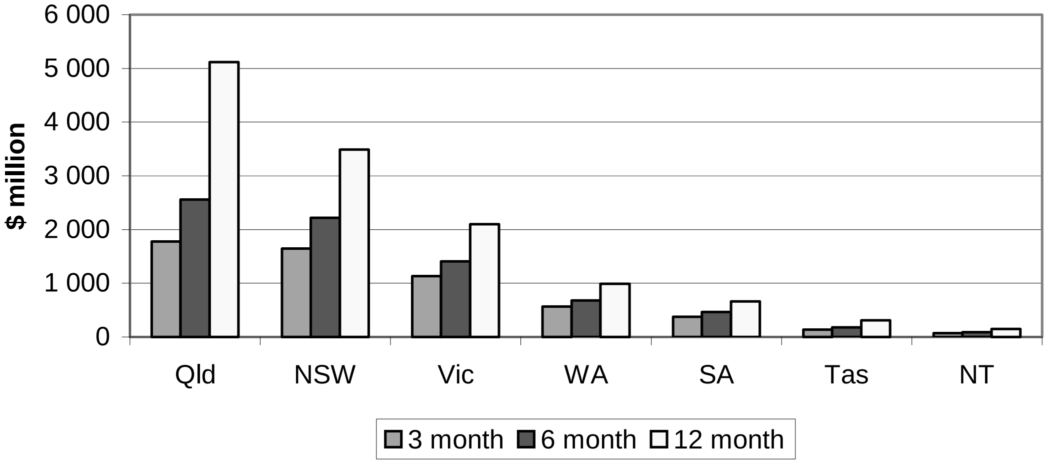
Net present value of revenue losses at the wholesale level



Source: PC estimates.

Figure 3 **Estimated revenue losses to the livestock industries, by State**

Net present value of revenue losses at the wholesale level



Source: PC estimates.

Indirect and economywide effects

The revenue losses to the livestock and meat processing industries and costs to control the outbreak would have wider impacts on the national economy. The Commission estimates that the 12 month outbreak scenario would reduce Australia’s Gross Domestic Product (GDP) by around $2 000 million in the first year and by between $8 000 million and $13 000 million over 10 years. The effects of a 6 month outbreak on GDP would be around half that of the 12 month scenario — see table 3.

Table 3 **Impact of the outbreak scenarios on Gross Domestic Product**

Outbreak scenario	*Loss in the first year*	*Total loss* [a]
	$m	$m
3 month	900	2 000 – 3 000
6 month	1 400	3 000 – 5 000
12 month	2 000	8 000 – 13 000

[a] Net present value of losses at the wholesale level.

Source: PC estimates.

Reflecting the direct impacts, activity and employment levels in the livestock industries are estimated to be significantly reduced. For instance:

- value added in beef production for a 12 month outbreak is projected to decline in the first year by 40 per cent and employment by 30 per cent. There would be a significant contraction of the feedlot industry — especially those operators geared towards production for the Japanese market;
- the meat processing industry would be affected to an extent similar to primary producers. It is estimated that, for the 12 month outbreak, activity and employment in meat processing would decline by around 30 per cent in the first year.

Employment in industries supplying inputs to livestock production would also fall. These include employment in road transport (around a 2 per cent decline), and in the agricultural and mining equipment industry (of around 2.5 per cent).

Measures to control the disease would also have an impact on other industries. In the UK, control measures had a large effect on the tourist industry. Australia’s tourist industry is not linked to agriculture to the same extent and most major tourist attractions would not be affected directly by an outbreak. A decline in domestic tourism in areas surrounding the outbreak may largely be transferred to other domestic tourism centres. There would also be some initial effect on international tourism because of a misperception that an outbreak would restrict tourist activities or cause health problems. The Commission estimates that initially the international tourism industry could lose around $300 million in receipts under the 12 month scenario, but that as a result of the trade effects of FMD on the exchange rate, cumulatively, there could be a small net boost to such tourism.

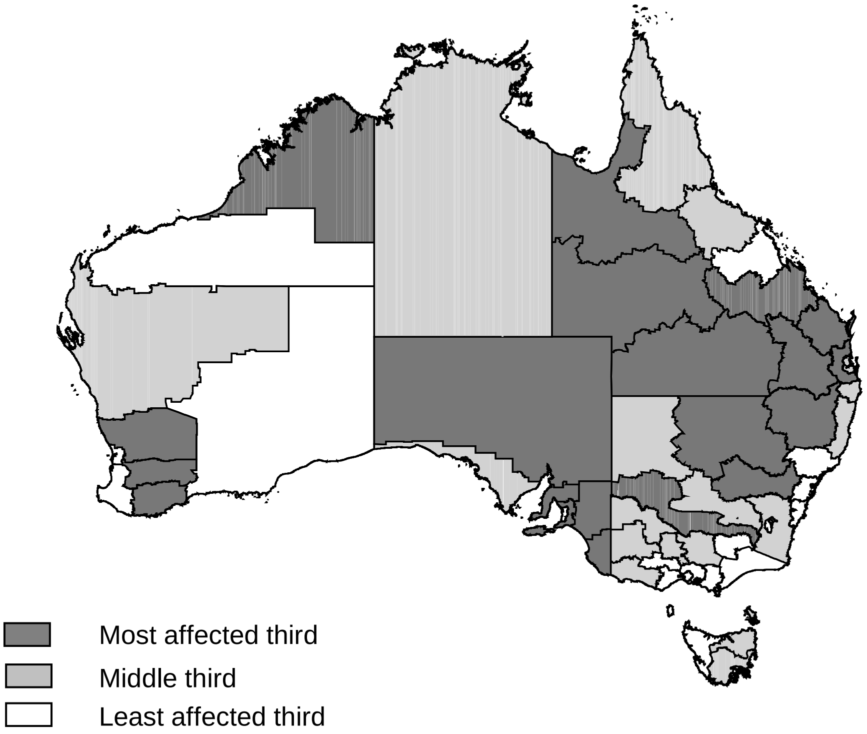
The Commission’s modelling also shows activity in some industries would increase, partially offsetting the livestock industry losses. For example, the loss of export markets for livestock commodities would add to pressure for a depreciation of the exchange rate. This could result in higher exports from other sectors of the economy, such as the mining industry and some manufacturing industries.

Impact by region

The effects within States are not uniform, but are generally concentrated in inland rural areas where livestock intensity is greatest and where a high proportion of people are employed in livestock production (figure 4).

Figure 4 **Regional pattern of the impact of the 12 month FMD scenario**

Cumulative change in output over 10 years



Source: MMRF model estimates.

Impact on farm receipts

Farm receipts are projected to be severely affected by an outbreak of FMD. For the 12 month outbreak, average broadacre farm cash receipts are projected to fall by $58 000 or 26 per cent of total receipts during the first year from the price effect of an outbreak alone. However, the decrease in cash receipts would differ significantly by farm type — ranging from 8 per cent of receipts for farms mainly producing wheat and crops to 70 per cent for predominantly beef production enterprises (table 4). Smaller farms would suffer a higher proportionate reduction in cash receipts than larger farms.

Table 4 **Impact of FMD on farm cash receipts, by broadacre farm type**

Average per farm for the first year of a 12 month outbreak

	Total farm cash receipts	*Estimated loss of farm cash receipts 12 month outbreak*	
	$	$	%
All broadacre	**224 736**	**58 200**	**26**
Wheat & crops	395 945	30 900	8
Mixed livestock & crops	244 989	43 000	18
Sheep	145 180	32 300	22
Beef	160 496	112 500	70
Sheep-beef	137 329	59 400	43

Source: PC estimates based on ABARE 2002a.

Such losses in receipts would undoubtedly cause financial hardship in many areas. On average, broadacre farms have low levels of debt and significant equity, which could provide some basis for support until prices improved. However, for farms that were already under financial stress, an FMD outbreak could prove the ‘final straw’.

Impact of vaccination and of establishing FMD-free trade zones

The terms of reference ask the Commission to estimate the impact on the costs of the 6 month and 12 month outbreak scenarios if a vaccination policy were adopted as part of the control strategy and if FMD-free zones were established.

Vaccination

Epidemiological modelling by AFFA has shown that using emergency ring vaccination during the 6 month outbreak in Northern Australia would not only increase the average length of the outbreak, but also create a large pool of vaccinated animals that, in all likelihood, would need to be slaughtered before

Australia could be declared FMD-free. Hence, using vaccination in this type of disease scenario would not be a sound policy.

In contrast, the modelling of the use of emergency ring vaccination in the 12 month scenario has shown that it considerably reduces the duration of the outbreak and increases the certainty of achieving control. The Commission estimates that by reducing the duration of the outbreak, and hence achieving quicker access to international markets, the losses in livestock industry revenue would be reduced by $1 000 million to $2 500 million. Against this benefit, the costs of vaccination and compensation for slaughter of vaccinated animals would be around $130 million. Thus, for the 12 month scenario, emergency ring vaccination would be an effective strategy.

More generally, whenever emergency ring vaccination offers the likelihood of materially reducing the duration of an outbreak, the benefits from quicker re-entry to FMD-free international markets would likely outweigh the additional costs involved.

Zoning

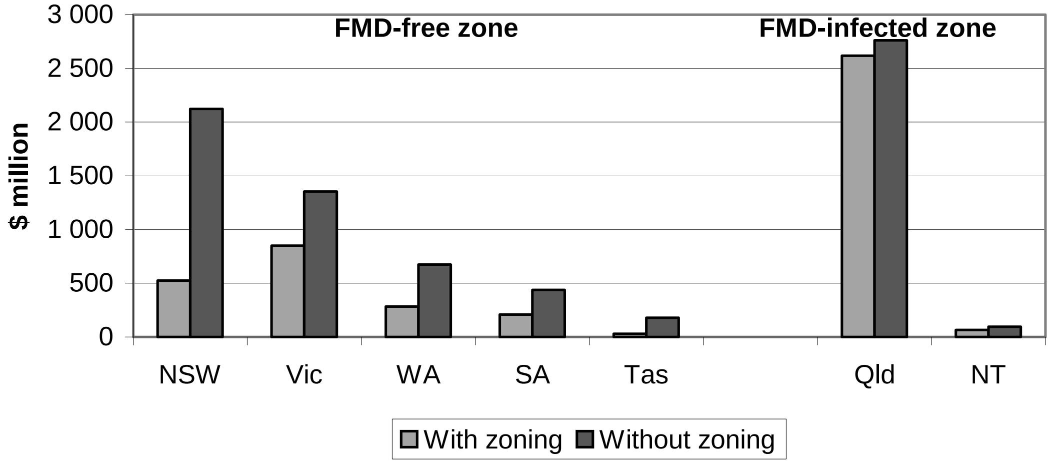
International trade rules relating to FMD provide for the establishment of FMD-free zones which would allow non-infected areas to continue to trade in international markets. In exploring the impact of zoning on the cost of an FMD outbreak, the Commission has assumed that an FMD-free zone could be established comprising all States that could demonstrate they did not have an infection, and that it would take three months for the necessary barrier control measures to be implemented and recognised internationally. The results indicate that zoning has the potential to dramatically reduce the costs of an outbreak on Australia. For example:

- for the 6 month outbreak scenario, the direct revenue loss to the livestock industry could be reduced by 40 per cent, or $3 000 million (figure 5); and
- for the 12 month outbreak scenario, the losses could be reduced by two-thirds or $8 600 million (figure 6).

Naturally, losses would be reduced most in the FMD-free zone. However, the Commission estimates that losses could also be reduced in the infected zone since the earlier re-establishment of exports from the FMD-free zone would allow the infected zone to rebuild export markets more quickly once it achieved disease-free status. The reduced time required to regain export markets reflects the fact that, with zoning, Australian meat products (albeit from the FMD-free zone) would continue to have a presence in export markets. Consequently, brand image and distribution systems could be rebuilt more quickly than would be the case if all exports ceased.

Figure 5 **Estimated impact of zoning on the 6 month outbreak scenario**

Revenue losses to the livestock industries by State with and without zoning [a]

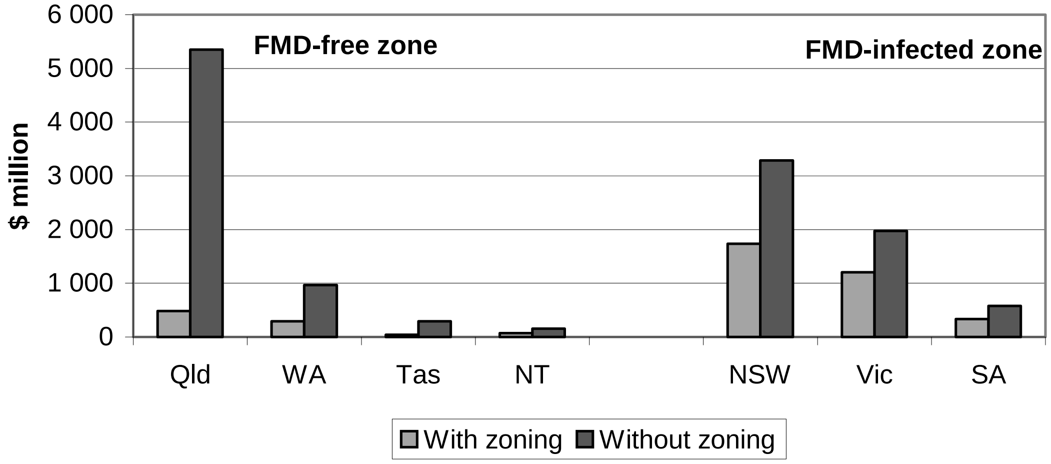


[a] Expressed as the net present value of the losses over the outbreak.

Source: PC estimates.

Figure 6 **Estimated impact of zoning on the 12 month outbreak scenario**

Revenue losses to the livestock industry by State with and without zoning [a]



[a] Expressed as the net present value of the losses over the outbreak.

Source: PC estimates.

Social impacts

The social impacts of an FMD outbreak would include a large range of effects on individuals and communities as a result of the disruption caused by the control and quarantine measures undertaken to contain and eliminate the disease, but also the pervasive effects throughout the livestock industries from the loss of revenue.

Previous outbreaks and natural disasters have identified financial stress or hardship as one of the main causes of adverse social impacts. In the case of FMD, significant negative social impacts would not be confined to the control zones — an outbreak would cause financial stress throughout rural communities in Australia.

However, within control zones, there would be significant added pressures on individuals, communities and emergency workers from: the trauma associated with the compulsory slaughter and disposal of livestock; the disruption and inconvenience associated with movement restrictions; and the long hours of work, often in the face of antagonism and the need to provide emotional support.

On the basis of previous outbreaks, the financial and other stresses arising from an outbreak could lead to problems for:

- individuals, such as depression and other psychological problems, substance abuse and physical health problems, ranging from insomnia to increased rates of heart attacks and stroke;
- families, including relationship problems within families, increases in domestic violence and disruption to children’s education; and
- communities, such as disruption to the cohesiveness of the community. For example, some groups could be unfairly blamed for spreading the disease and become scapegoats for the disruption to the community. Groups that receive compensation could be resented by groups that suffer losses but do not receive compensation. Emergency workers could be seen as unwelcome outsiders and also become a source of antagonism.

In many instances, the elimination of the disease would reduce the sources of stress and people’s wellbeing would quickly recover. However, some of the impacts identified above would result in longer-term problems. In particular:

- psychological problems generally take a significant amount of time to resolve;
- disruption to education can have long lasting effects; and
- previous experience suggests that community divisions and antagonism can persist long after the event.

Thus, while they cannot be costed in the normal manner, the social impacts from an FMD outbreak would clearly be significant. In some cases, they could be short term. However, in other cases, they could entail additional costs that extend well beyond the length of the outbreak for the individuals and communities concerned, and indirectly for governments through the health and welfare systems.

Environmental impacts

The potential environmental impacts of an FMD outbreak would be largely associated with disposal of animal carcasses. Carcasses can be buried, burnt on pyres or rendered (which involves boiling and reducing ground carcasses). Burial is the preferred disposal method in the AUSVETPLAN. Burial and pyre burning were used extensively during the 2001 FMD outbreak in the UK.

The main potential environmental problem with burial is contamination of ground water by leachates from the disposal pit. The UK experience indicates that burial would not be suitable in some areas where there is a high water table or aquifers close to the surface. However, in other areas, with appropriate monitoring, burial would have a minimal impact on the environment. Monitoring of burial sites in the UK to date has found that no water sources used for public or private supply have been affected by FMD disposals.

From an environmental perspective, burning can raise concerns about visual pollution and toxic emissions (particularly of dioxins). That said, monitoring in the UK has not shown any ongoing air quality deterioration, and concentrations of dioxins in soil samples close to pyres are within the range previously found in the rural environment.

The Commission has not attempted to cost the likely environmental impact of the outbreak scenarios. However, the key to minimising potential environmental problems is good preparation. Given the lessons from the UK — such as advances in pit design — and the considerable work on carcass disposal that is being coordinated by the NSW Government for a possible animal disease outbreak in Australia, the Commission considers that significant environmental problems could be avoided if there were an outbreak in Australia. However, this would involve ongoing monitoring and remediation costs as necessary. While the costs of ensuring environmental impacts are minimised would not be small in absolute terms, in relation to the economic and social consequences of an outbreak, their magnitude would be modest.

1 Introduction

The Government has asked the Productivity Commission to assess the potential economic, social and environmental impacts of a range of hypothetical Foot and Mouth Disease (FMD) outbreaks on Australia.

FMD is a highly contagious virus that affects cloven-hoofed animals such as cattle, sheep, pigs, goats and deer. It does not generally kill otherwise healthy mature animals, but can cause the death of young animals and reduce livestock productivity. It does not pose a risk to humans. As the recent outbreaks in the United Kingdom (UK) illustrate, an outbreak of FMD in Australia would have a significant impact on our trade with other countries, on livestock production and on rural communities generally.

Australia’s agricultural industries are key sectors of the Australian economy and contribute significantly to its exports. Production in these sectors is valued at almost $35 billion. Exports totalled around $15 billion in 2000-01 or 10 per cent of total exports.

Geographical isolation and sound quarantine procedures have protected Australia’s agricultural industries from major diseases. Nevertheless, with FMD outbreaks in Japan, Korea and Malaysia in the last 12 months, Australia cannot afford to assume that border protection will guarantee it against an outbreak. It must also have in place procedures to manage an outbreak and to limit the trade impact.

The Council of Australian Governments (COAG) meeting held in June 2001 noted that, if a significant outbreak of FMD occurred in Australia, ‘the technical, logistical, social and financial resources needed to manage the situation would be on a whole-of-government level not experienced before in peacetime’. The meeting agreed to the continued high priority review and revision of national whole-of-government frameworks for the prevention, preparedness for, and management of a major emergency disease outbreak such as FMD.

1.1 The project

As an input to the broader FMD management processes, and to assist in the planning for, preparedness of and response to an FMD outbreak, in late December

2001 the Parliamentary Secretary to the Treasurer asked the Productivity Commission to undertake research to evaluate the full economic, social and environmental impacts of a range of specified outbreak scenarios on the agricultural sector, regional Australia and the national economy. These scenarios are:

- a small single point outbreak;
- a medium-sized outbreak which impacts two states and takes 6 months to control; and
- a large multipoint outbreak which takes 12 months to control and eradicate.

For the second and third scenarios, the Commission has been requested to give consideration to scenarios with and without vaccination of livestock and with and without a zoning policy in place (under which non-infected areas or States could be declared FMD-free and continue to export products). The specific scenarios modelled by the Commission are set out in box 1.1.

Box 1.1 **FMD scenarios used in this study**

The Commission's modelling of the impact of FMD is based on the following scenarios that have been developed by the Commonwealth Department of Agriculture, Fisheries and Forestry – Australia (AFFA) in consultation with State Government epidemiologists.

- The small single point outbreak has been modelled as occurring in the wheat-sheep zone of south west Western Australia, primarily affecting sheep.
- The medium outbreak has been modelled as starting in north Queensland and spreading to the Northern Territory, primarily occurring in beef cattle.
- The multi-state outbreak has been assumed to begin in southern NSW and to spread to western Victoria and south east South Australia. It has been modelled as spreading through several regions in each State and affecting high density mixed livestock, including beef and dairy cattle, sheep and pigs.

Source: Garner 2002.

The Commission was asked to complete its research and report six months after receipt of the terms of reference.

1.2 The Commission's approach

To estimate the impact of various FMD outbreaks on Australia, the Commission has brought together a number of strands of analysis. These include:

- epidemiological modelling of the disease outbreak scenarios by AFFA;

- wide consultation with industry and governments to develop plausible assumptions about the likely production and trade effects under the outbreak scenarios;
- using the assumptions as inputs, the development of a cash-flow model to estimate the direct trade and production effects on each scenario;
- general equilibrium modelling using the Monash Multi-Regional Forecasting (MMRF) model of the Australian economy to estimate the economywide impacts of the disease, including the flow-on effects to other industries; and
- using a range of techniques to quantitatively and qualitatively analyse the likely socioeconomic and social impacts of the disease on farmers, farming communities and the environment.

Upon receipt of the terms of reference, the Commission conducted a round of industry and Commonwealth, State and Territory government visits. The purpose of these visits was to draw on industry and government expertise to:

- develop plausible assumptions about the production and trade effects of an outbreak;
- discuss likely control and eradication costs; and
- gather information on the likely socioeconomic effects of a disease outbreak. To help gauge the social costs of the disease, the Commission met with personnel involved in controlling the UK outbreak in 2001 and with those involved in managing disease outbreaks in Australia, such as the Newcastle disease outbreak in chickens at Mangrove Mountain in New South Wales.

The Commission released its preliminary modelling assumptions to stakeholders for comment and, in March 2002, held a workshop to discuss the methodology, assumptions and preliminary results for the project. The workshop was attended by over 50 government and industry representatives and provided useful feedback on the Commission's work. The assumptions were broadly accepted, although the Commission made specific modifications in the light of the comments received.

The Centre for International Economics was commissioned to run a series of international trade scenarios using its model of the international meat trade. This provided another check on the study's assumptions on the trade effects of an outbreak. It also assisted in developing realistic scenarios in relation to world meat prices and the flows of trade if Australia were to establish FMD-free zones (which could continue trading) in response to an outbreak.

The Commission's trade and production model, developed to estimate the direct economic impact of the disease, was refereed by an external consultant — Professor

Ron Duncan, Executive Director of the National Centre for Development Studies at the Australian National University.

The Commission records its thanks to those that participated in the workshop, and to all other individuals and organisations that contributed to this research project.

1.3 Interpreting the Commission's results

In March 2002, the UK Government released a paper on the cost of the UK FMD outbreak. In presenting its estimates the Government commented that:

> These assessments are limited by the nature of the available information. … the conclusion of this report has to be treated with great care, as "best available estimates" rather than as hard fact. (DEFRA 2002, p. 1)

Estimating the impacts of *potential* outbreaks is an even more difficult exercise. Many of the estimates of the impact of FMD presented in this report are sensitive to the assumptions used. While the Commission has consulted widely on its modelling assumptions, many factors associated with an outbreak are difficult to predict in advance, and there are areas where experts can disagree. The Commission's estimates should, therefore, be interpreted as being relative orders of magnitude rather than precise calculations.

Given these factors, the Commission considers that the modelling in this report is a means to an end rather than an end in itself. For policy making, relative differences between scenarios are more important than the absolute numbers — for instance, results from zoning compared to those without zoning, or the differences in regional impact. Similarly, to plan for recovery from any outbreak, understanding the nature of the impact on farmers and the community is clearly as important as the precise value of those losses.

1.4 Structure of the report

The report is structured as follows:

- Chapter 2 outlines the key characteristics of FMD, its recent spread throughout the world and the approach that Australia would take to controlling an outbreak.
- Chapter 3 summarises the work undertaken by AFFA to model the epidemiology of the three outbreak scenarios developed to meet the terms of reference, discusses the control costs of these scenarios and explores issues regarding vaccination.

- Reflecting the central importance of trade issues to any outbreak, chapter 4 examines the products and export markets that would be affected by bans imposed by Australia's trading partners.
- Chapter 5 then describes wider economic impacts arising from an FMD outbreak.
- The results of the Commission's modelling of the disease's direct and economywide impacts, including the flow-on effects to other industries, are presented in chapter 6.
- Chapter 7 explores how these impacts would be felt at the regional and farm level, and examines a range of socioeconomic indicators relevant to assessing the regional impact of an outbreak.
- Chapter 8 explores the likely social impacts on farming families, emergency workers and rural communities.
- Finally, chapter 9 examines environmental impacts.

2 FMD and its management

2.1 Epidemiology of FMD

FMD is a highly contagious viral infection of cloven-hoofed animals, manifested typically by fluid filled blisters (called vesicles) and ulcers in the mouth, muzzle, feet, teats and udders of infected animals. Affected animals usually have a fever, are lame, off their feed and may display excessive drooling.

FMD is caused by a picornavirus with seven identified serotypes — O, A, C, SAT1, SAT2, SAT3 and Asia 1. Moreover, within these seven types there is a wide range of antigenic diversity (AUSVETPLAN 2001a; Ekboir 1999).

In Australia, animals susceptible to infection include those in intensively managed dairies and piggeries, extensive cattle and sheep properties, and feral populations such as wild pigs, goats, buffalo and camel. While FMD may be transmitted to mice, rats and rabbits, these species are not generally associated with the spread of the disease. Horses do not become infected with the FMD virus (AUSVETPLAN 2001a). Snowden (1968), reporting on testing based on the experimental inoculation of Australian marsupial species, concluded that only in exceptional circumstances could Australian fauna participate in the spread of FMD.

Clinical signs of FMD can vary in severity, particularly across the different susceptible species — for example, in sheep, the disease can be mild with lameness more apparent than mouth lesions. Indeed, drawing on the work of Donaldson (1994) and Geering et al. (1995), Garner et al. (1997a) note that:

- pigs are highly susceptible to FMD and once infected excrete, in aerosol form, high concentrations of the virus — accordingly, pigs are considered to be a major *amplifying host* for FMD and have been implicated with windborne spread of the disease;
- cattle are considered to be an *indicator species* for FMD owing to their high susceptibility to infection and ready display of its symptoms; and
- sheep are accorded the status of *maintenance hosts* as they can have mild symptoms that may be difficult to detect and can be short-term carriers of the disease.

These general observations vary according to the strain of the FMD virus. For example, the Pan-Asian strain of FMD which reached the UK in 2001, was strongly associated with sheep, whereas the epidemic in the UK in the late 1960s essentially progressed through pigs to cattle. The FMD outbreaks which have struck Taiwan since 1997 have essentially been confined to pigs.

In adult animals, the morbidity is high but the overall mortality rate stemming from FMD is usually low. Ekboir (1999) reports that, after a short period (around two to three weeks), most animals will recover from the lesions and become productive again, but in some cases a permanent loss of productivity has been observed.

On recovery from FMD, up to 80 per cent of ruminants may become ‘carriers’ (that is, persistently infected) and could potentially cause fresh outbreaks if in contact with susceptible animals (Ekboir 1999). Vaccinated or immune animals can also become carriers if exposed to FMD. According to Donaldson (1994), the maximum recorded periods for carriage of FMD are over three years for cattle, nine months for sheep and four months for goats. However, the importance of carrier animals in the epidemiology of FMD remains unclear. Although circumstantial evidence from the field suggests that carrier animals may occasionally transmit virus to susceptible animals in close contact with them, it has been extremely difficult to demonstrate transmission of infection by carrier animals under controlled experimental conditions.

People are rarely affected by FMD virus. In the unlikely event that this were to occur, any infection would be temporary and mild (with symptoms of fever and vesicles on the hands, feet or mouth). Thus, FMD is not considered a public health problem (AUSVETPLAN 2001a, p. 2).

Source and transmission of FMD

The key factors contributing to the spread of FMD have been identified as including:

- a wide range of hosts and the ability to initiate infection through a variety of sites;
- a small infective dose;
- a short incubation period;
- the ability for FMD to spread before clinical signs become apparent;
- the large quantities of virus excreted from infected animals (virus is in all secretions/excretions such as milk) — pigs excrete around 1 000 times as much virus in expired air than ruminants; and

- its persistence in the environment (see AUSVETPLAN 2001a and Garner et al. 1997a).

The many modes of transmission make FMD highly contagious. While direct contact and inhalation are the primary methods of transmission, other factors such as wind and contaminated vehicles can be important. FMD can also be transmitted through insemination from an infected donor. Where animals are in close proximity — such as milking sheds, piggeries and watering and feeding points — the spread of infection can be very high.

Airborne virus is expelled over four to five days after an animal has been infected and may occur several days before the onset of clinical signs. At peak excretion levels, pigs may reach 100 million infectious units (IUs) in 24 hours, whereas the equivalent peak for cows, sheep and goat is around 100 thousand IUs. Cattle, sheep and pigs can be infected by inhaling doses as low as 10–25 IUs (Ekboir 1999).

The AUSVETPLAN states that ‘windborne spread’ of FMD can result in infection of animals ‘remote from known foci’. Windborne spread of infection may occur over many kilometres, depending on factors such as the strength of the wind, the species of affected animal and the stage of the disease. Infected piggeries appear to pose the greatest problem. Indeed, the pattern of windborne spread most commonly observed is from piggeries to cattle situated downwind. In the recent UK outbreak, during the period of infectivity before FMD was first confirmed, the windborne spread of virus infected cattle and sheep on nearby farms in Northumberland (DEFRA 2002). Even milk tankers have been implicated in the spread of FMD by venting infected aerosols when collecting milk at unaffected dairies. Most experts consider that temperature and humidity would need to favour the spread of the virus for this to occur.

One relatively common source of FMD outbreaks is the practice of swill feeding of pigs with infected animal products. Uncooked garbage from foreign ships has also been implicated as a source of FMD infection in pigs. For example, an outbreak in South Africa in 2000 was traced to meat scraps from a ship’s garbage being fed to pigs (Nunn 2001). In the recent UK outbreak, DEFRA noted that the precise means of introduction of the virus is unknown and subject to continuing investigations. It stated that ‘it may have been introduced in illegally imported meat or meat products’ (2002, p. 13). The AUSVETPLAN notes that:

> The first case of FMD in Australia would probably be in pigs. FMD virus is most likely to be introduced in contaminated meat products (Geering 1990). These materials are most likely to be eaten by pigs than other livestock, and pigs are highly susceptible to infection by ingestion. If the infected pigs were wild or belonged to a swill feeder unconcerned about or reluctant to report sick animals, the initial outbreak could well go unnoticed and uncontrolled. (AUSVETPLAN 2001a, p. 13)

Such products could be brought into the country by international passengers, or could enter via passengers' contaminated clothing and footwear. Articles entering by post, garbage from ships and yachts, and refuse from aircraft also raise risks.

Animal Health Australia (AHA 2001) recently observed that:

> Australia cannot become complacent about FMD… Between similar periods in 1997 and 2000 there was a 29% increase in declared and detected animal products accompanying passengers entering Australia from FMD-infected countries. For the highest risk bloc of countries the increase was 43%. Undeclared food accompanying incoming travellers is arguably the highest risk route of introduction of FMD virus into Australia. AQIS border operations staff pay particular attention to passengers arriving from countries with endemic FMD, who may not fully appreciate Australia's quarantine laws and who have a cultural propensity to carry high-risk food.
>
> A lower, though definite risk of introduction of virus is by contaminated clothing and personal effects of travellers from FMD-infected countries. There was a minor increase between the June quarters of 1997 and 2000 in the number of passengers from infected countries arriving in Australia.

While Australia, as an island continent, is somewhat protected from illegal movements of infected livestock, which have been a source of infection in countries with land borders, freedom from FMD cannot be guaranteed. The Pan-Asian strain of the type O virus, for example, has spread rapidly throughout the world since the early 1990s, infecting a number of countries that had been free of FMD for many years (for example, Japan and South Korea).

There do not appear to be any significant insect vectors for the spread of FMD. However, animal species and humans can be involved in the spread of the virus. Indeed, the virus can be spread through contaminated vehicles and, as noted above, via footwear and clothing. Humans can also carry the virus in the nasal passages and throat. Effluent from infected piggeries and dairies — perhaps draining onto stock routes — can also contaminate animals, vehicles and equipment.

Livestock production and marketing systems are a critical determinant of the spread of FMD. In fact, Donaldson (1994) identified the movement of infected animals and the movement of contaminated animal products as the most important mechanism for the transmission of FMD. The rapid dispersion of infected animals over a wide area appears to have been a major influence on the spread of FMD in the UK in 2001 (see box 2.1). The UK experience is also relevant to Australia. As noted in the AUSVETPLAN (2001a):

- the capacity to trace livestock and product movements is critical for the early control of an outbreak;
- the movement of sheep is particularly important because affected sheep may not readily display clinical signs of disease;

- in many pastoral areas of Australia, livestock are managed extensively and disease could be harder to detect (the low density may also provide limited opportunity for spread and the disease could die out);
- in intensively managed areas, stock movements to and from saleyards could cause a rapid spread of infection over a wide area; and
- high risk enterprises such as piggeries and feedlots may influence the spread of FMD in a region.

2.2 The global pattern of FMD

FMD is present in many parts of the world, particularly in Africa, Asia and regions in South America (figure 2.1). There has been a significant increase in the incidence of FMD outbreaks reported in Asia over the last few years. The expansion of the Pan-Asian strain of type O FMD has been most pronounced. Since it was first identified in north India in 1990, it has spread to 28 countries throughout the Middle East, Europe and Asia. By 1999, this strain had reached Japan (FMD-free since 1908), South Korea (free since 1934), eastern Russia (free since 1964) and Mongolia (free since 1973). The 2001 UK outbreak also was caused by the Pan-Asian strain of type O FMD. Linked to this UK outbreak were subsequent outbreaks

Figure 2.1 **Countries recognised by the OIE as foot and mouth disease free countries where vaccination is not practised**[a]

[a] Those countries that are shaded are FMD-free, according to the provisions of chapter 2.1.1 of the International Animal Health Code. The UK regained FMD-free status without vaccination on 21 January 2002.

Source: http://www.oie.int/Cartes /world/A_Monde.htm (accessed 4 April 2002).

in France, the Netherlands and the Republic of Ireland. (The FMD status of countries is maintained by the Office International Des Epizooties (OIE) and is available on its website at <http://www.oie.int/eng/info/en_fmd.htm>.)

The movement of other strains of FMD has been monitored in Africa, Asia, South America, the Middle East and Europe. In 2000, Argentina lost its recently acquired free status owing to an incursion of the type A virus. In the same year, Uruguay recorded its first cases for 10 years (of type O virus). Similarly, the Asia 1 type of the virus caused the first disease outbreak in Greece for four years. There were also outbreaks of the SAT 2 virus in Saudi Arabia and Kuwait, and types O and SAT 1 in South Africa (AHA 2001).

Since 1994, a pig-adapted strain of type O virus (different to the Pan-Asian type O virus) has occurred in Russia, the Philippines, Vietnam and Taiwan. The outbreak in Taiwan, previously FMD-free for nearly 70 years, resulted in the slaughter of over 35 per cent of the national pig inventory (3.85 million pigs) (AHA 2001).

The OIE currently recognises 55 countries as FMD-free without vaccination (see box 2.1). Australia and North America are free of FMD and, subject to the outbreaks noted above, Europe has largely been FMD-free since the 1960s. Countries in close proximity to Australia including Indonesia, Singapore, New Zealand and the Pacific nations are also FMD-free.

Australia has been free of FMD for some 130 years. Minor outbreaks of possible FMD in Australia were reported in 1801, 1804, 1871 and 1872. The last case, associated with a bull imported from England, was probably due to contaminated straw and involved only two farms before the disease was eradicated (Bunn 1998).

The recent experiences of South Korea, South Africa and the Netherlands demonstrate that, in contrast to the UK experience, early identification and prompt introduction of control measures can contain the spread of FMD. This issue is taken up in section 2.3.

OIE’s Animal Health Code

The OIE’s International Animal Health Code provides international guidelines for trade in relation to specific animal diseases, including FMD. Box 2.2 describes the OIE’s role. The Animal Health Code is intended for use by authorities of veterinary departments, import/export services, epidemiologists and all those involved in international trade.

Box 2.1 **The FMD status of OIE Member Countries**

The OIE recognises the following countries as FMD-free where vaccination is not practised:

- Albania
- Australia
- Austria
- Belgium
- Bulgaria
- Canada
- Chile
- Costa Rica
- Croatia
- Cuba
- Cyprus
- Czech Republic
- Denmark
- El Salvador
- Estonia
- Finland
- Rep of Macedonia
- France
- Germany
- Guatemala
- Guyana
- Greece
- Haiti
- Honduras
- Hungary
- Iceland
- Indonesia
- Ireland
- Italy
- Japan
- Latvia
- Lithuania
- Luxembourg
- Madagascar
- Malta
- Mauritius
- Mexico
- Netherlands
- New Caledonia
- New Zealand
- Norway
- Panama
- Poland
- Portugal
- Romania
- Singapore
- Slovakia
- Slovenia
- Spain
- Sweden
- Switzerland
- Ukraine
- United Kingdom
- United States
- Vanuatu

The OIE recognised France, Ireland and the Netherlands as FMD-free without vaccination as of 19 September 2001. The UK regained FMD-free status without vaccination on 21 January 2002.

Source: OIE (2002a).

Under the Code, a country is required to notify the OIE within 24 hours of the occurrence or re-occurrence of a priority disease, such as FMD, if the country or zone of the country was previously considered to be free from that particular disease.

2.3 Control and eradication strategy

In Australia, contingency plans for managing incursions of exotic diseases 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 unknown disease outbreak, or alternatively in response to a specific animal disease like FMD. Australia’s proposed technical

Box 2.2 **The Office International Des Epizooties**

The OIE — the World Organisation for Animal Health — is an intergovernmental organisation created by an agreement between member countries in 1924. There are currently 158 member countries of the OIE. The OIE aims to improve and promote the animal health status of countries throughout the world through:

- Ensuring transparency of a country's animal disease status – each Member Country undertakes to report the animal diseases that it detects on its territory. The OIE then disseminates the information to other countries, which can take the necessary preventive action.
- Collecting, analysing and disseminating scientific information on animal disease control. Providing expertise and promoting international solidarity for the control of animal diseases — the OIE provides technical support to member countries requesting assistance with animal disease control and eradication operations.
- Developing rules that member countries can use to protect themselves from diseases without setting up unjustified sanitary barriers, for example, the OIE's International Animal Health Code.

The International Animal Health Code is the result of work which began in 1960. The objective is to prevent the spread of animal diseases, while facilitating international trade in live animals, animal products, semen and embryos. The OIE Code is a reference document for use by authorities of veterinary departments, import/export services, epidemiologists and all those involved in international trade.

Measures recommended in the Code cover 'priority' diseases and take into account the wide range of conditions which may prevail in importing and exporting countries. The Code provides a series of recommendations, relating to issues such as the transport of animals and standards for the epidemiological surveillance of certain animal diseases.

Source: OIE (2002b).

responses to outbreaks of major exotic diseases are described in the Australian Veterinary Emergency Plan, AUSVETPLAN (for details refer http://www.aahc.com.au/ausvetplan/index.htm). The documents provide guidance based on analysis, policy, strategies, implementation, coordination and emergency management plans.

The AUSVETPLAN (2001a) contains a policy for the control and eradication of an FMD outbreak. The principles in this Plan, conforming with the OIE International Animal Health Code, involve:

- preventing contact between susceptible animals and the FMD virus;
- stopping the production of virus by infected animals; and
- increasing the resistance of susceptible animals (AUSVETPLAN 2001a, p. 18).

The primary strategy for eradicating FMD in the shortest possible time is by a policy of 'stamping out'. Stamping out involves quarantine, slaughter of all infected and exposed susceptible animals, sanitary disposal of destroyed animals and contaminated animal products, and decontamination of infected premises in order to remove the source of the infection. These and a number of other control measures, including vaccination and zoning, are discussed below.

Quarantine and movement controls

In the event of an outbreak, the AUSVETPLAN provides for strict movement controls to ensure that the virus is contained and to help prevent the spread of the virus.

Total movement control would be imposed on *infected premises* and on premises containing susceptible animals, or infected or exposed products, which have been in direct or indirect contact with an infected premises or infected animals or products (termed *'dangerous contact premises'*). Premises with suspect animals would be subject to quarantine and surveillance until there is no evidence of infection.

A *restricted area* of at least a 10 km radius would initially be drawn around all infected and dangerous contact premises, including as many suspect premises as practical. The actual size and shape of this area would be influenced by factors such as geography, climate and feral animal distribution. The restricted area would be subject to movement control and surveillance.

In addition, the whole State/Territory affected would initially be declared as the *control area*, and subject to movement restrictions. This measure is designed to control stock movement of susceptible livestock while completing trace-back and epidemiological studies. Once the limits of the disease have been confidently defined, it may be possible to reduce the control area boundaries and movement restrictions.

Zoning

'Zoning' involves the identification and designation of areas within a country as either FMD infected or FMD-free. It has been endorsed by the OIE that has developed a generic code on Zoning and Regionalisation, with disease-specific requirements included in specific disease codes. Article 2.1.1.4 of the OIE FMD code clearly identifies a number of requirements that must be met for zoning to be accepted, namely:

- the FMD-free zone must be separated from the rest of the country (infected zone) by a surveillance zone or physical or geographical barriers;
- animal health measures that prevent entry of the virus must be implemented so that a country must;
  - have a record of regular and prompt disease reporting;
  - supply documentary evidence of an effective system of surveillance for the FMD-free zone and the surveillance zone, if applicable; and
  - describe in detail the boundaries of the FMD-free zone and the surveillance zone, the system for preventing entry of the virus into the FMD-free zone, and supply evidence that these are properly implemented and supervised; and
- provide documentary evidence that there is a system of intensive and frequent surveillance in the FMD-free zone.

In principle, zoning could be used to reduce the adverse economic effects by maintaining international market access from areas demonstrated as being FMD-free. However, although the OIE Code on Zoning and Regionalisation has international acceptance, in practice, there is considerable uncertainty about how and under what conditions zoning will be accepted by individual importing countries.

In the past, the principles of zoning have been applied in FMD outbreaks in Italy (in 1993), Greece (in 1994), and in Zimbabwe and some South American countries to gain access to European Union markets for deboned meat (see chapter 4, box 4.2). Based on the OIE codes and recent international experience, it seems likely that, to apply zoning, a country would need to demonstrate:

- movement controls between the infected zone, the surveillance zone and the rest of the country;
- clinical surveillance; and
- serological surveillance in the FMD-free zone to provide quantitative data to support claims of FMD freedom (that is, the blood testing of herds to demonstrate the absence of antibodies against a specific pathogen).

The surveillance required to demonstrate that a zone is free of FMD would depend on negotiations with the OIE and our overseas trading partners. This would have implications for the resources required for such activities as zone security, collection of samples and laboratory testing (Garner 1997b).

The AUSVETPLAN notes that, initially, state/territory boundaries would provide the most acceptable limits because it could be argued internationally that these are distinct geopolitical boundaries. Thus, zoning for trading purposes would not be the same as zones for disease control purposes. As the situation is clarified, it is possible that the infected zone for trading purposes could be reduced to an area within state boundaries.

Tracing and surveillance

Rapid trace-back and trace-forward from the infected premises assist in containing the disease. According to the AUSVETPLAN, trace-back should be applied for a minimum of 14 days before the onset of clinical signs. Trace-forward should be applied up to the time that quarantine is imposed. Tracing should include all movements of susceptible livestock, animal products, vehicles, grains/crops and people.

Surveillance is used to determine the spread of the disease so that an appropriately sized restricted area can be declared and to establish disease-free zones. This involves inspection of stock, investigation of reports of suspect disease and serological surveillance. Factors such as potential spread by wind or wild animals may complicate the surveillance task in some areas.

Slaughter of infected animals and dangerous contacts

The AUSVETPLAN provides that, for FMD control, all animals are to be slaughtered on all infected and dangerous contact premises. Animals on suspect premises are to be regularly inspected and observed over an agreed period of least 14 days. Animals considered to be most infective or at risk would be given priority for destruction. Clinically-infected animals would be slaughtered first to reduce virus excretion, with infected pigs slaughtered before cattle and cattle before sheep, based on the relative volumes of virus excreted by these various species.

Treatment of infected animal products/by-products

The AUSVETPLAN specifies a very cautious approach with detailed procedures set out for the salvage of animal products and by-products. The movement of most products and by-products from infected premises and dangerous contact premises would be prohibited. Certain products such as wool, semen and embryos may be permitted to be marketed under special conditions or after treatment, with their movement subject to permit. For example, the movement of wool is allowed under permit after storage at 18 degrees celsius for at least four weeks and/or industrial scouring, with the precise treatment dependent on when animals were shorn in relation to the earliest likely onset of infection.

Products from suspect premises would be treated in the same way while under surveillance, but specified products, such as meat and hides, may be permitted to leave the property for sale subject to treatment under OIE guidelines and permit, or after an agreed period. Products from FMD-free premises within the restricted area would be subject to permit and/or treatment prior to release.

Disposal

There is a range of methods for disposing of carcasses and other infected products including burial, pyre burning, rendering and incineration. The AUSVETPLAN endorses burial as the preferred means of disposal of carcasses, milk and feedstuff — it is easier, quicker, uses less resources and is less polluting. However, a number of factors such as soil type, water table depth and topography should be considered in the selection of sites. (See chapter 9 for a more detailed discussion of disposal methods and the environmental considerations.)

Under certain circumstances, alternative methods of disposal (such as rendering) may be possible and should be considered.

Decontamination

Certain products such as hay, hides and wool and equipment, materials and buildings that may be contaminated need to be cleaned and then disinfected. The strategy stresses a need to reduce the generation and dispersal of infective dust and aerosols. If items cannot be adequately decontaminated, they should be destroyed.

Wild animal control

Australia has a range of wild and feral animals, such as feral pigs, goats, cattle, buffalo, camel and deer that are susceptible to FMD, and sometimes are in close contact with domestic livestock. However, there is great variation in their distribution, density and habits between and within regions. Feral pigs have been identified as the greatest wild animal threat to the disease’s control, while feral deer and camels are regarded as unlikely to be important as carriers of FMD virus.

The AUSVETPLAN 2000, Wild Animal Management Manual notes that ‘the role of carrier animals in the transmission of FMD has been uncertain, and transmission from carrier to susceptible cattle has never been unequivocally demonstrated’ (AUSVETPLAN 2000, p. 6). Further, ‘in the unlikely event that wild animals are a primary source of virus, or infection is being maintained in wild animal populations, then monitoring and control programs may need to be instigated’ (AUSVETPLAN

2001a, p. 23). Thus, although wild and feral animals may become infected if exposed to the virus, the role that they might play in spreading and maintaining infection is less clear.

Assessment of the extent of risk posed by feral animals requires information about:

- their density and distribution;
- social organisation;
- habitat;
- perceived contact with domestic species;
- the strain of FMD virus; and
- the length of time feral animals have been exposed to the virus.

This information influences decisions about whether further measures will need to be taken including containment, survey and surveillance, and population reduction. In the event that wild animals are regarded as a risk factor in the dissemination or persistence of infection, the manual suggests that, where control operations are considered, pigs should be targeted first.

At the end of an eradication campaign, sampling of wild animals may be required to prove freedom from disease. However, in some outbreaks overseas (for example, Italy in 1993), there was no eradication of wild animals and the lack of disease in domestic animals was accepted as proof that there was no disease in wild animals.

Vaccination

The OIE Code defines criteria for vaccine standards and for determining when vaccination should be used. The AUSVETPLAN states that vaccination is not a preferred option for control of FMD. However, it may be approved in special circumstances.

While vaccination protects against disease, vaccinated animals are not totally resistant — they can still become infected with FMD and shed the virus, but at a reduced rate.

A number of factors need to be considered in deciding whether to vaccinate such as:

- the trade implications;
- masking of clinical disease;
- the diversion of scarce personnel resources;
- the extent to which FMD has spread; and

- the availability of vaccine.

The decision on whether to use vaccination, in conjunction with a policy of stamping out, is a complex one. In larger outbreaks, where availability of resources may be an issue, and in high risk situations, vaccination could help contain the spread of the disease and thus reduce control and compensation costs. Vaccination of high risk premises, such as large intensive piggeries and feedlots, may offer significant benefits. In such situations, vaccination can ‘buy time’ to help in the logistical problems associated with the destruction, disposal and decontamination of such large livestock enterprises.

However, there are also some disadvantages in pursing a strategy of vaccination. First, it is a resource intensive operation, particularly when re-vaccination is needed (after about 4–6 months). Second, it can defer the declaration of freedom from disease, thus prolonging the adverse effects on producers. Currently, vaccinated animals must be permanently identified as they will need to be slaughtered towards the end of the campaign for a country to achieve eradication and disease-free status within a three-month period. While improved testing techniques that will allow confident differentiation between infected and vaccinated animals are being developed, they will require approval by the OIE. Consideration is currently being given by the OIE to changes to the FMD code proposing modification to periods for regaining FMD freedom when emergency vaccination is used, provided serological studies using the newer diagnostic tests are done. However, this has not yet been endorsed.

A further disadvantage associated with vaccination is the potential for vaccination teams to inadvertently spread the virus.

Vaccination options include:

- ring vaccination (regarded as the most likely application) which involves vaccination of all susceptible stock in a ring of fixed width around an outbreak to contain the disease while stamping-out operations are carried out; and
- blanket vaccination, which is general vaccination over a wide area where other disease control methods would be too demanding of veterinary resources or too costly in terms of compensation payments.

If vaccinated animals are slaughtered at the end of the outbreak, then the period until recognition of FMD freedom is three months (as for stamping out). If vaccinated animals are not slaughtered, currently, the country must wait 12 months.

In Australia, a very strong preference has been expressed for stamping-out by slaughter. Until recently, vaccination has only been considered as a control measure where efforts to stamp out the disease have not been successful. Recent developments, such as the newer diagnostic tests, marker vaccines, changes to community attitudes and a growing awareness of the limited availability of trained staff to combat exotic disease outbreaks, have seen a change of attitude to the way vaccination might be used, including consideration of its use as an emergency control option.

The National FMD/BSE Policy Forum held in Canberra in November 2001 considered that emergency vaccination could be used under certain circumstances, with all vaccinated animals being subsequently slaughtered. This resolution was endorsed by the Primary Industries Ministerial Council. This policy may be able to be eased in the future with changing trends towards the handling of vaccinates in international trade standards and the OIE code.

Australia has access to an emergency source of FMD vaccine through its membership of the UK International Vaccine Bank. This stock of vaccine concentrate can be reconstituted at short notice to provide up to 500 000 doses of each of four serotypes (types O, A, C and Asia 1). After that, Australia would have to depend on commercially held vaccine stocks of an appropriate serotype or arrange for supply from overseas. Current arrangements for access to FMD vaccines are under review.

Decision making

The Emergency Animal Disease National Management Group (NMG), comprising chief executives of government agencies and presidents of relevant livestock industry organisations, has been formed with responsibility for decision making on policy and resource allocation issues associated with the control of any outbreak. Its role is to approve response plans and budgets and monitor expenditure.

The Consultative Committee on Emergency Animal Diseases, comprising the Chief Veterinary Officer (CVO) from each of the States and Territories, the Commonwealth CVO, the head of the Australian Animal Health Laboratory and industry representatives, is the key technical coordinating body. In the event of an FMD outbreak, it would advise the NMG on the national response.

Cost-sharing arrangements

In Australia, each State and Territory has operational responsibility for the control and eradication of animal diseases within its borders. To this end, each jurisdiction administers its own emergency disease control legislation which is supported by emergency services arrangements. Commonwealth legislation includes powers under the Quarantine Act 1908 that would be available to support the States and Territories.

An Emergency Animal Disease Response Agreement (EADRA) outlines funding arrangements for an initial response to a disease incursion or outbreak by the Commonwealth, State and Territory governments and major livestock industry organisations. It classifies 63 diseases according to their impact on human health and society in general (including the economy, the environment and livestock production). A different mix of funding is proposed for each category. FMD is regarded as a category 2 disease that has little impact on human health, but considerable impact on the economy through trade losses, national market disruptions and severe production losses in the associated livestock industries. If called upon, funding by government would amount to 80 per cent, with 20 per cent funding by industry. The costs of each party would be managed by applying an ‘agreed limit’ that ensures examination of costs and benefits before committing to further national resources. An agreed limit to cost sharing of 1 per cent of the gross value of production of the industries involved applies (calculated to be around $112 million in 2001).

In relation to the industry contribution, where more than one animal species is affected by a disease, the contributions from the affected industry parties would take account of both the gross value of production of each industry and the importance of that disease for the particular industry. The latter is assessed by the use of an agreed weighting. In the case of FMD, the weighting is 50 per cent for cattle, 30 per cent for sheep/goats and 20 per cent for pigs.

The costs of wages and salaries, operating expenses, capital costs incurred by parties responding to the disease and compensation to affected owners for livestock destroyed are covered by this arrangement. Compensation policies are an important component of a control program. In their absence, there could be an inadequate incentive for farmers to report outbreaks, or even an incentive to evade detection. Conversely, too generous a level of compensation could reduce the incentive for farmers to contain the spread of the disease. Compensation arrangements are described in the next section.

In relation to the government contribution, FMD is also included in the list of diseases for which arrangements exist under the Commonwealth/States cost-sharing agreement for the eradication of certain exotic animal diseases. Under this arrangement, the Commonwealth would contribute 50 per cent of the eradication and associated control costs and the States and Territories would collectively contribute the remaining 50 per cent on an agreed pro-rata basis. These proportions for FMD (table 2.1) are based on the latest 10-year average figures for the numbers of susceptible livestock and the gross value of production of susceptible livestock.

Table 2.1 **Current apportionment of eradication costs**

Per cent

State/territory	*Vesicular disease including FMD*[a]
NSW	14.347
Qld	11.613
Vic	10.863
WA	6.833
SA	3.861
Tas	1.423
NT	1.061
ACT	0.015
Cwlth	50.000

[a] In accordance with section 17 of the Agreement, the apportionments apply for the diseases shown for the five years beginning on 1 July 1998.

Source: AUSVETPLAN 1999, Appendix 3.

Compensation arrangements

The AUSTVETPLAN and EADRA 2002 contain provisions for compensation to be paid for any livestock which is destroyed for the purpose of eradication or prevention of the spread of FMD. These costs are shared between the Commonwealth and State governments, and the livestock industry.

Compensation applies only to direct losses, rather than to any indirect or consequential losses arising from the outbreak. For example, it would apply to vaccinated animals that were subsequently destroyed, but it would not apply to any livestock (inside or outside the control area) that had to be destroyed because they were unable to be marketed. As such, compensation is more appropriately viewed as a control measure to encourage reporting of disease outbreaks rather than a program which attempts to fully offset stock losses arising from FMD.

The EADRA outlines the basis for valuing stock for compensation purposes. It provides for compensation to be paid to the owner at potentially two stages:

- when the disease is identified for any livestock or property which is destroyed for the purposes of eradicating or controlling the spread of FMD; and
- when the property is cleared for restocking, if the valuation of livestock at this time is higher than at identification.

3 Outbreak scenarios and control costs

3.1 Background

As noted earlier, the terms of reference ask the Commission to consider the impact of three FMD outbreak scenarios:

- a small single point outbreak;
- a medium-sized outbreak which impacts on two States and takes up to 6 months to contain and eradicate; and
- a large multi-point outbreak which takes up to 12 months to control and eradicate.

The location and specific details of these outbreaks have been developed by AFFA in consultation with State and Territory Governments through a Veterinary Committee's Working Group. For each scenario, Commonwealth, State and Territory epidemiologists provided expert advice and local knowledge on livestock production and farm management in each of the outbreak regions. As discussed below, the medium and large outbreaks cover more than one regional area.

AFFA used an epidemiological FMD model, which it has developed over a number of years, to estimate the size and duration of the outbreaks in each infected region. It then combined the regional results to estimate the duration of the total epidemic under each scenario. Key factors that affect the size of an outbreak are:

- the delay until FMD is recognised;
- the rate of spread within the region;
- the availability of resources to control an outbreak; and
- the effectiveness with which control measures are implemented.

Each of these factors has been incorporated in the model (see box 3.1 for a description of the model).

Box 3.1 **AFFA FMD model**

The model is a state-transition model (developed from a Markov chain) that has been modified to incorporate random events and probabilities. The herd or flock is the unit of concern. The model simulates herd-to-herd spread of disease on a week by week basis. In the model, the population is considered in terms of possible 'states' that herds could be in, namely:

- susceptible to the disease;
- latent, meaning infected, but not yet infectious to other herds;
- infected with the disease and capable of spreading the disease;
- immune after recovery from the disease or after vaccination; or
- dead or destocked as a result of the disease.

During any time period, depending on various factors, a herd has a probability of remaining in that state or moving to another state (a transition).

Values for a number of disease parameters (latent, infectious and immune periods, and dissemination rate — a measure of the disease's ability to spread to other herds) and control variables are specified for each scenario. These in turn determine the probabilities of transition from one state/condition to another. Resource limits are imposed on the number of herds able to be stamped out or vaccinated per week. The model is non-spatial, so it is necessary to set the number of discrete foci of infection and the width of vaccination 'rings'.

As the model includes stochastic elements, it can give different results each time it is run. It is run repeatedly to generate a meaningful distribution of likely outcomes. Results are reported as means and standard deviations derived from 1000 simulation runs in each case. The mean is the average of the results, while the standard deviation is an indicator of the variability of results around that average.

Source: Garner 2002.

The modelling also simulated two different control strategies. The baseline control strategy was based solely on identification and stamping out of infected and dangerous contact herds (the stamping out strategy is described in chapter 2). However, in accordance with the Commission's terms of reference, the option of using emergency ring vaccination as part of the control strategy was included for the medium and large outbreaks.

Collectively, the scenarios provide a range of plausible examples of what could happen if FMD were introduced into Australia as a basis for assessing the economic, social and environmental effects of an outbreak. Each of the scenarios is described in sections 3.2–3.4, followed by an overview of the modelling results in section 3.5.

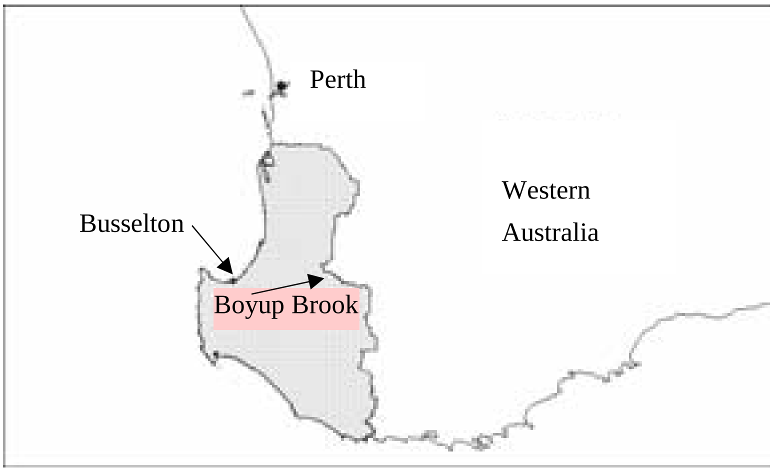
3.2 Small outbreak — scenario 1

Stamping out and dangerous contact slaughter

This involves a single state outbreak (using the Type O Pan-Asia strain of FMD virus) in south western Western Australia in the wheat-sheep zone. The disease is spread within the region primarily among sheep.

In this scenario, FMD is assumed to be discovered in an abattoir in Busselton. It is traced back to a smallholding property where the owner had purchased some goats from a local sheep producer. This sheep producer also operates as a ‘tourist’ farm with tame livestock, including pigs. It is thought that a local itinerant worker or international visitor, who fed the ‘display’ pigs with contaminated food scraps, introduced FMD to the tourist farm about two weeks prior to its discovery. The producer has moved sheep to his brother’s property at Boyup Brook, where FMD has also subsequently been confirmed (figure 3.1).

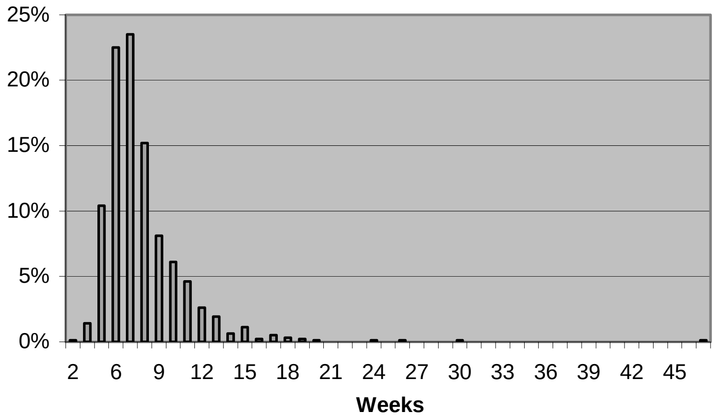
Figure 3.1 **Location of scenario 1**



Source: Garner 2002.

Figure 3.2 shows the probability distributions of the duration of the outbreak when the strategy of stamping out of infected herds and dangerous contact slaughter is successful. On this basis, the model reveals that the outbreak could last from two to 47 weeks, with a 90 per cent probability of it lasting less than 11 weeks. The long tail reflects the situation where the disease persists due to the failure to detect and remove infected sheep flocks. There is a small probability (0.2 per cent) that the outbreak will not be contained with the available resources.

Figure 3.2 **Probability distribution of the duration of an outbreak under scenario 1**



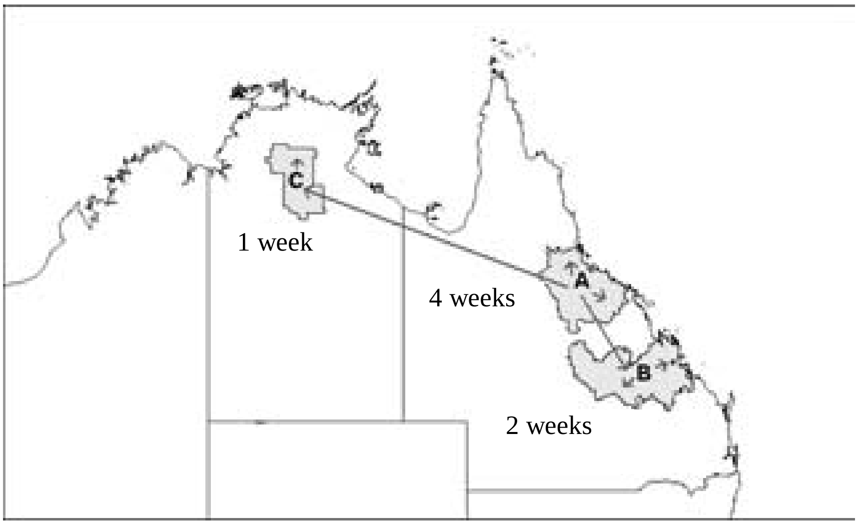
Source: Garner 2002.

On average, the outbreak lasts 7.8 weeks. As FMD is not recognised until two weeks after introduction, the duration of the outbreak would be 5.8 weeks from the time of first detection. There would be 15 infected herds and a total of 53 infected and dangerous contact herds stamped out to eradicate the disease. Further details are provided in table 3.1 (see section 3.5 for the modelling results). A total of approximately 38 000 stock (with nearly 30 000 sheep) would be destroyed during the eradication campaign.

3.3 Medium-sized outbreak — scenario 2

This scenario involves FMD occurring in three separate regions, two in Queensland and one in the Northern Territory, primarily in beef cattle. Under this scenario, FMD is first detected in a feedlot west of Rockhampton (region B). Tracing of livestock consignments brought into the feedlot finds evidence of infection on a large extensive beef property south west of Charters Towers (region A). It also operates as a bed and breakfast catering for overseas visitors. FMD was introduced with contaminated food scraps fed to pigs kept on the property for consumption and tourist viewing. This property also sent a consignment of steers for live export through Darwin. Tracing of this group finds them at a live cattle export holding property, located near Katherine NT, where the presence of FMD is also confirmed (region C).

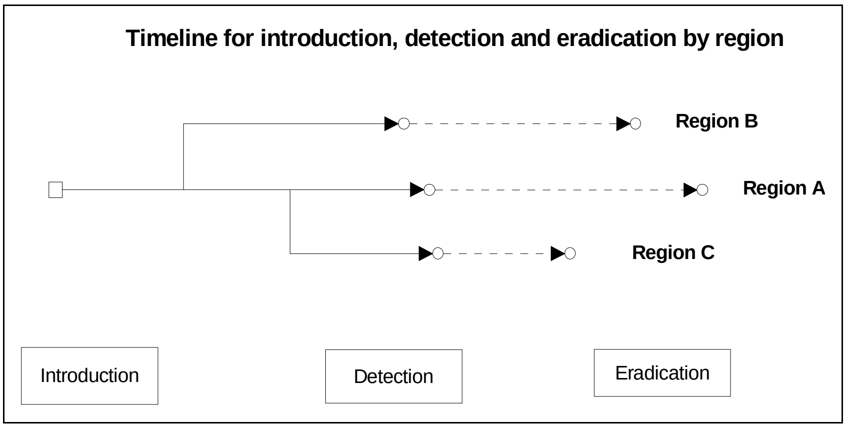
Figure 3.3 **Location of scenario 2**



Source: Garner 2002.

A schematic representation of the timing of events is shown in figure 3.4.

Figure 3.4 **Timelines for scenario 2**

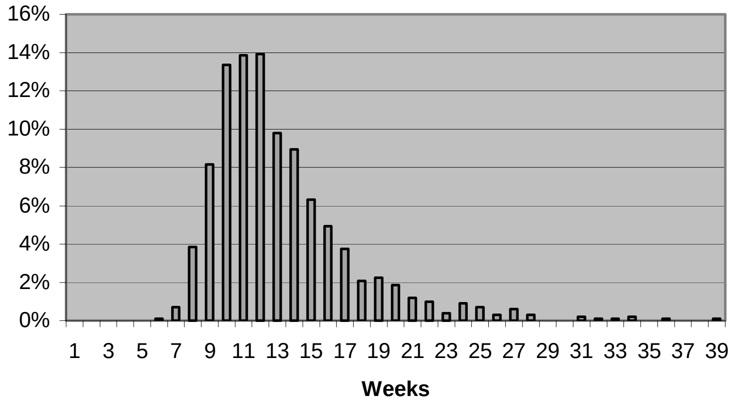


Source: Garner 2002.

Stamping out and dangerous contact slaughter

The model results indicate that for the Qld-NT epidemic overall, the outbreak would last between six and 39 weeks from when it was first introduced, with a 90 per cent probability that it would be less than 19 weeks.

Figure 3.5 **Probability distribution of the duration of an outbreak under scenario 2 — stamping out and dangerous contact slaughter**



Source: Garner 2002.

On average, the outbreak lasts 13.2 weeks from introduction. As the disease is not recognised for four weeks after initial introduction, the average duration of the epidemic is 9.2 weeks from detection. Seventy-two herds would need to be removed to achieve eradication, with 27 of these being infected herds and 45 dangerous contact herds. In total, about 50 000 livestock, primarily beef cattle, would be destroyed to eradicate the disease (see table 3.1, section 3.5 for the modelling results).

Stamping out and ring vaccination

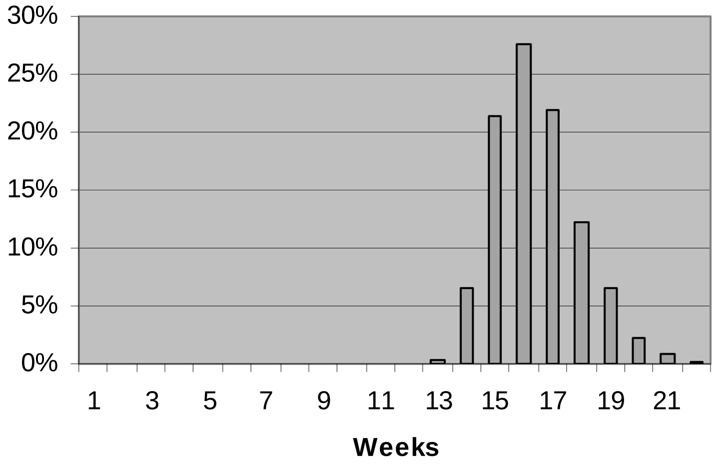
AFFA modelled vaccination for this scenario to meet the Commission's terms of reference. However, given the livestock densities, the type of management systems and expected low rate of spread of FMD in northern Australia, it is unlikely that vaccination would be considered as a 'front-line' control strategy. Nevertheless, the modelling assumes that a decision to use a containment (ring) strategy around infected premises in regions A and B is taken in week two of the outbreak, with vaccination beginning in week three. Region C is excluded as NT authorities are confident that stamping out can contain the outbreak in that area.

The decision is taken to create a containment buffer zone 10 km wide around five distinct foci of infection in the affected regions (two in region A and three in region B). Given travel times, the average size of herds and the time taken to muster and yard animals, it is assumed that a vaccination team will be able to vaccinate one herd per week. As well as administering vaccine, teams must ensure that all vaccinated animals are permanently identified (earmarked) and good records are kept. In the first week of operations, four vaccination teams are assembled (two in each region) and over the next few weeks as additional resources become available capacity increases to 12 herds able to be vaccinated per week (six in each region).

The epidemic overall lasts between 12 and 22 weeks, with a 90 per cent probability that it lasts less than 18 weeks (figure 3.6).

The disease is not recognised for four weeks after its initial introduction, so the epidemic lasts, on average, for 16.4 weeks from introduction. Based on average herd sizes, the number of destroyed animals is estimated at just over 46 000 and there would be about 41 000 vaccinated animals (table 3.1).

Figure 3.6 **Probability distribution of the duration of an outbreak under scenario 2 — stamping out of infected herds and vaccination**



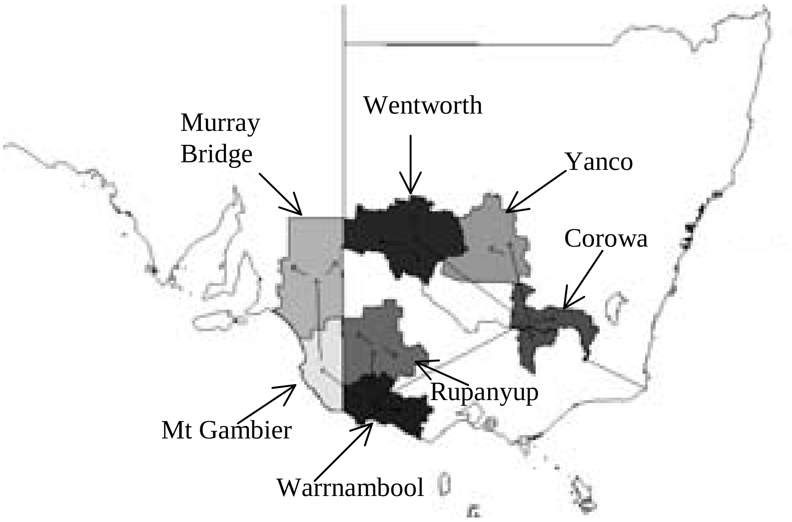
Source: Garner 2002.

3.4 Large outbreak — scenario 3

This scenario is a multi-state outbreak in south east Australia occurring in seven regions across three states — Victoria, south east South Australia and southern New South Wales — in high density mixed livestock, including beef, dairy cattle, sheep and pigs. In this case, FMD is first detected in a stud dairy herd near Corowa in New South Wales. Investigations reveal that a nearby infected piggery is the most likely source of the outbreak. The infection spreads from the dairy herd in a consignment of pregnant dairy heifers sent to the Warrnambool area in south west Victoria and to the Mount Gambier district in South Australia. A neighbouring cattle property to the piggery is also found to be infected. It has sent cattle to a feedlot in Yanco, setting up another focus of infection.

At these three sites, there is local spread within the regions as well as secondary spread to two additional regions — the Rupanyup area of north west Victoria and the Lower Murray River/Lakes area of South Australia. From the original focus near Corowa, the disease is introduced into the extensive sheep areas of south western New South Wales by means of a contaminated livestock transport vehicle, where it was undetected for some time (figure 3.7). Initially, there are 16 infected foci in six regions, with another three identified some weeks later in south west New South Wales.

Figure 3.7 **Location of scenario 3**



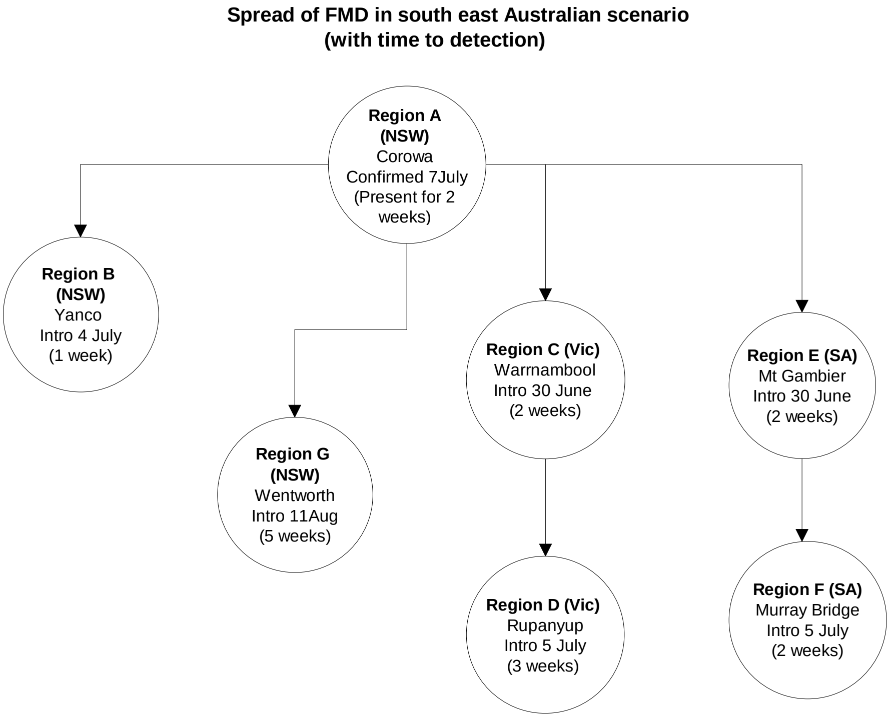
Source: Garner 2002.

Figure 3.8 shows when FMD is introduced into each region and the delays until it is recognised.

Stamping out and dangerous contact slaughter

In several cases, the regional modelling produces a distribution that is bi-modal. This means that, with the available resources, the outbreak is either controlled relatively quickly or it gets out of control and spreads widely. In some cases, the outbreak ends, not because FMD has been eradicated, but because there are no susceptible herds left in the area. Under these circumstances it is unlikely that the outbreak would be contained, and subsequent analyses were restricted to those simulation runs where the control program is effective.

Figure 3.8 **Timelines for scenario 3**

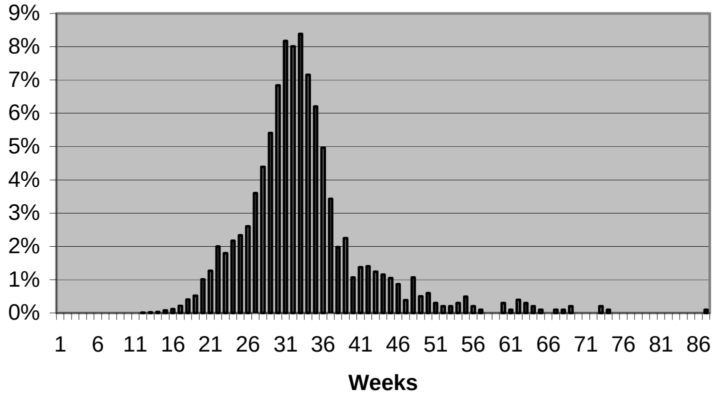


Source: Garner 2002.

The overall duration of the epidemic was determined by combining the modelling results for each region. For those simulations where the control program is effective, the probability is that the epidemic as a whole lasts between 10 and 87 weeks, with a 90 per cent chance that it is less than 43 weeks (figure 3.9).

The average size and duration of the outbreak for the epidemic as a whole when FMD is successfully controlled is shown in table 3.1 (see section 3.5 for the modelling results). The probability of successfully containing the outbreaks in each region with the resources available varied from 79 to 100 per cent. Overall, there is a low probability (43 per cent) that, with the resources available, the epidemic would be successfully controlled in all regions. However, these figures overstate the severity of the situation because, as the disease is controlled or is less severe in one region, additional resources would become available to be used in other regions. Nonetheless, it is important to appreciate that in using a stamping out and dangerous contact slaughter policy, with the available resources, there is a real risk that FMD will not be controlled.

Figure 3.9 **Probability distribution of the duration of an outbreak under scenario 3 — stamping out and dangerous contact slaughter**



Source: Garner 2002.

The disease is not recognised for two weeks after its initial introduction, so the average duration of the outbreak (when FMD is successfully controlled) will be 33 weeks from first introduction. There would be an average of 211 infected premises identified and 493 premises in total would be destocked to achieve eradication. In this case, more than 750 000 animals would be destroyed, with the majority (over 90 per cent) of these being sheep.

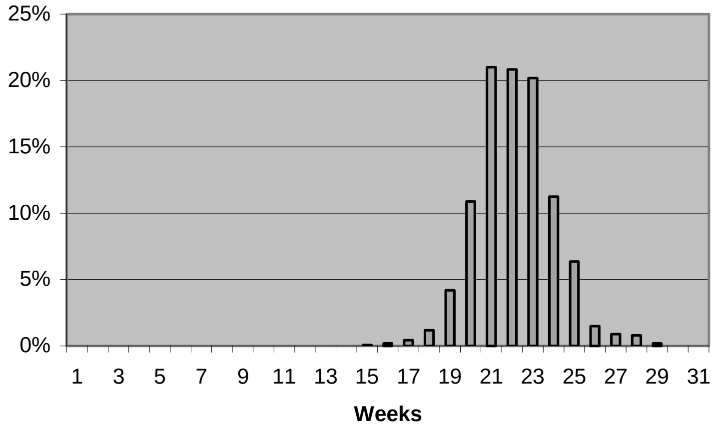
Stamping out and emergency ring vaccination

For this scenario, the effectiveness of ring vaccination was also evaluated. As this outbreaks occurs in one of the more intensively managed livestock areas of Australia, with high animal densities and piggeries being involved (with the potential for wind-borne spread of virus in at least some of the areas), the decision is taken to use emergency ring vaccination early in the outbreak.

In most regions, a 5 km ring is considered adequate for ring vaccination. However, for two regions with high pig populations and another region where the situation is uncertain and there are large property sizes, a 10 km ring is used.

The results show that (again when FMD is successfully controlled) overall, with stamping out and emergency ring vaccination, the epidemic lasts between 10 and 29 weeks, with a 90 per cent probability that it lasts less than 24 weeks (figure 3.10).

Figure 3.10 **Probability distribution of the duration of an outbreak under scenario 3 — stamping out of infected animals and vaccination**



Source: Garner 2002.

On average, the outbreak lasts 20 weeks from first detection, as the disease is not recognised until two weeks after initial introduction. There would be an average of 349 infected premises destocked and 594 premises vaccinated to achieve eradication. Around 450 000 animals would be destroyed to eradicate the disease and nearly 600 000 animals would be vaccinated (table 3.1).

3.5 Modelling results

The results of the modelling are summarised in table 3.1. They indicate that stamping out of infected herds and dangerous contact slaughter is effective in eradicating FMD in scenarios 1 and 2. However, it is less effective in scenario 3 as there is a high probability that the epidemic would not be contained with the available resources.

Under the assumptions used in the study, a control strategy of stamping out and emergency ring vaccination is effective in containing FMD. However, under scenario 2, this strategy increases the average length of the outbreak and results in some 41 000 vaccinated animals to be dealt with at the end of the outbreak. This control strategy, however, reduces the variability of the outcome and results in a marginal decline in the total number of herds removed (68 compared to 72 — equivalent to some 4 000 animals).

Table 3.1 **Average size and duration of epidemics by scenario and control strategy**

	Scenario 1	*Scenario 2*	*Scenario 3*
Strategy of stamping out and dangerous contact slaughter			
Duration of outbreak from infection, assuming 90% probability of FMD control (weeks)	11	19	43
Infected herds	15	27	211
Dangerous contact herds	38	45	282
Total herds removed	53	72	493
No. of animals destroyed	38 000	50 000	750 000
Strategy of stamping out and emergency ring vaccination			
Duration of outbreak from infection, assuming 90% probability of FMD control (weeks)	na	18	24
Infected herds	na	62	349
Dangerous contact herds	na	6	0
Total herds removed	na	68	349
No. of animals destroyed	na	46 000	450 000
Herds vaccinated	na	68	594
No. of animals vaccinated	na	41 000	600 000

na not applicable.

Source: Garner 2002.

In contrast, a policy of stamping out and emergency ring vaccination is effective in eradicating FMD from all regions under scenario 3. It reduces the variability in the outcome, the average duration of the epidemic (by about 11 weeks) and the total number of herds removed (by some 144 herds or 300 000 animals). However, there would be about 600 000 vaccinated animals at the end of the outbreak that would have to be dealt with in such a way as to avoid undue trade restrictions.

The results indicate that with large herd sizes and relatively low rates of spread, emergency vaccination does not appear to offer any advantages for control. If resources are limited, stamping out should concentrate on infected herds, even if this is at the expense of removing some dangerous contact herds. In situations where the disease is likely to spread rapidly and resources may be limited, emergency ring vaccination can be an effective tool for containing outbreaks as it can reduce the overall duration of the outbreak and the probability that it will get out of control. However, it will result in the presence of vaccinated animals. This problem will have to be managed to minimise the trade effects.

The exercise appears to have produced plausible outcomes when compared to the size and duration of a range of incursions that have occurred previously in FMD-free countries. With few exceptions (UK 1967-68 and 2001 and Taiwan 1997), most of the incursions were relatively small and controlled quickly.

3.6 Costs of eradication, control and compensation

Chapter 2 described the stamping out and emergency ring vaccination measures set out in the AUSTVETPLAN that would be used to control and eradicate an FMD outbreak.

Significant government and industry resources are required to ‘stamp out’ FMD. For example, in the recent UK outbreak which affected over 2 000 properties, total government control costs (excluding compensation for animals destroyed) were over 1 billion pounds — around $A2.7 billion.

Australia has not had an acute animal disease outbreak on this scale. The biggest outbreak to date was the 1999 Newcastle disease outbreak in chickens in the Mangrove Mountain area of New South Wales. Although the disease was confined to one area, it took three months to control, involved up to 5 000 people working on eradication and is conservatively estimated to have cost governments around $22 million (excluding compensation).

If there were an outbreak of FMD in Australia, the control and eradication costs would depend primarily on the scale and duration of the outbreak. Estimates of the number of regions affected, herds affected and animals slaughtered under each scenario for this study are summarised in table 3.1. As in the UK, control and eradication of an outbreak in Australia would be a major logistical exercise. For example, a large outbreak could entail the slaughter and disposal of about 750 000 animals from nearly 500 properties.

Given the two stage process for compensation described in chapter 2, it is not straightforward to estimate the value of compensation as it partly depends on the timing of eradication in relation to the duration of the outbreak. To simplify the analysis, the Commission has estimated the costs of compensation using pre-FMD values. Based on the number and species of the animals eradicated under each of the scenarios, the Commission estimates the cost of compensation for the outbreaks to range from about $4 million to $68 million (see table 3.2).

Table 3.2 **Compensation costs for the FMD outbreak scenarios**

Outbreak	*Compensation*[a]
	$m
3 month outbreak — WA	4
6 month outbreak — Qld, NT	19
12 month outbreak — Vic, SA, NSW	41
12 month outbreak with vaccination — Vic, SA, NSW	68

[a] Calculated at pre-FMD-outbreak values.

Source: PC estimates.

Control costs

In principle, the control costs of the outbreak scenarios used in this study could be estimated by calculating the cost of each component of the stamping out control strategy — slaughter, disposal, disinfection, movement restrictions etc. However, the detailed information required is not available, and previous attempts to construct such ‘bottom up’ estimates have fallen well short of actual outbreak costs. Instead, reliance has been placed on more aggregated estimates of likely control costs (see box 3.3). These measures are based on the costs of actual outbreaks, but involve significant imprecision. They can yield significantly different results depending on the estimation method used. Reflecting the lack of precision, the Commission has estimated a range of control costs for each scenario rather than a single value (see table 3.3).

Table 3.3 **Estimated eradication and control costs**

Outbreak	*Eradication and control costs*[a]
	$m
3 month outbreak — WA	20 – 25
6 month outbreak — Qld, NT	130 – 150
12 month outbreak — Vic, SA, NSW	360 – 420

[a] Estimates have been rounded.

Source: PC estimates.

While these estimates are imprecise, they indicate that a significant level of resources would be required to control an FMD outbreak. Adding together compensation and control costs (both of which are covered by the EADRA), a large FMD outbreak could entail costs of over $400 million — an amount well in excess of the $112 million threshold for cost sharing established in that agreement.

Box 3.2 **Estimating the costs of eradication and control**

To estimate the control costs for this study, the Commission has drawn on the costs of the UK outbreak in 2001 and the costs in Australia of the Newcastle chicken disease outbreak at Mangrove Mountain in New South Wales.

There are a number of ways of extrapolating the costs of the Australian scenarios from those of the UK outbreak. For instance, the cost per month of outbreak, cost per infected site or cost per animal destroyed in the UK could each be applied to the Australian scenarios. However, each of these is an imperfect measure. For example, the cost per site suggests an artificially low value because average farms in the UK are much smaller and have far fewer livestock than typical Australian farms.

The Commission considers that the total control cost per animal destroyed is likely to provide the closest basis for comparison. The gross cost per animal destroyed in the UK was around $A600 per animal. The Commission has adjusted this cost according to the composition of the animals destroyed in the UK compared to each of the Australian scenarios. For example, in the 6 month scenario, nearly all livestock eradicated are cattle, whereas in the UK the majority of animals destroyed were sheep. The control costs estimated using this method are tabulated below.

The costs to government of the Newcastle disease outbreak in chickens can also provide an indication of control costs for an FMD outbreak. The stamping out approach used to control this outbreak is the same as would be used for an FMD outbreak, and includes the costs of quarantine, disposal, decontamination and movement restrictions. Discussions with the NSW Department of Agriculture concluded that the control costs of $22 million, excluding compensation, could form a base for calculating the costs of one Local Disease Control Centre (LDCC) for FMD. The Commission has adjusted this figure to account for the volume of livestock that would be disposed of in each of the scenarios relative to the Newcastle disease outbreak, and the number of LDCCs in each of the outbreak scenarios (one for the 3 month outbreak, three for the 3 month outbreak and seven for the 12 month outbreak). The estimated control costs using this method are also shown in the following table.

Outbreak	*Cost per animal method*	*Cost per local disease control centre*
	$m	$m
3 month	26	23
6 month	130	149
12 month	366	418

Source: PC estimates.

3.7 Impact of vaccination

In addition to epidemiological considerations, the decision to use vaccination as part of an FMD control strategy would need to take account of the implications that vaccination has for the time it would take Australia to regain FMD-free status and recommence trade. The OIE International Animal Health Code for FMD status governs the effect of using vaccination on regaining FMD-free status internationally. This code states, among other requirements, that:

> When FMD occurs in an FMD free country or zone where vaccination is not practised, the following waiting periods are required to regain the disease free status:
>
> a) 3 months after the last *case*, where stamping-out and serological surveillance are applied; or
>
> b) 3 months after the slaughter of the last vaccinated animal where stamping-out, serological surveillance and emergency vaccination are applied.
>
> When FMD occurs in an FMD free country or zone where vaccination is practised, the following waiting periods are required to regain the disease free status:
>
> a) 12 months after the last *case* where stamping-out is applied; or
>
> b) 2 years after the last *case* without stamping-out, provided that an effective surveillance has been carried out. (OIE, Article 2.1.1.6)

The high cost to the economy from the loss of access to FMD-free markets means that disease control strategies which reduce the waiting period for the re-establishment of disease-free status are inherently more efficient. The high cost of delayed re-entry reflects the higher prices from the sale in FMD-free markets of a large proportion of Australian meat production. It also means that a very large increase in slaughterings could be justified to achieve an early return of access to those FMD-free markets.

As a result, if vaccination were to be used as part of a control strategy, then minimising the overall cost of the FMD outbreak to the community would also involve the early slaughter of vaccinated animals rather than letting vaccinated animals live and waiting 12 months after the last case is stamped out.

As noted in section 3.5, the results from the epidemiological modelling undertaken by AFFA indicate that using ring vaccination in the control strategy for the medium-sized outbreak would be unlikely to reduce the costs of an outbreak. It would increase the outbreak's average duration, and thereby prolong the period until access to markets is regained.

In contrast, ring vaccination offers the prospect of significantly reducing the duration of the large outbreak. In addition, it increases the certainty of being able to achieve control of the disease, as indicated by the lower variability of the results.

Thus, in a long outbreak, ring vaccination combined with early slaughter of vaccinated animals could result in Australia regaining access to international markets more quickly than with stamping out alone. This would be likely to reduce the overall cost of an outbreak to the economy.

There would, however, be some costs associated with achieving those benefits. While ring vaccination reduces the number of herds on infected and direct contact premises which would need to be stamped-out, it increases the total number of herds which would have to be slaughtered before the three month waiting period for FMD-free recognition could begin. This would increase significantly (by around one-third from 750 000 to 1 050 000) the number of animals that would need to be slaughtered as part of the control strategy. Nevertheless, the cost of vaccination and the increased slaughterings would be more than offset by the earlier re-entry to FMD-free markets and the increased revenue from the sale of product in those more profitable overseas markets. An indication of the net benefits of using ring vaccination as part of the strategy to control a large outbreak is given in section 6.4.

The above discussion indicates that there would be a particular size of outbreak (between a medium and large outbreak) at which there would be a switchover with respect to the use of ring vaccination. This highlights factors that determine the magnitude of the additional benefits and costs that ring vaccination could bring to a stamping-out strategy. As mentioned, these include significantly reducing the time in re-establishing disease-free status, earlier access to the price premiums available in FMD-free markets overseas, slaughter and disposal costs, the costs of vaccination, the number of animals vaccinated and the available markets, if any are available at such a time, for the rapid sale of products from vaccinated animals.

The conclusion that there are circumstances where ring vaccination as a supplement to a stamping out strategy could reduce the total cost of an FMD outbreak, is consistent with earlier work by the Bureau of Resource Sciences (Garner, Allen and Short 1997a) and other studies. The Bureau work draws attention, among other things, to the physical limits to slaughtering and disposing of large numbers of animals, the high demands placed on scarce veterinary resources at such times and the benefits of focussing the use of them on supervising the stamping out of known infections, surveillance and decontamination of infected premises.

The decision on whether or not to use ring vaccination raises some complex issues, apart from the economic issues discussed above. These involve recognition that such a decision would have to be made early in an outbreak, that it would involve the judgment that the (largely unknown) spread of the disease was outstripping the ability of the available resources to identify, stamp-out and decontaminate infected premises, and that containment of the disease could be achieved by diverting resources from stamping out and decontamination to vaccinating animals within an encircling zone. Also, it would involve decisions on the location and width of vaccination zones.

The work on the use of vaccination also draws attention to the scope for selective vaccination to contribute to an efficient control strategy. By targeting high-risk enterprises such as intensive piggeries and feedlots, it could reduce the peak demand on scarce veterinary resources during an outbreak and provide for a more orderly slaughter and disposal of animals.

In addition and as indicated, blanket vaccination is only ever likely to be part of a cost-effective control strategy where the spread of the disease in an area has outstripped the ability of specialist veterinary resources to identify, stamp-out and decontaminate infected premises.

New developments

As mentioned in chapter 2, research work is currently underway to develop diagnostic tests which are able to differentiate between animals infected with FMD and animals vaccinated against FMD. When developed and recognised internationally, such tests would encourage a much wider use of vaccination as part of an FMD control strategy. If commercially available, the tests would reduce the market-driven need to slaughter quickly all vaccinated animals (or the delay in recognition of FMD-free status with retention of vaccinated animals), and hence the costs associated with the use of vaccination. In turn, this would increase the benefits of using ring vaccination and selective vaccination as part of a stamping-out strategy for cost-effective control of FMD. By influencing the supply of FMD-free product, it could also reduce the FMD-free market premium.

4 Trade impacts of foot and mouth disease

Most effects of a foot and mouth disease outbreak in Australia would be due to the trade impacts.

Australia is a large agricultural exporter. Annual livestock exports constitute 6 per cent of total exports by value, or almost $10 billion in 2000-01 (ABARE 2001a). The closure of key livestock export markets — especially premium FMD-free markets — would have a marked effect on the domestic economy and rural communities, regardless of the outbreak location. Indeed, the significance of the impact on trade would be the largest difference between an outbreak in Australia and the 2001 outbreak in the UK. As the UK livestock industry is focussed on satisfying domestic needs, its export losses totalled only $A350 million — a very small portion of the total loss attributable to the outbreak (DEFRA and DCMS 2002).

This chapter discusses the trade consequences of an FMD outbreak for Australia — what products and markets would be affected, how significant the impact would be and how long it would take to regain market share. These responses underpin the assumptions used to model the economic effects of an outbreak on the Australian economy (see chapter 6 and appendix C for this modelling and its results).

4.1 Why do export markets close?

Because FMD is highly contagious, countries that are free from the disease generally are fearful of importing meat and other susceptible products from FMD-endemic countries. As a consequence, the world market for meat is divided into FMD-free and FMD-endemic markets. FMD is endemic throughout the Middle East, South America, Asia and parts of Europe (see box 2.1).

In the event of an FMD outbreak in Australia, countries that are FMD-free would immediately ban Australian imports of susceptible agricultural products. In the short-term, exports to some FMD-endemic countries are also likely to be affected, particularly if the FMD virus strain in those countries differs to that found in Australia. Such bans would be consistent with the international agreements governing the use of quarantine measures and with the Office International Des Epizooties (OIE) Animal Health Code. The Animal Health Code and the role of the OIE is described in chapter 2.

The OIE standards are recognised by the World Trade Organisation (WTO) as reference international sanitary rules — that is, if a country imposes a ban in line with the provisions of the Code, it is protected under the Sanitary and Phytosanitary (SPS) Agreement from actions in the WTO. The SPS Agreement allows countries to impose necessary regulations and standards to protect human, animal or plant, life or health. Member countries of the WTO are encouraged to use international standards, guidelines and recommendations, such as the OIE's Animal Health Code, where they exist. However, members may use measures which result in higher standards if there is scientific justification.

As discussed in chapter 3, under the OIE Code, a country which was previously FMD-free and where vaccination was not practised, such as Australia, can regain disease-free status three months after the last reported case of the disease, if there is stamping out and serological surveillance. Should a previously FMD-free country choose to vaccinate as an emergency control strategy, the country can regain its disease free status three months after slaughter of the last vaccinated animal, if stamping out and serological testing is applied. Alternatively, if vaccinated animals are not slaughtered, the country must wait 12 months after the last known infection has been stamped out.

The OIE permits a country to 'zone' an area as FMD-free. The FMD-free zone must be separated from neighbouring infected areas by a physical or geographical barrier, or by a surveillance zone, and animal health measures must be introduced which prevent entry of the disease. Zoning is discussed further in section 4.5.

4.2 Which products are affected by trade bans?

Products that can carry or transmit the FMD virus include fresh meat and meat products, milk and milk products, wool, straw and forage, skins and hides, and semen and embryos. However, the risk associated with each product differs, as does the capacity to treat products to inactivate the virus. The OIE provides guidelines for veterinary administrators in considering whether there is a risk with regard to FMD in importing particular products from FMD-endemic countries. Table 4.1 outlines the OIE guidelines for inactivating the FMD virus for some of the more commonly traded products.

Table 4.1 OIE guidelines for the inactivation of the FMD virus in animal products

Product	*Guidelines*
Meat	To inactivate the FMD virus present in meat, one of the following procedures should be followed: 1. *Canning* – Meat is subject to heat treatment of at least 70°C for a minimum of 30 minutes, or an equivalent process that is demonstrated to inactivate the FMD virus. 2. *Thorough cooking* – Meat, previously deboned and defatted, can be heated to a temperature of 70°C or more for a minimum 30 minutes, and shall be packed so it cannot be exposed to a source of virus. 3. *Drying after salting* – When rigor mortis is complete, the meat must be deboned, salted with cooking salt (NaCl) and completely dried.
Milk and cream (for human consumption)	Products must originate from herds or flocks which were not subject to any restrictions due to FMD at the time of milk collection and have been processed to ensure destruction of the FMD virus in conformity with one of the OIE procedures (Article 3.6.2.5): 1. Ultra-high temperature (UHT); 2. If milk pH < 7.0, simple high temperature – short-term pasteurisation (HTST); or 3. If milk pH > 7.0, double HTST. Necessary precautions must be made to avoid contact with products with any potential source of FMD virus.
Milk powder and milk products	Products must be derived from milk complying with the requirements for milk and cream and necessary precautions must be made to avoid contact with products with any potential source of FMD.
Wool and hair	Products must be processed to ensure destruction of the FMD virus in conformity with one of the OIE procedures (Article 3.6.2.2): 1. Industrial washing; 2. Chemical depilation by means of slaked lime or sodium sulphide; 3. Fumigation in formaldehyde in a sealed chamber for 24 hours; 4. Industrial scouring; or 5. Storage of wool at 18°C for 4 weeks, or 4°C for 4 months, or 37°C for 8 days. Necessary precautions must be made to avoid contact with products with any potential source of FMD virus.
Straw and forage	Products must be: 1. Subject to steam at a minimum temperature of 80°C in a closed chamber for at least 10 minutes; 2. Subject to formalin fumes in a closed chamber for at least 8 hours at a minimum temperature of 19°C; or 3. Kept in bond for at least 3 months before exportation.

Source: OIE (2001).

Inactivation processes may impose additional costs, but can provide the opportunity for trade to continue. For example, in the case of wool, the FMD virus can be deactivated by scouring or storing wool at specified temperatures for given periods of time. Clearly, the extent to which trade can continue depends on other countries' willingness to accept inactivation procedures. During the UK outbreak, for example, Australia did not allow the import of any UK dairy products, even though some were processed to deactivate the virus in accordance with the OIE guidelines.

The FMD virus can remain infective in the presence of organic matter such as soil and manure, or on chemically inert materials such as straw, hair and leather, although the risk of spread by these means is very small. Trade in agricultural products such as grains, which are not directly affected by the FMD virus, may be interrupted, but given the low risk of disease spread, this is likely to be short-term.

4.3 Effects of market closures

Experience from previous outbreaks suggests that all agricultural markets will initially close after the confirmation of an FMD outbreak until further details of the outbreak — the disease strain, location, extent and control mechanisms — are known. This was the case during the recent outbreaks in the UK, Ireland, France, the Netherlands and Argentina.

After an initial shut down, the likely consequences for exports will depend, among other things, on the extent of the outbreak, the ability to establish control and trade zones and the time taken to be readmitted into overseas markets. The consequences will also vary between products according to market and product characteristics.

The key Australian exports likely to be affected and the likely scale of these effects are discussed below.

Beef

Beef meat

Australia is the world's largest beef exporter, supplying over 25 per cent of the world beef trade. Over 1 300 kilotonnes (carcase weight), or 60 per cent of Australia's total beef production, is exported annually. Australia also exports almost 900 000 live cattle a year. Australia's beef and live cattle exports are valued at around $4 500 million per annum (ABARE 2002b).

Over 70 per cent of Australia's beef and live cattle production, by value, is sourced from Queensland and New South Wales, Queensland exports over 80 per cent of its production and accounts for almost 60 per cent of Australia's beef exports and 20 per cent of its live exports by value. On the other hand, production in New South Wales and other States is more targeted to the domestic market — both New South Wales and Victoria export around 40 per cent of production, while South Australia and Western Australia each export around 15 per cent of production. Live cattle exports are sourced mostly from Western Australia (40 per cent by value) and the Northern Territory (30 per cent by value) (ABS 2002b).

Figure 4.1 shows Australia's key export markets for beef and live cattle. Australia relies heavily on the FMD-free Japanese and US beef export markets — 45 per cent of beef by value (36 per cent by volume) is exported to Japan and 34 per cent to the USA (39 per cent by volume). Australia also exports smaller quantities to Korea, Canada, South East Asia and Taiwan. Importantly, just 15 per cent of Australia's beef by volume is currently exported to FMD-endemic countries (ABARE 2001). More generally, less than 25 per cent of total world beef exports are to FMD-endemic countries (USDA 2002).

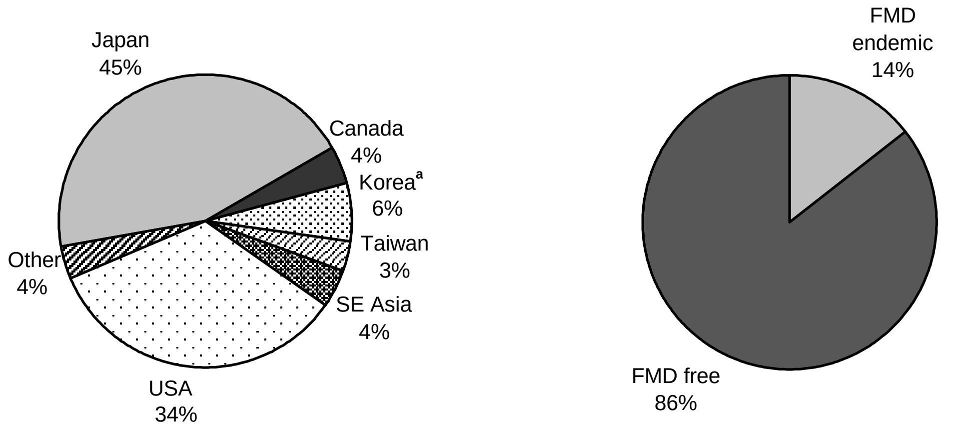
In the event of an FMD outbreak, Australia would lose a large portion of its current beef export markets, as over 85 per cent of its exports are to FMD-free markets — often referred to as the Pacific Basin markets. This includes the high value Japanese market. These markets would remain closed for at least three months after the disease has been eradicated. Given Australia is a major supplier to the Pacific Basin market, exclusion of Australian beef from these markets will raise prices and redirect trade.

FMD-endemic markets — often referred to as the Atlantic Basin markets — may provide some opportunity for diversion of product, though at relatively low volumes and prices (a price differential of between 25 to 50 per cent could be expected). Views differ as to how much extra product could be sold on the Atlantic market and on the impact this would have in dispersing prices further. Some previous studies, such as Lembitt and Fisher (1992), have assumed that all product could be diverted to the Atlantic Basin market. However, the Commission considers that, given the large export volumes that would have to be diverted (up to 1 000 kilotonnes for a 12 month outbreak), and the limited size of alternative markets (FMD-endemic markets throughout the world constitute only 1 300 kilotonnes in total), the scope for a large scale diversion of trade would be limited. The experience of Argentina since FMD re-emerged in 2001 reinforces this view.

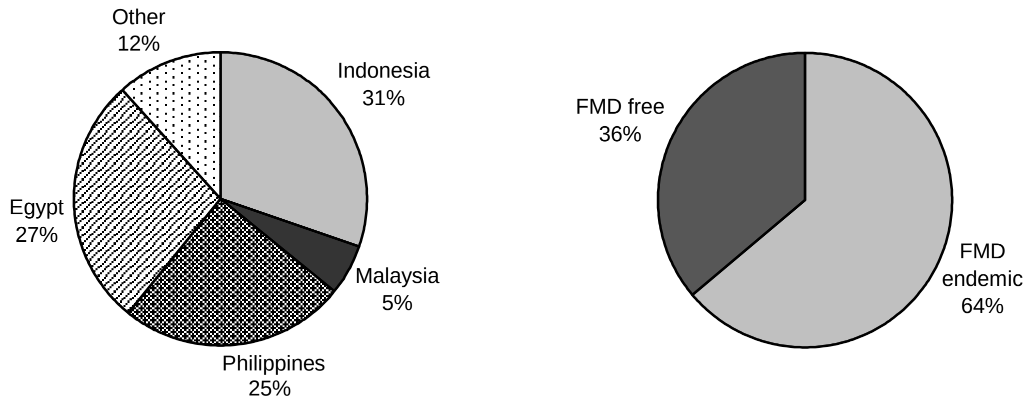
Figure 4.1 **Value of beef and live cattle exports by destination, 2000**

Free on board

Beef exports by destination



Live cattle exports by destination



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[a] The OIE recently suspended the Republic of Korea's status as FMD-free without vaccination after the disease appeared on 6 May 2002.

Sources: ABARE (2001a); PC estimates.

Argentina is the world's fifth largest beef producer and seventh largest beef exporter (see figures 4.2 and 4.3). Even though its exports are only one-third of Australia's export volume, Argentina has only been able to divert a relatively small proportion of its exports to other markets during periods when they were declared FMD-endemic. Box 4.1 examines the extent to which Australian beef can be diverted to alternative markets by reference to the Argentine experience.

Figure 4.2 **World beef production by country, 2000**

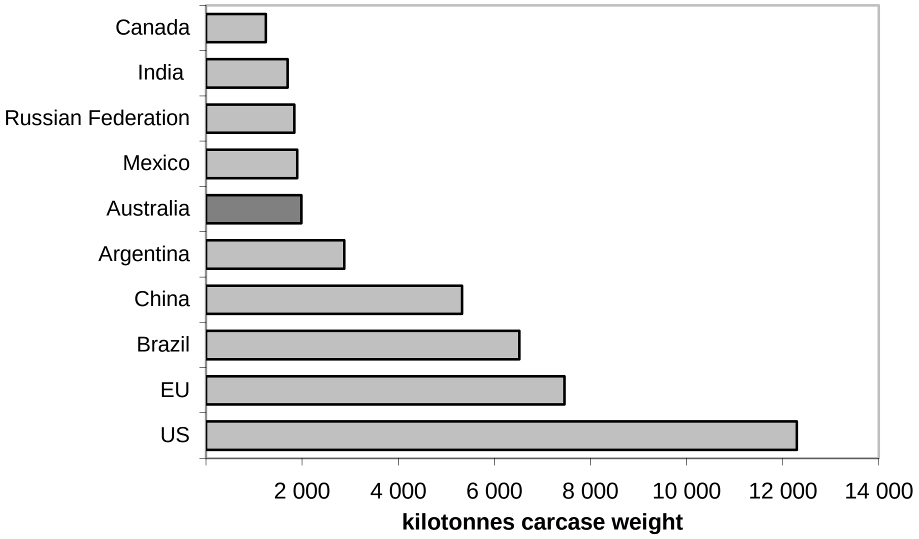
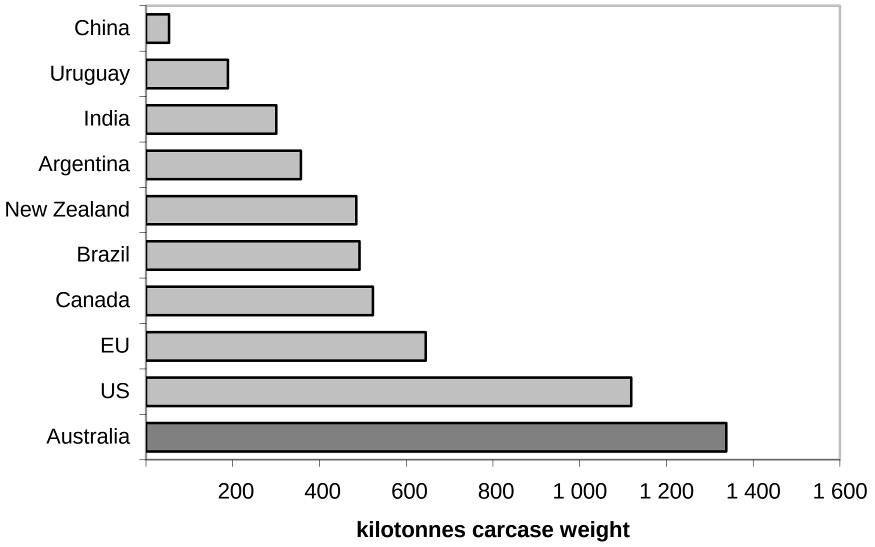


Figure 4.3 **World beef exports by country, 2000**



Source: USDA (2002).

At the earliest, FMD-free countries such as Japan, the USA and Canada would not resume trade with Australia until it was declared FMD-free by the OIE. Subsequently, as discussed below, the ability and extent to which these markets can be reclaimed are highly dependent on each market's specific features — in particular, the USA and Japan that together contribute almost 80 per cent of Australia's beef export revenue.

Box 4.1 **Diversion of beef to other markets — the Argentine experience**

The Argentine experience provides insights into the extent to which Australia could develop other markets in response to an FMD outbreak.

Argentina was FMD-endemic for much of the last century until May 1997, when it was declared FMD-free without vaccination. However, in March 2001, FMD re-emerged. As a consequence:

- Argentine exports fell by 54 per cent in 2001 (USDA 2002).
- Argentina is now confined to exporting to countries such as Peru, Hong Kong, Brazil, Israel and some African countries.
- The EU agreed to re-open its market to Argentine beef after it embarked on a vaccination program (but this option is not open to Australia, given our 7 000 tonne EU quota) (MLA 2002).
- The USDA (2001) does not believe Argentina will be able to find new markets until the disease is once again eradicated – 'like Uruguay, Argentina is forced to deal with its excess supply through a combination of increased consumption, reduced slaughter, and a slight increase in thermo-processed production'.
- Over the longer-term and despite production which has generally exceeded that of Australia, Argentina's exports have always been significantly less than Australian exports (figures 4.2 and 4.3). Consequently, Argentines consume very high quantities of beef domestically — over 65 kilograms per person, per annum.

Recovery in the Japanese market is likely to be slow. Approximately two-thirds of Australia's export volume to Japan is high quality, 100 to 300 day feedlot beef, grown specifically for Japanese market requirements. Prices in Japan are likely to increase, as Australia is a major player in the Pacific Basin market — the CIE (2002) estimates retail prices in Japan would rise by 23 per cent if there was an FMD outbreak removing Australia from the Japanese market. With large numbers of cattle on feed at any given time (currently 11.5 million cattle), the USA would be likely to increase sales to this high value market — the USA currently exports only 10 per cent of its production, and could divert domestic production to premium export markets (NASS 2002).

In addition, given that production of feedlot beef may fall off considerably with the loss of this market, Australia may face a supply constraint in the recovery of market share for chilled beef in Japan.

Australian beef exported to the USA is primarily lower grade manufacturing beef. Ultimately, regaining market share would depend on US producers' capacity to fill demand. Australia may regain market share relatively quickly, especially if Australia's beef is available at a discounted price, given the strong US demand for manufacturing beef and the potential for some US beef to be diverted to higher valued export markets in response to higher prices. The CIE (2002) estimates that US retail beef prices will rise by 8 per cent. Re-entry to the US market after an FMD outbreak is likely to be more rapid than to the Japanese market.

Live exports

As shown in figure 4.1, almost all of Australia's live cattle exports are destined for Asia and the Middle East, including 30 per cent to Indonesia, 27 per cent to Egypt and 25 per cent to the Philippines. Of Australia's live export markets, more than two-thirds are FMD-endemic.

In these countries, there is limited ability to substitute chilled beef for live cattle as they have poor distribution systems and limited ability to handle chilled beef. Consequently, there is potential for some of the live export trade to resume once the strain of virus has been identified and prior to Australia regaining FMD-free status (provided that the virus strain is not different to that existing in endemic markets).

Sheepmeat

Australia is the world's third largest lamb and mutton producer (with annual production of around 700 kilotonnes — carcass weight) and the world's second largest exporter after New Zealand. Australia also exports almost 6 million live sheep annually (ABARE 2002b).

Together, Victoria and New South Wales are responsible for (in volume terms) 60 per cent of Australia's total lamb and mutton production. These States are also large exporters, accounting for over 60 per cent of total lamb exports and 70 per cent of total mutton exports. Almost 75 per cent of live sheep exports are shipped from Western Australia (ABS 2002b).

Australia's exports of sheepmeat were valued at almost $1 200 million in 2000-01 — consisting of lamb ($500 million), mutton ($420 million) and live sheep ($260 million) (ABARE 2002b). Each of these markets has distinct characteristics and, consequently, an FMD outbreak is likely to have a different effect on each product.

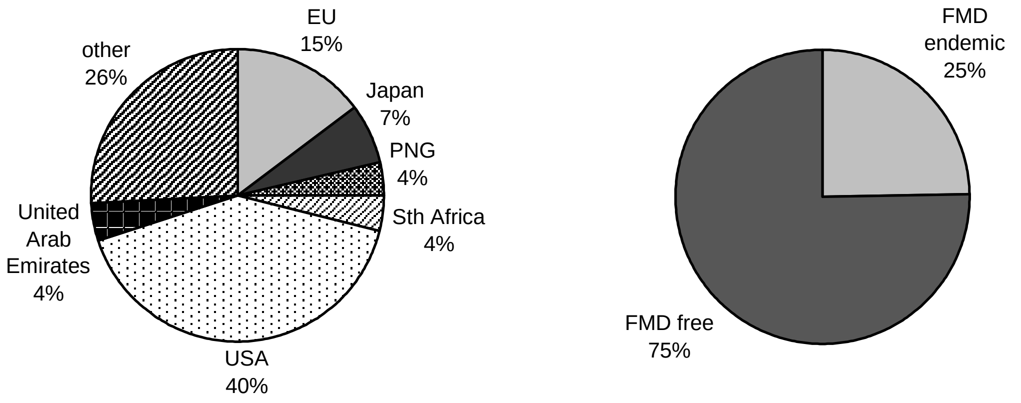
Lamb

The USA is Australia's key lamb market, receiving around 40 per cent of lamb exports by value. The EU and Japan are also important markets, accounting for 15 and 7 per cent of exports respectively (see figure 4.4).

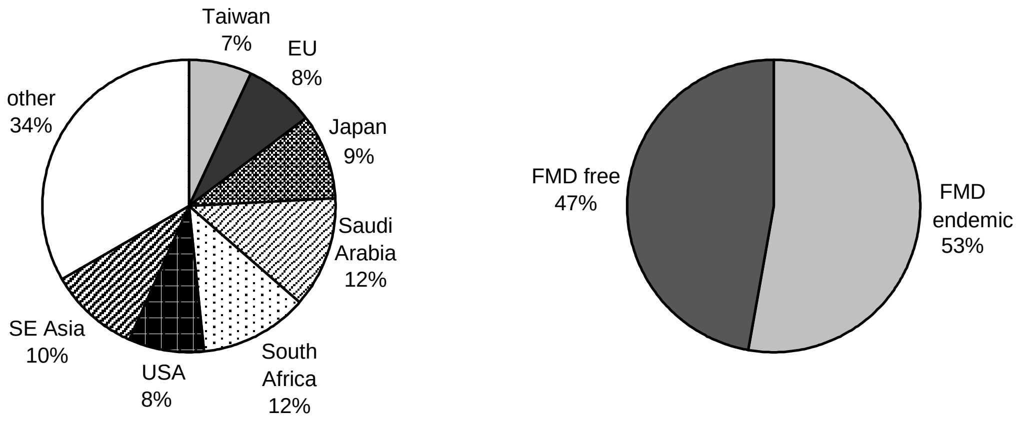
Figure 4.4 **Sheepmeat exports by destination, 2000**

by value, fob

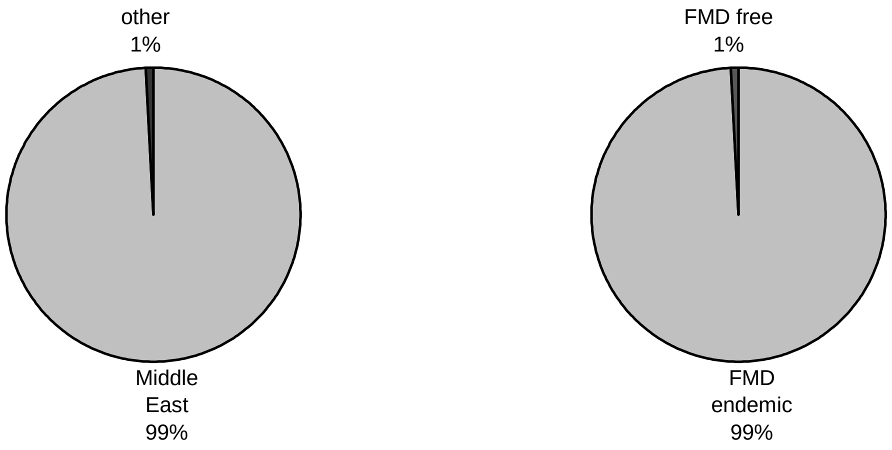
Lamb exports by destination



Mutton exports by destination



Live sheep exports by destination



Sources: ABARE (2001a); PC estimates.

Around three-quarters of Australia's lamb exports are destined for FMD-free markets. These markets would be lost during an outbreak, although recovery may be relatively quick, given demand is likely to remain for lamb and given there are limited substitute lamb producing countries able to fill our large market share in the short to medium term. (Although New Zealand is the largest lamb exporter, its lamb production is falling and it is not currently filling its EU quota.)

There may be some opportunity to recommence trade with FMD-endemic countries, although developing new markets in other countries may be difficult in the short-term and could involve significant price discounts.

Mutton

The demand for mutton is highly price sensitive. As shown in figure 4.4, major markets for Australia in 2000-01 included South Africa (12 per cent of exports by value), Saudi Arabia (12 per cent), Japan (9 per cent), the USA (8 per cent) and the EU (8 per cent).

Almost half of Australia's mutton exports is to markets free of FMD. These markets would remain closed for the duration of the outbreak. However, there may be some opportunity to continue to export to existing FMD-endemic markets such as Saudi Arabia, South Africa and parts of Asia, and some other FMD-endemic markets, particularly given a price discount.

Live exports

Australia is the world's largest live sheep exporter, exporting almost exclusively to the Middle East where FMD is endemic. There are few alternatives to Australian supply, particularly since some countries of the Middle East banned product from Africa owing to Rift Valley fever.

Given the limited substitutes and the FMD-endemic status of the Middle East, there are good prospects for resuming live sheep exports during an outbreak. However, should the FMD strain of Australia differ to that of the Middle East, resuming trade may be more difficult.

Pigs

Australia produces around 365 kilotonnes of pigmeat annually of which around 20 per cent is exported, primarily to Singapore, Japan and Korea. Pigmeat exports were worth over $180 million in 2000-01 and have more than doubled since 1998-99 owing to new market opportunities in Singapore and Japan as a result, in part, of an FMD outbreak in Taiwan and a Nippah virus outbreak in Malaysia (ABARE 2002b).

New South Wales contributes around 30 per cent of Australian pigmeat production, with Queensland and Victoria each producing around 20 per cent. Australian exports are mainly from New South Wales (40 per cent), Queensland (30 per cent) and Victoria (15 per cent).

After an initial market closure, Australia’s pigmeat markets would be difficult to recapture. In pigmeat, Australia took advantage of other countries’ disease outbreaks to capture market share. If there were an FMD outbreak in Australia, importing countries would be able to source product easily from other countries, such as Canada, which have the capacity to fill our small market share. For example, Australia has only a 1 per cent share of the Japanese market.

Dairy

Australia produces over 10.5 billion litres of milk per year. Exports of dairy products account for around 50 per cent of that production and are valued at over $3 billion annually. Australia is the world’s third largest dairy exporter (16 per cent), although it contributes only 2 per cent of world milk production (ADC 2001).

Milk production is concentrated in the south-east corner of Australia, with Victoria accounting for over 60 per cent of total output and New South Wales 13 per cent. Victoria accounts for over 85 per cent of the value of Australia’s total dairy exports.

Australia’s key dairy export markets are in Asia, accounting for almost two-thirds of exports by value (see table 4.2). Japan imports large volumes of Australian cheese (40 per cent), while milk powder is mostly exported to Asia (80 per cent) — primarily the Philippines, Thailand, Malaysia, Taiwan and Indonesia.

As milk can carry the FMD virus, the OIE provides a set of guidelines for the safe importation of dairy products from FMD-endemic countries (see table 4.1). In most cases, the use of double pasteurised milk, or processing, inactivates the FMD virus, although untreatable products such as soft unpasteurised cheese can still carry the disease. Untreatable products account for a very small portion of Australia’s dairy exports.

Experience from the FMD outbreak in the UK suggests that, although some markets would initially close, the negligible risk of dairy products transmitting FMD and pressure on world supply would lead most countries to recommence trade fairly quickly. For example, most countries continued trade in dairy products with the UK during the 2001 outbreak, including our major Asian trading partners.

Table 4.2 **Value of Australian dairy exports by region, 2000-01**

$A million, fob

	Sth East Asia	*Other Asia*	*Europe*	*Middle East*	*Africa*	*Americas*	*Other*	*Total*
Butter/AMF[a]	73.0	46.9	27.6	53.7	51.4	41.7	2.6	296.9
Cheese	61.2	430.0	160.0	186.7	33.5	69.9	9.4	950.7
Milk	35.0	28.6	0.7	3.1	1.3	0.6	12.4	81.8
SMP/BMP[b]	478.0	139.6	2.6	41.5	15.5	55.3	2.1	734.5
WMP[c]	298.5	233.6	4.4	69.8	58.8	38.6	26.2	729.8
Other	58.0	89.7	10.5	0.4	1.7	86.8	23.8	270.9
Total	1003.7	968.3	205.8	355.1	162.2	293.0	76.5	3064.6

[a] anhydrous milk fat. [b] skim milk powder/buttermilk powder. [c] wholemilk powder.

Source: ADC (2001).

While the trade in dairy products is small worldwide (around half the size of the US market), and competitive (for example, New Zealand and Australian products are highly substitutable), Australia holds a large market share in several key dairy importing countries. Japan sources almost half of its cheese imports from Australia and competitors like New Zealand would find it difficult to fill that demand. Similarly, Australia supplies a large proportion of the Asian milk powder market and is unlikely to lose significant market share in the medium to long-term.

Overall, Australia is likely to be able to resume most dairy trade relatively soon after the initial ban.

Wool

Australia produces around 650 kilotonnes of wool annually, although in the past five years it has exported on average 800 kilotonnes a year (underpinned by sales from the wool stockpile), with a value of over $3.8 billion (ABARE 2002b). Now that the wool stockpile has been sold, annual exports are expected to more closely reflect production. Australia exports 98 per cent of its wool production and supplies 85 per cent of the world export market. New South Wales, Victoria and Western Australia contribute almost 80 per cent of Australia's wool exports (ABS 2002b).

While an FMD outbreak would have some impact on Australia's wool trade, it is likely to be of a relatively short-term nature compared to the impact on livestock and meat markets. Australia's wool export markets would close immediately after an outbreak given that wool can carry the FMD virus, but the duration of the closure would ultimately depend on the disease strain and Australia's ability to disinfect wool. (The OIE outlines a set of guidelines to disinfect wool including scouring and storage (see table 4.1)).

Only 30 per cent of Australia’s wool is exported in its scoured form, mainly to the FMD-free markets of Italy, Germany and France. Scoured wool could be exported immediately after an outbreak under the OIE rules, and Australia may have some limited capacity to increase its output of scoured wool. During the UK outbreak, scoured wool was still accepted by most countries.

Australia’s key export markets for greasy wool are China, Taiwan and Korea. Given these markets are FMD endemic, they may not require wool to have undergone a disinfection process (depending on the disease strain). However, during the UK outbreak, greasy wool was banned by most countries. Should Australia choose storage as a means of disinfection, raw wool could not be exported for at least four weeks under the OIE rules.

Field crops

Australia produces around 75 million tonnes of field crops a year — including grains, oilseeds, cotton, sugar cane, tobacco, wine grapes, fodder and horticulture — valued at over $18 billion, with exports of almost $15 billion (ABARE 2002b).

Of total cropping exports, grains and oilseeds contribute almost 50 per cent by value — primarily to the Middle East, Asia and Africa.

Although the FMD virus can remain infective for several weeks in the presence of organic matter such as soil, or on chemically inert materials such as straw, crops are not directly affected in any way by the virus. Furthermore, the OIE Animal Health Code and the AUSVETPLAN do not specify guidelines for the importation of grains or other field crops (other than straw or forage), as is the case for animal products, except for crops that have been grazed with FMD-infected animals.

Experience suggests that, given the negligible risk of spreading FMD via grains and other crops, and the likely pressure on supply, most countries would open markets to imports after an initial short period of disruption to trade. Argentina, for example, is the largest wheat exporter despite being declared FMD-endemic. Furthermore, a large portion of Australia’s cropping exports are to FMD-endemic countries.

4.4 Modelling assumptions

The direct effects of an outbreak on production and trade depend importantly on the assumptions made about the effects on exports, domestic consumption and production for each livestock category. To ensure these are as realistic as possible, trade and production assumptions have been generated after consultation with industry and stakeholders. (A list of parties that have been consulted and attendees at the Commission's workshop are listed in appendix A.)

Based on the analysis provided in section 4.3, table 4.3 presents parameters for an outbreak of 12 months duration, with no zoning or vaccination, and with Australia regaining access to all markets three months after the eradication of the disease as specified under the OIE guidelines. Other scenarios have been modelled by making appropriate adjustments to the core assumptions and are available on request.

The Commission acknowledges that there is no single 'correct' value for many model parameters, but rather there is a range of plausible values. However, in order to generate useful and indicative quantitative estimates for policy purposes, point estimates have been generated.

4.5 Zoning

The principle of zoning was accepted internationally in 1992 when the OIE developed new trade and zoning guidelines for FMD and the use of vaccination. Zoning was also recognised in the SPS agreement by the Uruguay Round of the General Agreement of Tariffs and Trade (GATT) in 1993. Implementation of these guidelines is now under the jurisdiction of the WTO.

Zoning provides the opportunity for a disease-infected country to continue trade with disease-free countries by defining areas within the country as infected and disease-free. Under the OIE Code, an FMD-free zone must be sealed off from disease-infected zones by tight movement and quarantine controls and an effective surveillance and reporting system must be implemented to demonstrate that the virus has been contained within the infected zone (see chapter 2). However, the amount of surveillance required to demonstrate that an area is disease-free will ultimately depend on negotiations with overseas trading partners.

As noted in chapter 2, zoning has been successfully applied in a number of other disease outbreaks throughout the world, including the FMD outbreaks in Italy in 1993 and Greece in 1994, and the 1995 papaya fruit fly outbreak in Australia (see box 4.2).

Table 4.3 Modelling assumptions — 12 month outbreak

Per cent change from base case

Period	*Q1*	*Q2*	*Q3*	*Q4*	*Y2*	*Y3*	*Y4*	*Y5*	*Y6*	*Y7*	*Y8*	*Y9*	*Y10*
Beef and veal													
Export quantity	-100	-90	-90	-80	-40	-20	-35	-25	-20	-5	0	0	0
Export price	-50	-50	-50	-50	-30	-10	0	+5	+5	0	0	0	0
Production held back	40	60	60	50	10	0	0	0	0	0	0	0	0
Domestic consumption	-10	+25	+40	+40	+20	+5	0	-2	-2	0	0	0	0
Domestic price (w'sale)	-50	-50	-50	-50	-30	-10	0	5	5	0	0	0	0
Live cattle													
Export quantity	-100	-50	-40	-30	-20	0	0	0	0	0	0	0	0
Export price	-30	-30	-20	-20	-10	0	0	0	0	0	0	0	0
Lamb													
Export quantity	-100	-80	-70	-60	-40	-20	0	0	0	0	0	0	0
Export price	-50	-50	-50	-50	-20	-10	-10	0	0	0	0	0	0
Production held back	30	30	20	10	0	0	0	0	0	0	0	0	0
Domestic consumption	-10	10	20	15	13	6	-2	0	0	0	0	0	0
Domestic price (w'sale)	-50	-50	-50	-20	-10	0	0	0	0	0	0	0	0
Mutton													
Export quantity	-100	-80	-60	-40	-20	-10	-10	0	0	0	0	0	0
Export price	-50	-50	-40	-30	0	0	0	0	0	0	0	0	0
Production held back	50	20	43	33	0	0	0	0	0	0	0	0	0
Domestic consumption	-12	-25	-25	-20	-10	0	0	0	0	0	0	0	0
Domestic price (w'sale)	-50	-25	-25	-20	-5	0	0	0	0	0	0	0	0
Live sheep													
Export quantity	-100	-80	-40	-30	-10	0	0	0	0	0	0	0	0
Export price	-40	-40	-30	-20	-10	0	0	0	0	0	0	0	0
Production held back	50	20	43	33	0	0	0	0	0	0	0	0	0
Pigs													
Export quantity	-100	-100	-100	-100	-60	-60	-60	-50	-50	-40	-20	-10	0
Export price	na	na	na	na	-10	-10	-10	-5	-5	-10	-10	0	0
Domestic consumption	+5	+5	-20	-20	-5	0	0	0	0	0	0	0	0
Domestic price (w'sale)	-60	-60	-50	-50	-20	-10	0	0	0	0	0	0	0
Dairy													
Export value	-50	-20	-10	-10	-5	0	0	0	0	0	0	0	0
Wool													
Export quantity	-50	+20	+20	+10	0	0	0	0	0	0	0	0	0
Export price	-20	-10	-10	-5	0	0	0	0	0	0	0	0	0
Field crops													
Export value	-20	+5	+5	+5	0	0	0	0	0	0	0	0	0

Source: PC estimates.

Zoning has the potential to substantially reduce the trade losses of an FMD outbreak in Australia, as shown in several studies (such as Lembit and Fisher 1992 and Barry et al. 1993) as well as in the Commission's modelling work (see chapter 6 for these results). However, to support zoning, additional resources would be required for sampling, laboratory testing and to maintain adequate movement controls on livestock and products.

The Commission's modelling has followed the AUSVETPLAN's recommendation in using State/Territory boundaries when establishing trade zones, as they would provide the most acceptable limits and are identified internationally as distinct geo-political regions.

Regional effects of zoning and market closures

The overall ability to reduce trade losses of an FMD outbreak will ultimately depend on where the outbreak is located and how long it takes for the zones to gain international acceptance. For example, the ability to zone Queensland as FMD-free would significantly reduce Australia's trade losses as Queensland exports around $2 500 million beef annually. On the other hand, production in other States, such as South Australia, is more targeted towards the domestic market.

Regardless of the outbreak scenario, an FMD-free zone for trading could not be established overnight. As noted above, a zone would require movement restrictions on susceptible animals and their products, and substantial clinical testing of herds. For its modelling purposes, the Commission has assumed that zones would take three months to establish from detection of the disease.

Because of the time lags involved in establishing an FMD-free zone, export volumes may not recover immediately. However, States that are zoned as FMD-free would benefit from continued exports, and in some cases, may face higher demand (and receive higher prices for their exports) because of a lack of competition from the FMD-infected zone in Australia. The infected zone would not only lose export markets, but could also be banned from selling product on some domestic markets — a State that is zoned as FMD-free is unlikely to accept product from an FMD-endemic state for fear that this would jeopardise its FMD-free status.

However, States in the FMD-infected zone would also be likely to benefit from a zoning policy. With a continuation of Australian product on the world market, it would take them less time to rebuild trade once they were declared FMD-free.

The terms of reference ask the Commission to evaluate the impact of zoning on the medium and large outbreak scenarios. This issue is considered below.

Box 4.2 International experiences with zoning

FMD in Italy – 1993

In February 1993, several cases of FMD were confirmed in the Potenza province of southern Italy. By March, a small number of cases had also been reported within the Verona province in northern Italy. In all, 57 farms were affected.

Initially, in response to the outbreak, a ban was imposed on the movement of all animals and animal products (fresh meat, untreated milk products and reproductive materials) to the rest of the EC. However, after visits by EC missions, and once the nature of the outbreaks was better understood, national restrictions were replaced by restrictions on designated areas in Italy. Zoning was accepted within one month of the disease being recognised. These remaining restrictions were progressively lifted as the situation became clearer and epidemiological investigations were undertaken. All restrictions were repealed in July 1995.

FMD in Greece – 1994

In July 1994, the FMD virus was reported in Greece. By March 1995, 95 outbreaks had been recorded, all of which could be linked to Lesvos Island and Evros.

Zoning was effectively implemented after a decision by the Commission of European Communities in August 1994 (less than three weeks after the first reported outbreak). The Commission sent a mission to Greece to examine the FMD situation and were satisfied that Greece had acted in accordance with the Council directives for controlling the virus (which included a nationwide serological survey and the establishment of approved inspection and certification procedures). Infected areas were identified and restricted from exporting live cloven-hoofed animals, fresh meat, untreated milk products and reproductive materials to other member States.

Greece was not declared FMD free until October 1995 — some 15 months after the FMD virus was first reported.

Papaya fruit fly in far north Queensland – 1995

When Papaya fruit fly was discovered in far north Queensland in 1995, access to overseas markets for Australian fruit and vegetables was immediately suspended. Losses from export bans were estimated to be over $100 million.

Given the serious nature of the disease, the outbreak area was immediately quarantined and, within 10 days of the initial detection, the Government commenced an eradication campaign. Australian quarantine officials were able to quickly demonstrate to the satisfaction of export markets that the fly was absent from certain areas. Australia also gained acceptance that treatments applied by growers inside the quarantine zone were effective. This quick work enabled exports to continue and protected the livelihood of local export growers. When the fly had been fully eradicated in 1999, Australia negotiated recognition that the area was free from contamination so trade could return to normal.

Sources: Garner et al. (1997b); QDPI (2002) and DFAT (2002).

Zoning under scenario 2

As detailed in chapter 3, scenario 2 involves a six-month outbreak that starts in north Queensland and spreads to the Northern Territory. Under this scenario, the Commission has modelled New South Wales, Western Australia, South Australia, Victoria and Tasmania as FMD-free zones.

Queensland would suffer large losses from an outbreak, given a large portion of Australia’s beef is produced in northern Australia (50 per cent) and most is exported (80 per cent). Furthermore, Queensland’s beef would not be able to be sold on the domestic market in the States zoned as FMD-free. Producers in other States, such as New South Wales, may obtain higher international beef prices as there would be no competition in export markets from Queensland and Northern Territory production in the FMD-free market.

The overall impact on certain commodity groups, such as dairy products and live sheep, would be significantly less if FMD-free zones could be created. Live sheep, for example, are exported almost exclusively by Western Australia (over 75 per cent), while Victoria produces over 85 per cent of Australia’s dairy exports. Exports from Queensland, which would be affected by the assumed outbreak, represent only 5 per cent of sheepmeat exports and less than 1 per cent of dairy exports.

Zoning under scenario 3

Scenario 3 involves a large outbreak which takes 12 months to contain and spreads from southern New South Wales to western Victoria and south east South Australia. Under this scenario, it may be possible to zone Western Australia, Northern Territory, Queensland and Tasmania as FMD-free.

Irrespective of zoning, the dairy industry and the sheepmeat industries would be adversely affected by an outbreak in south east Australia, given that a large proportion of production is sourced from these regions. In contrast, most live cattle and sheep exports are sourced from Western Australia, Queensland and the Northern Territory. Thus, these States and Territories could potentially continue to export large volumes.

Queensland would benefit from being zoned as FMD-free given that it could continue to service some of Australia’s key export markets. The smaller quantities of beef that are exported from New South Wales, Victoria and South Australia could be sold on the domestic market in these States. Quantitative estimates of the impacts of zoning are presented in chapter 6.

5 Other economic effects

The impacts of an FMD outbreak in Australia would arise from two separate sources — first, the loss of income from the closure of export markets for many Australian livestock products, and second, the control and eradication of the disease. Each source will have subsequent effects on livestock production and domestic consumption of meat, as well as flow-on effects to a range of industries such as tourism, feed providers and transport agents. This chapter describes these indirect economic impacts of FMD.

5.1 Impact on livestock production

Loss of FMD-free markets would have an immediate impact on saleyard prices. The consequential impact of low prices on production would depend on the product, on the length of the outbreak and, just as importantly, on producers' perceptions about the duration of low prices. However, the loss of overseas markets would have a significantly greater effect on production than would control measures. This is because even in the large outbreak, restricted and control areas would comprise only a relatively small part of all Australian land devoted to livestock production.

Immediate impact of an outbreak on production

Under the short outbreak scenario, it is reasonable to assume that domestic producers of beef and sheep would know that the disease had been controlled relatively quickly and infer that they would be able to recommence trade with FMD-free markets in the not so distant future. In this situation, producers are likely to view price falls as temporary and to retain some stock that they would otherwise have sent to market in order to 'ride out' the outbreak. Consequently, production would be likely to fall initially, and then rise above normal levels once the disease is controlled and the withheld stock is put onto the market. Importantly, given the temporary nature of the price change, the size of breeding herds is likely to remain largely unchanged and production is likely to return to normal levels relatively quickly.

In the case of pigs, the ability to hold back production, even in the short term, is strictly limited as market-ready animals quickly lose value. During a short outbreak, however, product may be stored at the manufacturing stage for later release, resulting in a minimal effect on the breeding herd.

Longer-term impacts on production

A longer outbreak is likely to have a far more substantial impact on production, particularly of beef.

In the short term, as in the case of the short outbreak, producers might initially hold back some stock in the hope of the outbreak ending. However, the ability to hold and feed stock — in effect to allow herd sizes to increase — is limited. Thus, if the outbreak showed no sign of ending, producers would be forced to dump stock on the market. Faced with a prolonged outbreak, and a further period to reclaim lost markets when the disease is eradicated, producers would recognise that low prices would persist for a considerable time.

Prolonged low prices would lead to lower levels of production for beef, sheep and pigmeat. However, the effect of low prices and lower production on total herd numbers is likely to vary by product.

- In the case of sheep meat production, the ability to substitute to wool production may mean that the size of the breeding herd would not fall significantly. Hence, as demand increases after elimination of the disease, it is likely that supply would be able to expand relatively quickly to fill that demand.
- In the case of pigmeat production, a period of prolonged low prices could render some piggeries commercially unviable. This would lead to a significant fall in the number of breeding sows. However, the ability to rapidly rebuild pig numbers and production levels should also allow supply to expand relatively quickly as domestic prices and demand (but not necessarily export demand) recover after the outbreak.
- In the case of beef, as discussed below, the adverse effects on production and herd numbers are likely to be more long term and could constrain recovery in the industry.

Impact of a long outbreak on beef production

Beyond the initial holdback and consequent dumping of stock on the domestic market, farmers are likely to significantly reduce beef production and reduce herd sizes. Producers would shift to other activities in an attempt to maintain returns although, as noted by Lembit and Fisher (1992), the extent to which this is possible would vary by region.

> Farms with mixed enterprises are able to do this [shift production] at moderate cost by changing the emphasis of their enterprise mix. However, farmers who produce predominantly beef will suffer much higher costs to switch to alternative enterprises. For example … movements into cropping are also likely to require expenditure on machinery. In some cases it may not be possible to find viable alternative enterprises because of agronomic and climatic constraints. (pp. 84–5)

Owing to the difficulty of switching quickly to other agricultural products, the responsiveness of beef production to price changes is relatively low — studies generally find that a 1 per cent fall in the price of beef leads to no more than a 0.5 per cent decrease in the production of beef in the medium term (Griffith et al. 2001b). Nevertheless, prolonged low prices that are likely to be associated with a long FMD outbreak would cause herd sizes and production of beef to decrease.

In turn, the reduced size of beef herds is likely to provide a constraint on returning to pre-FMD levels of earnings or exports. More specifically, when demand and prices eventually recover, producers will not be able to increase supply instantaneously. Indeed, the normal response of livestock industries to increased prices is to reduce the turn off of young and older female animals in order to build up the breeding herds and, thus, increase future production. The lagged supply response suggests that the effect on the industry of an extended outbreak is likely to persist after market access and demand have returned to normal. Thus, the initial losses from low export demand (and low prices in accessible domestic and FMD-endemic markets) during and immediately after the outbreak would be compounded by additional losses arising from supply constraints. Previous studies of the impact of FMD in Australia (such as Lembitt and Fisher 1992, Cao et al. 2002 and Dent 2002) have found that such constraints could persist for a number of years.

Both demand losses and losses caused by supply constraints in the beef industry have been included in the estimates of the economic impact of the outbreaks presented in chapter 6.

Possible additional cull beyond disease eradication

According to latest estimates, almost seven million animals were destroyed during the UK outbreak (DEFRA and DCMS 2002, Annex C). As noted, four million of these were attributable to eradication and control measures, while an additional three million were slaughtered for animal welfare reasons, such as insufficient feed or poor conditions. The Government paid farmers for these additional livestock losses through the Livestock Welfare Disposal Scheme (see box 5.1).

Box 5.1 Livestock Welfare Disposal Scheme

The Livestock Welfare Disposal Scheme (LWDS) commenced in March 2001 during the UK outbreak. It was operated by the Department of Environment, Food and Rural Affairs. It was a scheme of last resort for farmers whose animals were affected by FMD-related movement restrictions and were suffering welfare problems with no alternatives to alleviating the problems.

Eligible farmers transferred ownership of animals to the Rural Payments Agency (RPA) for killing on the grounds of animal welfare. The RPA bore all costs, from the collection of the animals from farmer through to disposal.

Total payments under the scheme totalled £210 million and were designed to fund relief of genuine animal welfare problems. The LWDS was not intended to provide compensation, nor was it designed to act as an alternative market.

Number of animals slaughtered as at June 2000

Animal	*Numbers slaughtered for disease control*	*Numbers slaughtered for welfare reasons*	*Total slaughtered*
Cattle	594 000	169 000	763 000
Sheep	3 334 000	2 112 000	5 446 000
Pigs	145 000	287 000	432 000
Other	4 000	5 000	9 000
Total	**4 077 000**	**2 573 000**	**6 650 000**

Sources: DEFRA and DCMS (2002).

In Australia, it is also likely that movement restrictions would result in some culling because of the difficulty of getting feed to stock in the control zone, or because moving animals would constitute an undue disease risk.

However, in contrast to the UK, given the likely loss of export volumes and the limited ability of the domestic market to absorb additional product, Australian producers outside restricted areas could also be forced to cull livestock. Producers could only hold stock for a limited period because of feed constraints. If, as is likely, producers could not sell all production (or the prices received were less than costs of transport to the saleyard), then they would have no option but to reduce herd numbers to sustainable levels.

Estimating the extent of any cull is very sensitive to assumptions relating to changes in domestic consumption, the ability to sell to alternative markets and the ability of producers to hold back stock from market. The degree of holdback will, in turn, be determined by the availability of feed, which is likely to vary both by region and by seasonal conditions. Seasonal conditions are particularly important in the short term. For instance, during a ‘good’ season, Queensland beef producers may be able to withhold a full year’s turn-off from sale, whereas during dry conditions, producers may only be able to hold back production for a couple of months.

Regardless of seasonal conditions, the ability to increase herd size is limited. It is very difficult to estimate the number of livestock that would be culled during a long outbreak. Even under optimistic assumptions about the ability to holdback stock, it is likely to exceed significantly the number eradicated for disease control purposes.

5.2 Domestic consumer responses

Although FMD is not a human health problem, this may not initially be recognised by all domestic consumers. As a result, the volume of meat products consumed (with the exception of chicken meat) is initially likely to fall. Estimating the extent of the fall is difficult. The FMD outbreak in the UK does not provide a sound guide to changes in consumption, as UK consumers had previously reduced their consumption of meat considerably because of BSE or ‘Mad Cow’ disease.

In Australia, the Commission has modelled an initial decline in the Australian consumption of beef, lamb and pork in the order of 10 per cent.

There are strong reasons to believe, however, that the initial decrease in consumption is likely to be relatively short-lived:

- Australian consumers have not displayed such adverse consumption responses to animal disease outbreaks in the past. For example, consumers did not reduce consumption of beef as a result of the anthrax outbreak in Victoria in 1997, or the anthrax outbreak in Queensland in January 2002. Nor was there a significant reduction in chicken consumption during the Newcastle disease outbreaks in 1999.
- The closure of export markets would lead to large falls in the price of meat — up to 50 per cent at the wholesale level and around 30 to 40 per cent or so at the retail level. Such price falls would induce a significant rise in consumption.

The magnitude of the consumption increase would depend on the responsiveness of meat demand to changes in its price. As outlined in box 5.2, a 1 per cent change in the price of most meat products is likely to lead to approximately a 1 per cent change in consumption of that product. While these relationships are usually measured over relatively small price and quantity changes, it is likely that a similar price and quantity relationship will hold for a much larger reduction in price. For example, in the mid 1970s, Australia lost access to the Japanese beef market (for political, rather than animal disease reasons) and domestic prices fell by around 40 per cent (see figure 5.1). This led to a large increase in the quantity of beef consumed, also in the order of 40 per cent.

Box 5.2 **Responsiveness of consumer demand for meat to changes in price**

There has been considerable work undertaken to measure how Australian consumers respond to changes in meat prices. The results are usually reported as elasticities of demand:

- ‘Own-price’ elasticities of demand indicate the extent to which buyers vary their purchases as the price of a product rises and falls.
- ‘Cross-price’ elasticities describe how a change in the price of one product, say beef, affects the quantity demanded of another substitute product, say chicken.

While there is a large range in the estimates of own price elasticities of demand for beef, typical values tend to be around -1, or a little greater. This means that a 1 per cent increase in the price of beef will lead to a 1 per cent (or slightly greater) fall in consumption of beef, and vice versa.

Lamb consumption appears to be somewhat more sensitive to changes in its price, with an estimated own-price elasticity of around -1.3 to -1.5.

There has been a long-term increase in chicken consumption which may partly be attributable to dietary changes, but also to a long-term decline in the price of chicken. The own-price elasticity of chicken tends to be lower than that of other meats, around -0.3 to -0.6.

The empirical studies also indicate the extent to which meats can substitute with each other. Beef is shown to be a strong substitute for lamb, with a cross-price elasticity of around 0.5 — implying a 1 per cent change in the price of beef may lead to a 0.5 per cent change in the quantity of lamb consumed. Similarly, pork and chicken can substitute for lamb and beef, although the relationships are weaker (cross-price elasticities are typically less than 0.25).

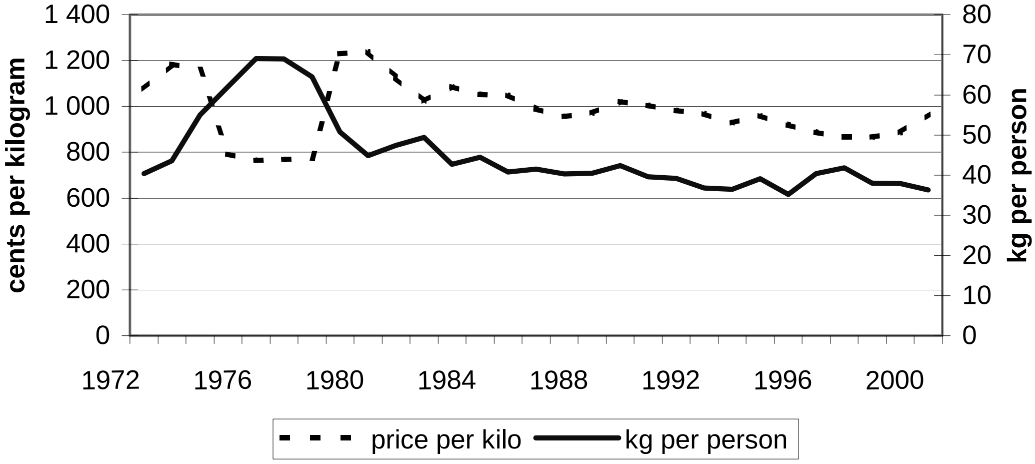
Source: Griffith et al. (2001a).

It is likely that there would be a similar response to such a fall in prices today. There has been a small decrease in beef consumption and a significant trend towards chicken consumption since the 1970s. This has been accompanied by a significant fall, of around 50 per cent, in the price of chicken (see figure 5.2).

Overall consumption of meat is not as price responsive as individual meats. For instance, during the period of low beef prices in the 1970s, total meat consumption increased from around 100 kg per person to just over 110 kg. This more modest increase overall reflects that the much larger increase in beef consumption was associated with falls in lamb and mutton consumption.

Figure 5.1 **Beef price and consumption, 1972 to 2001**

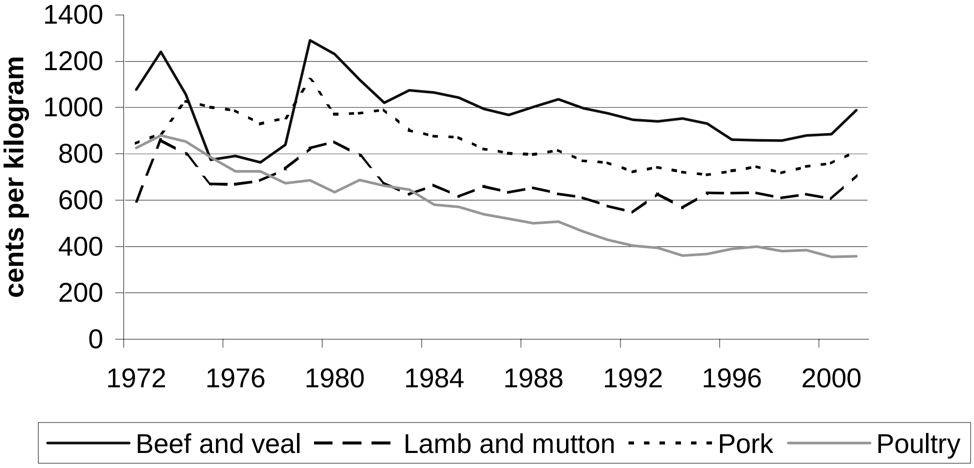
Real prices, 2001



Sources: ABARE (2001) and ABS (2002a).

Figure 5.2 **Meat prices, 1972 to 2001**

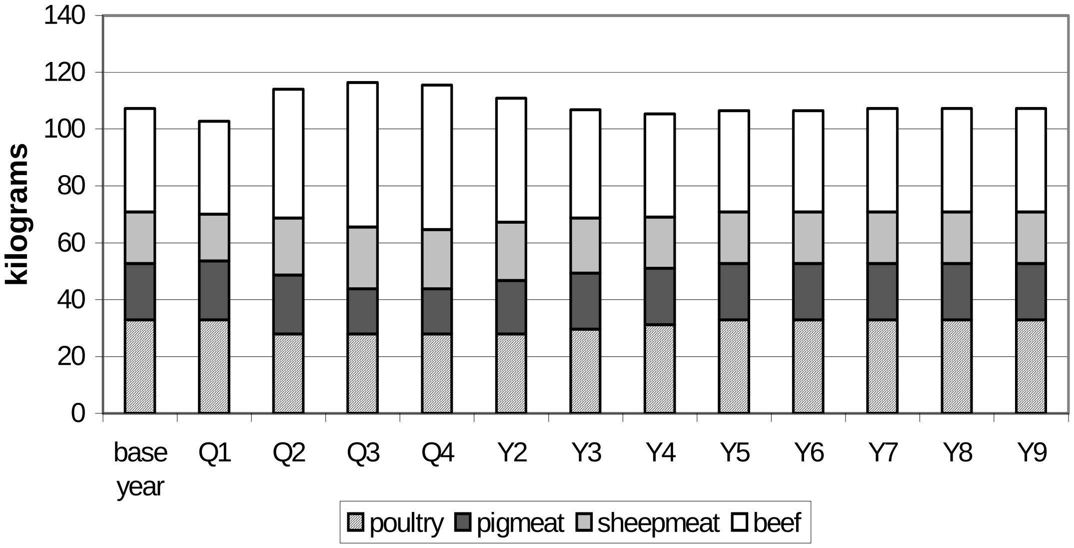
Real prices, 2001



Source: ABS (2002a).

The Commission considers that, if the price of red meats fell significantly, there would be a significant switch in consumption towards red meats, with total domestic meat consumption rising by around 10 per cent to just under 120 kg per person. The Commission's projected impact on consumption arising from the 12 month outbreak is shown in figure 5.3. A rise in beef and sheep consumption is estimated to be partially offset by a decrease in chicken and pig meat consumption in the third and fourth quarters of the outbreak. The large fall in pig meat consumption is mainly attributable to a decrease in supply. Given that pork production is an intensive industry with high variable costs, particularly feed costs, low prices could render some pig production uneconomic.

Figure 5.3 **Projected change in meat consumption resulting from the 12 month FMD outbreak scenario**



Source: PC estimates.

5.3 Impacts on other industries

The economic effects of FMD do not stop at the farmgate. Measures to control and eradicate the disease and the closure of export markets would have significant effects on other industries.

Effects on industries that rely on livestock

Industries upstream and downstream of livestock production, as well as the rural retail sector more broadly, would face significant costs if there were an FMD outbreak.

Upstream industries

Upstream industries that provide inputs to livestock production include feedstock suppliers and transporters, machinery suppliers and a range of other agricultural services.

In the first instance, holding back stock on properties would lead to increased hand feeding. However, this would only be a short-term response, and the demand for feed would fall in all but the shortest of outbreaks as production levels decreased. Indeed, many feedlots servicing the export market would face immediate closure, which would significantly reduce domestic demand for feed grains. Likewise, falls in production would lead to a fall in the demand for other agricultural inputs such as farm machinery and fertilisers, as well as transport providers and other service providers, although some farmers could switch to producing other commodities.

Downstream industries

A range of downstream industries beyond the farmgate would also be significantly affected. These include transporters, saleyards, meat processors, and stock and station agents, whose activities would be disrupted from movement restrictions and from export bans. For example, many export abattoirs would be likely to close through lack of demand (although higher domestic demand could provide some offset during longer outbreak scenarios). The closure of abattoirs can have severe regional impacts.

Rural retail sector

An FMD outbreak would present a mixed picture for the retail sector.

An initial decrease in demand for meat could see volumes and margins of butchers squeezed considerably. Retail meat sales by supermarkets would also be affected, although reduced spending on meat could partially be offset by greater spending on other food items commonly stocked in supermarkets. However, during longer outbreaks, the expected recovery and increase in domestic demand could see an increase in butchers' and other meat retailers' sale volumes.

More broadly, the rural retail sector would suffer from decreased farm income and low regional activity. For example, a reduction in farm income would flow through to many businesses in country towns and rural centres, such as suppliers of building products, consumer electrical goods and local restaurants. In turn, reduced commercial activity would further compound the financial impact on rural communities. In the UK, for example, a survey of rural small businesses in the North East of England found that 28 per cent of firms suffered a loss of more than 10 per cent of turnover during the UK FMD outbreak. Those sectors worst affected included hospitality, recreation and culture, agricultural based businesses and transport, in each of which a majority of firms were suffering. One in six of the affected firms reduced their employment due to Foot and Mouth (Bennett et al. 2001).

The Commission has estimated these ‘flow-on’ impacts of an FMD outbreak in two ways. First, it has used a general equilibrium (GE) model of the Australian economy to examine the links between the farm sector and other industries. The results of this analysis are presented in chapter 6. Second, in chapter 7, it has examined these effects at a regional level. This involves using the GE model not only to estimate the impact on regional employment but also to explore in more detail the economic links between farming and rural communities.

Tourism

It has been estimated that, in the UK, the largest impact from the 2001 FMD outbreak was not on the agricultural sector but on tourism. Movement restrictions associated with control of the disease led to the closure of many walking paths through farming areas which are a key attraction for UK rural tourism. The Cumbrian area and Lake District were particularly affected (DEFRA 2001). In addition, a broader perception that most of the countryside was closed during the outbreak is said to have deterred international visitors who had been planning to spend part of their time in London (and other cities) and part of their time in rural areas. The total direct cost to the tourism industry is estimated to have been between £2.7 and £3.2 billion ($A7.2–$A8.6 billion) (DEFRA and DCMS 2002).

Movement restrictions to control the disease could have some impact on tourism in Australia, but the effect is likely to be significantly less than in the UK.

First, in Australia, tourist activities and agriculture are not integrated to the same extent. There is little reason to expect that major international tourist destinations such as capital cities, the Gold Coast, the Barrier Reef or Uluru would be affected by an FMD outbreak (although some rural tourism, such as wine growing areas in the Barossa Valley in South Australia and the Hunter Valley in New South Wales, may be affected). Nor is it likely that major inland national parks would need to be closed to prevent the spread of the virus.

Second, lessons from the UK outbreak should enable Australia to handle an FMD outbreak in a way which minimises the collateral damage to tourism and other industries. Indeed, a significant amount of damage to the UK tourism industry appears to have been unnecessary. As noted by the Report of the Rural Taskforce (DEFRA 2001):

> The loss of domestic visitors to the countryside … arose in the first place mainly because of the almost complete closure of footpaths, suspension of sports such as fishing, cancellation of rural events and closure of many country houses and other visitor attractions. It went on much longer than necessary owing to the slowness of some local authorities to reopen footpaths and delay in reopening some visitor

> attractions, and because the perception that the countryside was closed continued long after it had ceased to be the reality. (p. 23)

To prevent such costs to tourism in the future, the Rural Taskforce recommended greater use of veterinary risk assessment to determine whether closures are necessary and proposed that such assessment should ‘take into account the impact on walkers and the businesses that cater for them besides the requirements of disease control’ (p. 39).

Thus, Australia’s lower integration of tourism and agriculture, and the lessons from the UK outbreak, suggests that an FMD outbreak would impose significantly lower costs on the tourism industry in Australia compared to the UK.

The UK Government has estimated that international tourism receipts fell by 5.9 per cent over the period of the 2001 outbreak (DEFRA and DCMS 2002). Australia’s lower integration of tourism and agriculture, and the lessons learned from the UK outbreak, suggest that an FMD outbreak would impose significantly lower costs on the tourism industry in Australia compared to the UK. Nonetheless, it seems inevitable that prospective international visitors’ limited knowledge of the effects of FMD would have some adverse impact on international tourist numbers. Reflecting a lower impact in Australia, the estimates of the cost of the major outbreak as presented in chapter 6, include a loss to the tourism industry of 2 per cent of receipts (equivalent to around $300 million).

In relation to domestic tourism, areas in and around the infection would suffer substantially. The affected areas and the magnitude of the effects would be highly dependent on the location of the outbreak. For this reason, the Commission has not attempted to estimate the impact on domestic tourism from the outbreak scenarios used in this study which, in geographic terms, are three of an almost infinite number of possibilities. Moreover, while particular areas could suffer, there would be a diversion of these tourists to other areas, or a diversion of this expenditure to other goods and services within the economy. Therefore, in aggregate the net economic impact of an outbreak’s effect on domestic tourism is likely to be low.

6 Quantifying the economic impacts

Chapters 4 and 5 described the trade responses and consequential effects of an outbreak of FMD. This chapter outlines the methodology the Commission has used to quantify those effects for each requested FMD outbreak scenarios and presents the results. In view of the many assumptions involved, the Commission considers that the results should be interpreted as broad orders of magnitude rather than as precise calculations.

6.1 Direct impacts of an FMD outbreak

The direct economic impacts of an FMD outbreak would primarily consist of the cost to governments and industry of control and eradication of the disease (which were estimated in chapter 3), and a loss of revenue to affected livestock commodities from a fall in export and domestic sales. There would, however, be a range of effects throughout the economy and community.

The Commission has used a trade and production cash-flow model developed for this study (see box 6.1) to estimate, for each of the outbreak scenarios, loss of revenue from Australia's export and domestic markets. It has also used the model to estimate, for each scenario, the loss of revenue for individual livestock products and for each State and the Northern Territory. Key results from the model are discussed below. Details are given in appendix C.

Loss of export revenue from the FMD outbreak scenarios

As shown in figure 6.1, an FMD outbreak, of any length, would have a dramatic impact on the export revenue from affected livestock commodities. The Commission estimates that in the year the outbreak occurs, the value of exports would be reduced by around $3 000 million for the single point outbreak up to $4 700 million under the 12 month scenario. This represents a loss of revenue to all activities involved in the production of the commodities for export, including those of farmers, saleyard operators, stock and station agents, transporters and meat processors.

Box 6.1 **Trade and production model**

The Commission’s trade and production model is a cashflow model designed to estimate the changes in production and revenue over a 10 year period that would result from an FMD outbreak in Australia.

The model uses data from the 1999–2000 financial year — the latest year for which complete data were available when the study was initiated. While exports and revenue for the majority of commodities of relevance to this study increased significantly in 2000-2001, data for 1999–2000 are very close to the average of the last three years. Reflecting the volatility of livestock revenue (for example, beef exports to Japan have fallen significantly in 2002) the Commission considers that it is appropriate to use data which is representative of the recent past.

The model consists of two interlinked components:

Production — ABS livestock production and herd size data are used to project a 10 year baseline for the model for each livestock product — cattle, sheep, lambs, pigs and milk. A zero growth rate has been used for all industries owing to the uncertainty of future growth rates and the sensitivity of the model to the growth variables.

Changes in production caused by an FMD outbreak are then estimated relative to the baseline. These changes are dependent on several key variables including:

- eradication data, compiled from the results of the epidemiological model for each outbreak scenario, which identifies how many animals must be slaughtered to control the disease; and
- producers’ response to large falls in prices resulting from an FMD outbreak — that is, the extent to which producers decide to hold back or dump livestock.

Seasonality is not incorporated in the model. The annual output for each livestock category is assumed to be constant throughout the year. Seasonality is impractical to model for each livestock category and, furthermore, has been found to have very little effect on the total losses attributable to the disease (ABARE 2002b).

Demand — ABS export and consumption data for each State for 1999-2000 was used to project a 10 year baseline for demand (quantity and price) for each affected commodity. Like the production component of the model, the baseline growth rate for price and quantity demanded for each livestock product is set at zero.

In the model, the overall effect on demand depends on changes to domestic and export demand. Export demand variables are estimated for the percentage change of quantities exported and the price of those products after an outbreak. Likewise, proportional changes to price and quantity of domestic consumption resulting from an outbreak have also been estimated. These assumptions have been formed after broad consultation with industry (see chapter 4).

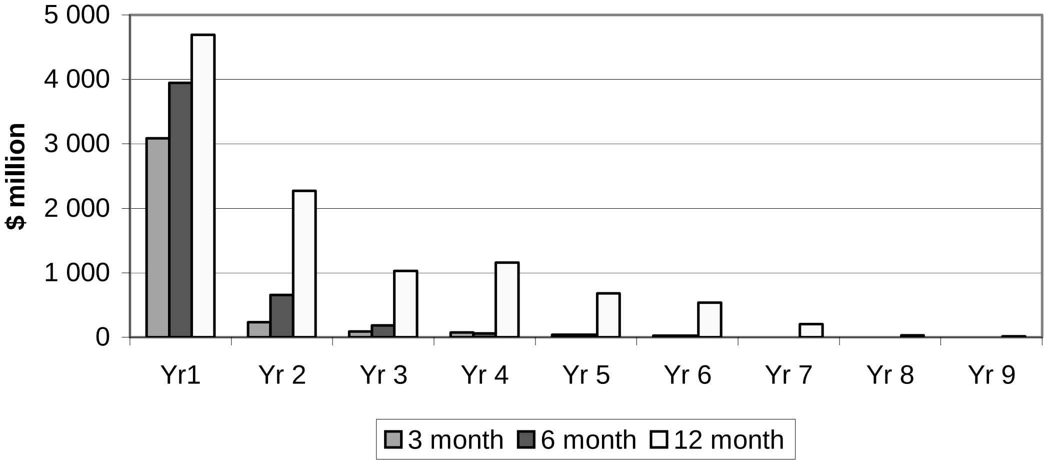
Based on these assumptions the model calculates changes in the value of exports and domestic consumption relative to the baseline. The model is manually manipulated to ensure that any production constraint is reflected in the export losses.

While the longer outbreak would involve the highest costs in the first year, a key difference between the outbreaks is the length of time it would take to recover to pre-FMD export levels. For the small and medium outbreaks, the majority of the total losses occur in the first year — 87 per cent for the small outbreak and 80 per cent for the medium outbreak. By contrast, the first year loss for the large outbreak is only 45 per cent of the total revenue loss from exports. The Commission estimates that, in this scenario, exports would not recover to baseline levels for up to seven years.

The long recovery time for the 12 month scenario occurs for three reasons. The longer the outbreak:

- the longer many export markets remain closed;
- the longer the period necessary for overseas demand for Australian products to return to previous levels once Australia had been readmitted to markets; and
- in the case of beef, the longer it would take for herd numbers and production to recover to pre-FMD levels.

Figure 6.1 **Annual loss in export revenue to the livestock industries by outbreak scenario**

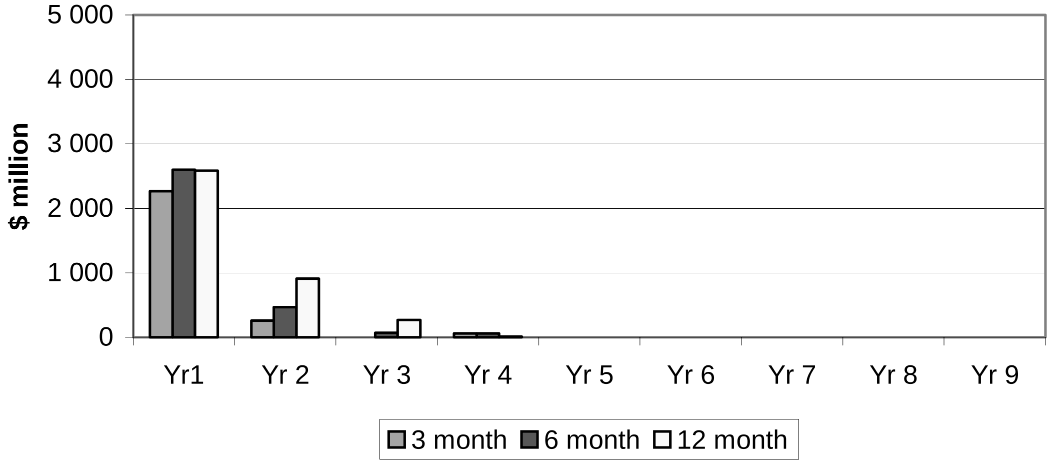


Source: PC estimates.

Decrease in livestock revenue from the domestic market

As discussed in chapter 5, the loss of export markets would also cause a large increase in meat supplies on the domestic market and a large fall in domestic prices. Even though domestic consumption would increase, industry revenue realised from the domestic market would decline in most periods. The annual decrease in revenue on the domestic market for each scenario is shown in figure 6.2. The figure shows that, although the decrease in revenue from this source is less than export losses, it is still significant — $2 000 million to $2 700 million in the first year depending on the outbreak scenario.

Figure 6.2 **Annual loss in domestic revenue to the livestock industries by outbreak scenario**



Source: PC estimates.

It should be noted that the economic effect of a reduction in livestock industry revenue on the domestic market is different to a reduction in export revenue. Loss of export revenue represents a direct loss of national income. However, the losses the industry suffers on the domestic market are primarily a transfer to meat consumers from the greater availability of lower priced meats. This would lead to an increase in the consumption of other goods and services in the economy and/or to increased savings.

Total direct economic impact of the outbreak scenarios

Table 6.1 summarises the total loss in revenue to the livestock industry in net present value terms (expressing annual losses over time as a single figure and obtained using a discount rate of 5 per cent). For comparative purposes, it also contains the compensation and control cost estimates calculated in chapter 3.

Table 6.1 **Direct losses from the FMD outbreak scenarios**

	Livestock industry revenue loss [a]			*Compensation and control costs*	
Outbreak	*Exports*	*Domestic*	*Total*	*Compensation*	*Control*
	$m	$m	$m	$m	$m
3 month	3 333	2 373	5 706	4	20 – 25
6 month	4 611	2 994	7 605	19	130 – 150
12 month	9 480	3 332	12 812	41	360 – 420

[a] Net present value of losses at the wholesale level over the outbreak.

Source: PC estimates.

The total cost to livestock industry revenue ranges from over $5 500 million for the small outbreak to nearly $13 000 million for an outbreak lasting 12 months.

As the length of the outbreak increases, export losses increase as a proportion of total revenue losses. For instance in the 3 month scenario lost export revenue is around 60 per cent of the total loss, whereas for the 12 month scenario this proportion rises to nearly 75 per cent. This would occur because:

- the volume of domestic sales would increase significantly during a longer outbreak, while export sales would remain depressed for key affected livestock products; and
- even after demand has recovered on export markets, reduced production capacity in Australia (of beef in particular) might not be able to fill that demand. This would lead to export levels being below the pre-FMD baseline for a number of years.

Table 6.1 also shows that the compensation and control costs for each of the scenarios are smaller than the trade costs but significant in absolute terms. These losses represent direct costs to government budgets and additional costs to the livestock industry. As noted in chapter 3, for a long outbreak these costs are likely to significantly exceed the ceiling of approximately $112 million for shared funding by Governments and industry set out in the Emergency Animal Disease Response Agreement.

The relatively modest compensation and control costs, as a proportion of total costs, are in contrast to the outbreak in the UK where control and compensation costs were more significant. It reflects Australia’s greater reliance than the UK on livestock-related exports.

While the decreases in revenue on the export and domestic markets are indicative of the impact FMD would have on the livestock industries, it should be noted that revenue losses are not the net economic impacts arising from an outbreak. In addition to the benefits to consumers from lower prices for meat identified above, losses in revenue to the livestock industry do not capture:

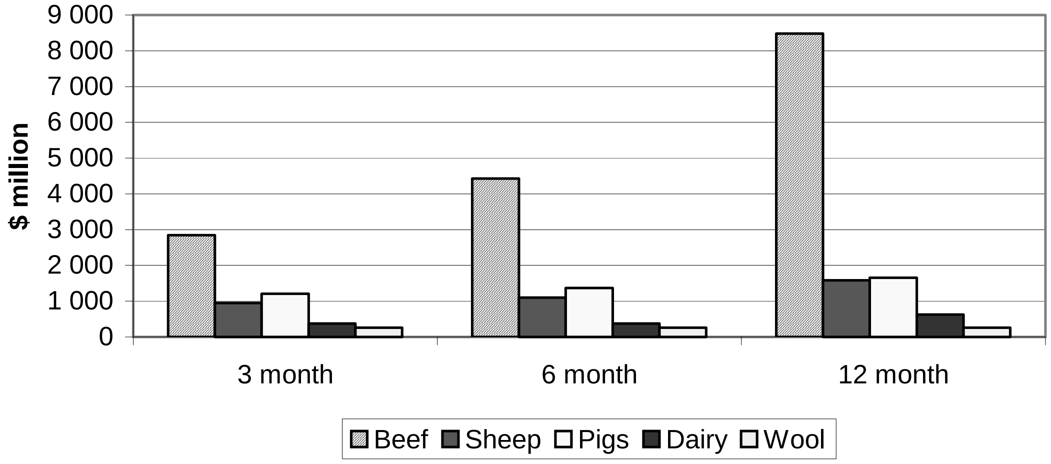
- any cost savings to the industry when production is reduced; or
- additional revenue that could be generated by switching from meat production to other unaffected farm activities such as cropping.

These effects will offset, to a minor extent, the impact of the revenue losses. They are taken into account in the general equilibrium modelling presented in the next section. In addition, appendix E uses a partial equilibrium framework to explore net changes in economic welfare arising from the outbreaks. For example, it estimates that the 12 month outbreak would reduce producer surplus by around $7.5 billion. Transfers to consumers would be about $5 billion, resulting in a net economic impact of around $2.5 billion.

Direct revenue losses by product

An FMD outbreak will not affect all livestock products equally. The beef industry accounts for the largest direct revenue loss in each scenario — $2 700 million in the 3 month scenario rising to over $8 000 million for the 12 month scenario (figure 6.3). This is because a high proportion of beef production is exported, and importers of Australian beef are overwhelmingly FMD-free.

Figure 6.3 **Wholesale revenue losses to the livestock industry by product**
Net present value of revenue losses at the wholesale level



Source: PC estimates.

As shown in figure 6.3, the absolute losses from beef relative to other products increase with the length of the outbreak. For instance, in the short outbreak, beef accounts for 50 per cent of the total revenue loss whereas, in the 12 month outbreak, it accounts for over 65 per cent of the decrease in revenue. This occurs because the longer beef markets are closed:

- the more difficult it is to regain market share in some of those markets; and
- the greater the switch in livestock production away from beef and consequent fall in herd sizes. This results in supply constraints for some years after demand returns to normal.

Lower losses are estimated for the sheep industry — $960 million for the 3 month outbreak rising to $1 600 million for the 12 month outbreak. This partly reflects the smaller size of the industry relative to beef, but also reflects:

- a greater orientation of sheep meat production for the domestic market than beef production — approximately 60 per cent of sheep meat production is consumed domestically, compared to around 40 per cent of beef production; and
- the assumption that the sheep products would be able to access export markets (particularly FMD-endemic markets) sooner than beef products.

Relative to the size of the industry (production around $1 000 million annually) the impact on the pork industry is relatively severe. As discussed in chapter 5, this would occur because:

- losses in exports would continue for a considerable period; and
- the fall in the price of pigmeat on the domestic market would lead to a significant contraction in the levels of production.

As discussed in chapter 4, the effect on the dairy industry under each scenario is estimated to be confined to the year the outbreak occurs. This reduces the total impact of the outbreaks on that industry. Similarly, the volume of wool exports is likely to be disrupted during the first quarter of each outbreak, but would increase in the following quarters to clear accumulated stock. However, it is likely there would be a loss in revenue ($279 million is projected for each scenario) from lower prices associated with the disruption.

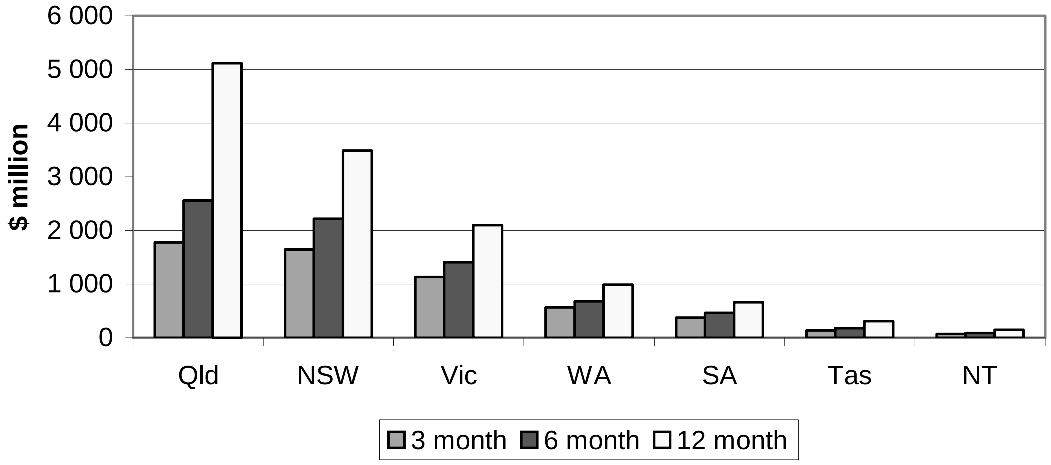
Grains exports are likely to be disrupted during the first quarter of each outbreak, but the Commission does not consider there would be an ongoing impact on grain exports arising from an FMD outbreak.

Direct revenue losses by States

Just as FMD would be uneven in its impact upon different livestock products, it would also have uneven State impacts. The industry revenue losses by State are illustrated in figure 6.4.

Figure 6.4 **Loss in revenue by State**

Net present value of revenue losses at the wholesale level



Source: PC estimates.

The significant impact on the beef industry is reflected in the breakdown of losses by State. As Australia's major beef producer and exporter, Queensland is more affected than other states in absolute terms. Again, reflecting the impact on beef, the magnitude of the effect on Queensland relative to other jurisdictions increases as the length of the outbreak increases.

The impact on New South Wales reflects a combination of losses in the beef, sheep and pork industry. This is also the case in Victoria, where dairy losses are overwhelmingly concentrated. While the losses in Western Australia, South Australia, Tasmania, and the Northern Territory appear smaller, relative to the level of production in those States they are, nevertheless, significant.[1] As discussed later in the chapter, establishing FMD-free trade zones could have a significant effect on the results for each State.

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[1] The absolute effect on the Northern Territory may be understated in figure 6.4. Cattle bred in the Northern Territory are often 'finished', slaughtered in, and exported from, Queensland, which means that production (as measured by animals slaughtered) and exports, understates the importance of the beef industry in the Northern Territory.

6.2 Indirect and economywide impacts

To estimate the indirect or flow-on effects of the FMD outbreak scenarios for Australia, the Commission has used the MONASH Multi-Regional Forecasting (MMRF) model — a computable general equilibrium model of the Australian economy (see box 6.2). The MMRF estimates the indicative impacts on the Australian economy of direct changes in production and demand (derived from the Commission's trade and production model) that would result from an outbreak, as well as employment effects. However, it is important to note that even sophisticated modelling techniques cannot capture all the subtle market changes that would result from an FMD outbreak in Australia.

National effect

The MMRF results confirm that the outbreak scenarios would have a significant effect on the Australian economy. For the 12 month outbreak, Australian real Gross Domestic Product (GDP) would, in the first year, decline by around $2 000 million — and the total cost of the outbreak is estimated to be between $8 000 million and $13 000 million over 10 years.[2] This is equivalent to a 1–2 per cent reduction in GDP for one year. The contraction in the economy would be most severe in the first six years following eradication of the outbreak, with the economy recovering to pre-outbreak levels eight years after the outbreak is eradicated. The results for the 6 month outbreak are about half that of the 12 month outbreak (see table 6.2).

Table 6.2 **Impact of the outbreak scenarios on Gross Domestic Product**

Outbreak scenario	*Loss in the first year*	*Total loss* [a]
	$m	$m
3 month	900	2 000 – 3 000
6 month	1 400	3 000 – 5 000
12 month	2 000	8 000 – 13 000

[a] Net present value of losses at the wholesale level over the outbreak.

Source: PC estimates.

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[2] The range for the estimated impact of the outbreak on Australia's GDP reflects alternative assumptions about the extent to which producers and investors in the economy respond to a lower Australian dollar (arising from a loss of livestock exports) by increasing exports or investment.

Box 6.2 **The Monash Multiregional Forecasting (MMRF) model**

For this study the Centre for Policy Studies at Monash University has configured the MMRF model database to classify the economy into 40 industries and 40 commodities, of which 7 industries and commodities fall within the agricultural sector. The agricultural industries, that are loosely based on geographic and climatic zones, allow the level and pattern of agricultural production to vary between zones, with farmers in most zones being able to produce multiple commodities (eg farmers in the wheat-sheep zone can produce wool, sheep, cereals, meat cattle, dairy cattle and pigs, and other agriculture). The database aggregation used also separately identifies the main agricultural-related processing and manufacturing industries (eg meat and meat products, agricultural machinery) as well as key input supplying industries (eg road and rail transport).

It is likely that an outbreak of FMD will only be temporary in nature. In keeping with this, and given that the model is used to estimate annual changes in behaviour, the standard MMRF modelling environment supplied by the Centre for Policy Studies was amended to make it more short run in nature. The environment used to estimate the possible effects of an outbreak of FMD assumes that:

- real wages remain fixed with employment allowed to vary;
- investors in industries directly affected by FMD are likely, given the magnitude of the direct effects, to be cash constrained after an outbreak of FMD, such that their investment decisions are likely to driven by rates of return;
- investors in industries not directly affected by FMD perceive that the outbreak will be a temporary phenomenon and, therefore, do not alter their investment decisions in response to short-term fluctuations in rates of return; and
- exports from non-affected industries are less sensitive to changes in their foreign currency price than in standard MMRF (the elasticity of demand was reduced from -20 to -4 for almost all non-affected commodities); consumers respond to temporary changes in income by maintaining the share of each dollar spent on consumption fixed (as opposed to the proportion of each dollar saved), so that aggregate consumption varies in line with changes in national income (ie the average propensity to consume is held fixed); and government debt levels are allowed to vary to maintain real government spending (as a result of the absence of debt accumulation).

As the MMRF does not accurately model debt accumulation, changes in real GDP will not provide an accurate indication of changes in welfare. The simulations were run in dynamic mode and cover a period of 10 years.

Source: Adams et al. 2000.

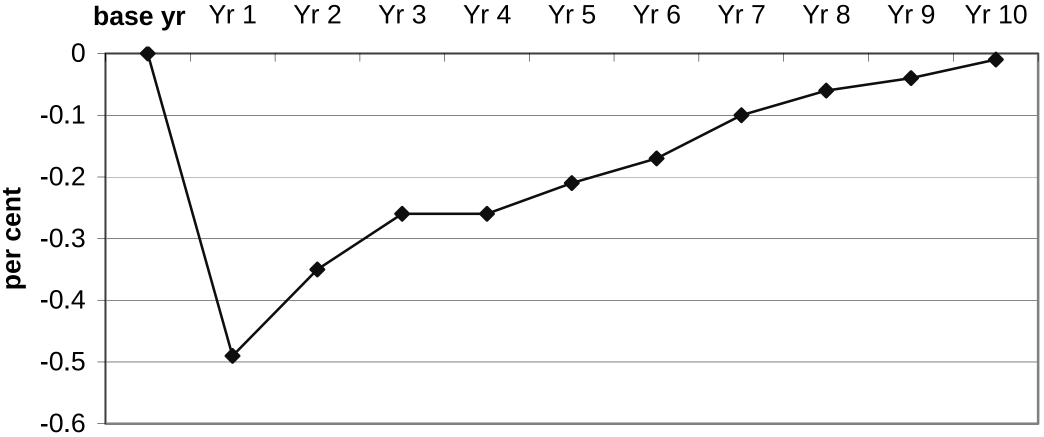
Industry and employment effects

Reflecting the direct impacts, the contraction in economic activity would be concentrated in the pastoral, livestock and meat processing industries. These industries are estimated to contract by between 20 to 40 per cent. Other industries, such as poultry and agricultural machinery, are also projected to contract, but by a smaller extent. More broadly, reduced consumption in the economy is reflected in small reductions in activity in the wholesale trade and retail trade sectors.

The decrease in activity is estimated to result in a contraction in employment in Australia of 0.5 per cent in the first year of the outbreak. Employment is not projected to return to baseline levels until nine years after the outbreak is contained (figure 6.5). Reflecting the declines in output, the most adversely affected industries are the agricultural, livestock and livestock processing industries.

Figure 6.5 **Change in employment in Australia relative to baseline**

Per cent decrease in employment



Source: PC estimates.

The fall in agricultural exports would be large enough to affect the exchange rate. The value of the Australian dollar is estimated to fall by 2.5 per cent in the first year of the 12 month outbreak and is projected to remain below pre-FMD levels for nine years. The depreciation could be expected, even in the relatively short term, to stimulate exports from some other industries. Exports from the mining industry are estimated to rise by 2 per cent and exports of some manufacturing industries are also projected to increase.

The Commission had modelled an adverse shock to international tourism, drawing on the experience of the recent FMD outbreak in the UK. However, the modelling results show a small rise in tourism with the beneficial effects of the depreciation of the dollar outweighing the adverse effects on international tourism. While this result is sensitive to the modelling assumptions used, it illustrates that the effect on international tourism is likely to be less than in the UK.

State effects

At the State level, the largest relative decline in economic activity is in Queensland reflecting the importance of its livestock industry. Although some jurisdictions are projected to experience a rise in activity in the first year after an outbreak, activity in all jurisdictions is projected to decline over the total duration of the impact (table 6.3).

Some of the largest effects would be observed at the regional level. The MMRF regional modelling results are discussed in the next chapter.

Table 6.3 **Impact of 12 month outbreak on economic activity of States**

State	*Impact in the first year*	*Total impact*[a]	*Total impact relative to Gross State Product*
	$m	$m	%
New South Wales	-351	-1 819	-0.8
Victoria	205	-566	-0.3
Queensland	-1 342	-4 181	-3.8
South Australia	-190	-651	-1.5
Western Australia	19	-270	-0.4
Tasmania	-20	-103	-0.9
Northern Territory	-32	-163	-1.9

[a] Net present value of the cumulative impacts over the outbreak.

Source: PC estimates.

6.3 Estimating the impact of zoning

The Commission has modelled the direct impact of the 6 month and 12 month outbreaks under a zoning policy. As discussed in chapter 4, consistent with current policy, zones would be established at State boundaries. For the 6 month scenario, FMD is confined to Queensland and the Northern Territory with the rest of Australia zoned FMD-free. Under the 12 month scenario, the infected zone comprises New South Wales, Victoria and South Australia — the other jurisdictions are zoned FMD-free. In each case, the Commission has assumed that it would take three months from the time of detection to establish a zone recognised by

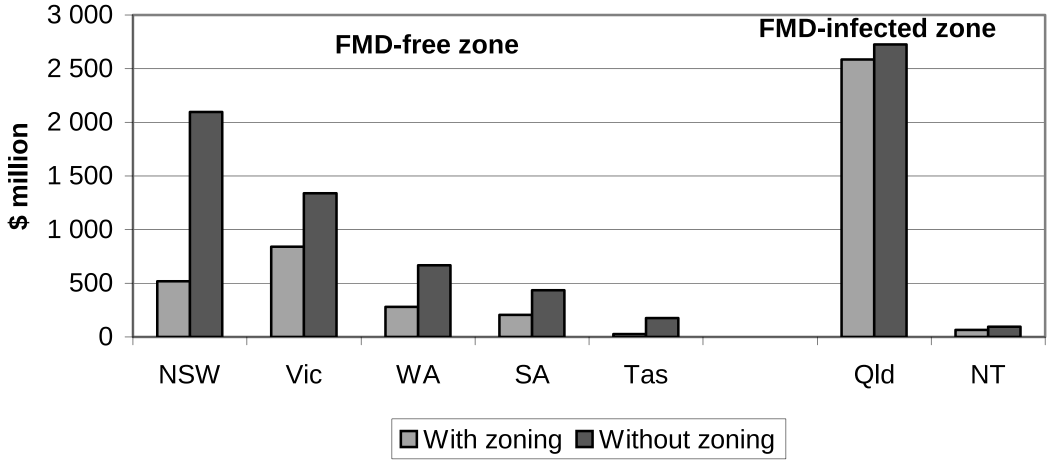
Australia's trading partners. It has also assumed that the specialist technical resources required to conduct the clinical surveillance necessary to establish an FMD-free zone would not reduce the resources available to the control effort, and hence would not have an adverse effect on the duration of the outbreak.

Effect of zoning on the direct impact of a 6 month outbreak

The Commission estimates that establishing an FMD-free zone during the 6 month scenario would reduce revenue losses to the livestock industry by over 40 per cent or $3 000 million. As shown in figure 6.6, the benefits of zoning would be concentrated in the FMD-free zone, which is able to return to international markets three months after the detection of FMD in Queensland. For example, in New South Wales revenue losses are estimated to fall from around $2 000 million to around $500 million. Such losses are incurred in the FMD-free zone primarily because of the time it would take to establish the zone. Once the zone is established, prices for some commodities (particularly beef) are assumed to increase owing to the absence of meat on the world market from Queensland and the Northern Territory. The Commission also estimates that there would be a small benefit to industry within the infected-zone arising from its ability to regain access to markets quickly because of the presence of Australian products from the FMD-free zone in those markets.

Figure 6.6 **Impact of zoning on the 6 month outbreak scenario**

Revenue losses to the livestock industry by State with and without zoning [a]



[a] Revenue losses expressed as a net present value of the losses over the outbreak.

Source: PC estimates.

Effect of zoning on the direct impact of a 12 month outbreak

For the 12 month scenario, the Commission estimates that establishing an FMD-free zone comprising Queensland, Western Australia, Northern Territory and Tasmania would reduce the total export and domestic revenue losses to the affected livestock industries by two thirds from $12 800 million down to $4 200 million.

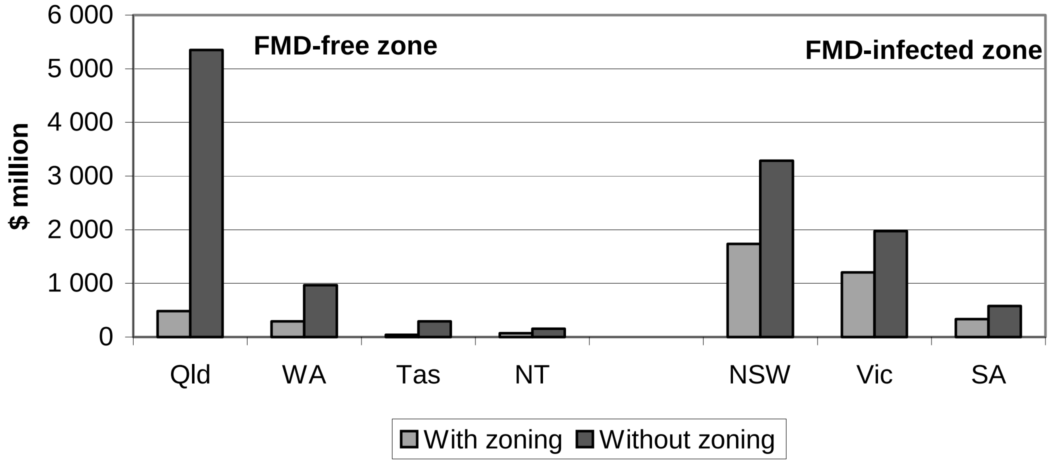
As shown in figure 6.7, in the FMD-free zone a substantial proportion of the revenue losses from a 12 month outbreak could be avoided if a zone was established after three months. In particular, beef exports from Queensland, live cattle exports from the Northern Territory and live sheep exports from Western Australia could continue.

The Commission also estimates that for this outbreak scenario, the infected zone would be better off under a zoning policy than without such a policy:

- the continuing presence of substantial Australian product from the FMD-free zone would make it easier for the infected zone to rebuild markets once it was free of the disease; and
- the absence of a glut of beef from Queensland in southern States would result in less of a domestic price fall in the infected zone and hence lower domestic revenue losses.

Figure 6.7 **Impact of zoning on the 12 month outbreak scenario**

Revenue losses to the livestock industry by State with and without zoning [a]



[a] Revenue losses expressed as a net present value of the losses over the outbreak.

Source: PC estimates.

6.4 Estimating the impact of vaccination

The terms of reference ask the Commission to estimate the impact of vaccination on the 6 month and 12 month scenarios.

Section 3.7 noted that, based on the epidemiological modelling, emergency ring vaccination would be likely to increase the average duration of the 6 month scenario and hence, is unlikely to be an appropriate control strategy for an outbreak in northern Australia. The Commission has, therefore, not further examined the impact of vaccination on the costs of the 6 month outbreak.

However, the epidemiological modelling found that as part of a control strategy, emergency ring vaccination could reduce significantly the length of the long outbreak — by around three to five months. Under the assumption that all vaccinated animals would be slaughtered, reducing the duration of the outbreak would reduce the time Australia would be out of international markets. In turn, this would reduce the trade costs of an outbreak.

Against this benefit, vaccination of animals requires resources. More importantly it would involve losses from the slaughter of otherwise healthy animals — vaccination would result in the slaughter of an additional 300 000 livestock — and increased disposal costs.

An estimate of the size of the benefits and costs of emergency ring vaccination for the 12 month outbreak is provided in table 6.4. As noted previously, revenue losses to the affected industries tend to overstate the economic loss to the economy from an outbreak. Nevertheless, the savings in revenue to the affected livestock industries are substantially larger than the additional costs from vaccination.

Table 6.4 **Impact of emergency ring vaccination on the direct costs of the 12 month outbreak**

Benefits and costs	*Value*
	$m
Benefit of reduced revenue losses from quicker return to markets	**1 000 – 2 500**
Cost of vaccination [a]	6
Cost of the value of additional livestock slaughtered [b]	30
Cost of additional disposal	94
Total costs	**130**

[a] Cost of vaccination estimated at $10 an animal. [b] Under the 12 month scenario, 450 000 animals are eradicated directly and 600 000 animals vaccinated. Assumes that all vaccinated animals are slaughtered and disposed of in the same way as infected and direct contact herds.

Source: PC estimates.

The Commission concludes that, whenever emergency ring vaccination would materially shorten the length of an outbreak, it would reduce total costs of that outbreak to the economy, and hence be a sensible policy option.

6.5 Sensitivity analysis

The Commission has conducted sensitivity analysis on key assumptions relating to the time Australia would be out of FMD-free markets and the level of adverse domestic consumer reaction to an FMD outbreak.

Time out of markets

As described in chapter 3, the epidemiological modelling shows considerable variability in the likely length of a major outbreak — with the possibility of the outbreak in some regions lasting longer than 12 months.

In addition, the Commission has predicated its modelling on regaining access to international markets after the period specified in the OIE guidelines (generally three months after eradication of the last infected animal). However, countries have some flexibility in applying the OIE guidelines. For the recent outbreaks in the UK, France and the Netherlands, there has generally been a relatively prompt recognition of FMD-free status by most countries. But there are also instances where some nations have taken longer than the OIE specified periods to open their markets to a country achieving disease-free status after an outbreak.

To take account of the possibility of a longer outbreak, or a delayed period until recognition of FMD-free status, the Commission has estimated the direct trade effects of Australia being out of FMD-free markets for two years. This represents a further nine months out of markets compared to the 12 month outbreak scenario (which would involve 15 months out of FMD-free markets when the three month period specified by the OIE to achieve diseases-free status is included).

As shown in table 6.5, the total loss in revenue to affected livestock industries is estimated to be over $14 800 million, compared to around $12 800 million for the 12 month outbreak. The distribution of the revenue losses among jurisdictions and affected commodities is not significantly different to the other outbreak scenarios.

Table 6.5 **Direct revenue losses from a 12 month outbreak and 2 years out of markets**

Net present value of revenue loss to the livestock industries

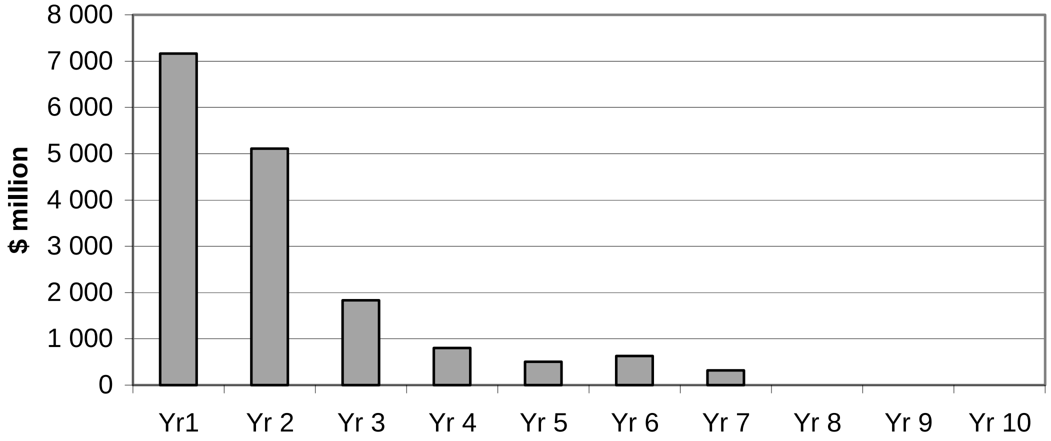
	12 month outbreak	*24 months out of markets*
	$m	$m
Loss in export revenue	9 480	10 398
Decrease in revenue from domestic sales	3 332	4 396
Total revenue loss	**12 812**	**14 794**

Source: PC estimates.

Figure 6.8 shows the estimated annual losses for the 2 year scenario. Although Australia does not trade with FMD-free counties for the whole second year, the losses in this period are lower than in the first year because of increasing trade with FMD-endemic countries (particularly in sheep meat and live cattle) and higher consumption on the domestic market.

Compared with the 12 month outbreak, a 2 year scenario results in higher revenue losses primarily in the second and third years. This reflects both the longer time out of markets and time taken to rebuild exports once access is obtained. The small increase in the loss in year six compared to year five reflects a supply constraint as producers rebuild herds to take advantage of a recovery in export prices.

Figure 6.8 **Annual revenue losses to the livestock industries from 2 years out of FMD-free markets**



Source: PC estimates.

Adverse consumer reaction

The Commission's estimates of the direct revenue impact of the outbreaks are based on:

- a projected 10 per cent decline in domestic consumption of beef and lamb in the first quarter of an outbreak; and
- followed by increases in total meat consumption in subsequent quarters of up to 10 per cent (comprising increases of up to 40 per cent in beef and lamb, offset partially by falls in poultry and pigmeat consumption).

The Commission has tested the sensitivity of the results to these assumptions by modelling both a more positive and more negative consumer reaction.

The initial 10 per cent fall in consumption is based on a consumer misperception that FMD poses a health risk. If no such perception eventuated, consumers would respond almost immediately to low prices by increasing consumption. Assuming consumption increased by 10 per cent in the first quarter, the modelling shows domestic revenue losses would be reduced by around 2 to 3 per cent and the total revenue losses by between 1 and 2 per cent. The overall results, therefore, are not particularly sensitive to this assumption.

To determine the impact of a more negative sentiment towards beef and lamb during an outbreak (a greater level of consumer misperception) the Commission has modelled the situation where, after the first quarter, consumption rises by only half the amount projected by the Commission. While the Commission considers that such a response would be unlikely, losses on the domestic market would rise by between 12 per cent and 20 per cent depending on the length of outbreak, which translates to around a 5 per cent total increase in revenue losses for each of the outbreaks.

7 Regional and farm impacts

The previous chapter examined the economic costs at the national and state level associated with the specified FMD scenarios. This chapter extends the analysis to the regional and farm level. More specifically, it considers:

- the regions and farm types which could be most affected by an FMD outbreak;
- the significance of the economic links between the livestock industry and the regional economy; and
- the capacity of regions and farmers to cope with the economic losses caused by an outbreak.

The scope for analysing the economic impact on regions, communities and farms is dependent on the availability, reliability and consistency of suitable data. To this end, the Commission has relied predominantly on the ABS's 1998 Integrated Regional Data Base[1] (IRDB98) (ABS 1998), ABARE's farm survey data (ABARE 2002a) and the regional results from the MONASH Multi-Regional Forecasting (MMRF) model .

7.1 Regions most affected

Most of the regional analysis in this chapter has been conducted at the Statistical Division (SD) level[2]. There were 66 SDs covering Australia in the 1996 Census. The SD level is the smallest regional level for which the MMRF model can compute results.

It is recognised, however, that because of their geographic size, SDs can contain smaller areas that are quite different. Accordingly, analysis at the SD level can mask smaller regional concentrations of livestock or related activity. Consequently, the

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[1] Most data relating to Statistical Divisions are only available from the Census of Population and Housing. IRDB98 includes data from the 1996 Census. The first release of data from the 2001 census is expected in June 2002.

[2] The ABS defines a statistical division as a relatively homogeneous region characterised by identifiable social and economic links between the inhabitants and between the economic units within the region, under the unifying influence of one or more major towns or cities (ABS 1995, p. 18).

Commission has supplemented the analysis at the SD level with some analysis at the Statistical Local Area (SLA) level.

The nature of regional economic impacts

The total economic impact on a region of an FMD outbreak will consist of the direct loss of farm income from the regional economic base and any indirect effects on regional activities, such as:

- changes in demand for local goods and services by livestock farmers and families in response to reduced farm receipts — for example, lower demand for farm inputs such as stock feed, equipment and transport, and demand for household items supplied by local businesses;
- changes in the volume of livestock supplied to downstream processing activities; and
- 'additional' impacts on economic activities within and around infected zones, including:
    - higher short-term demand for accommodation and food by emergency services personnel; and
    - reduced productivity from increased travel and transaction times because of roadblocks and searches.

The combined direct and indirect impacts on a region will depend on the particular structure of economic activity of that region. Regions which suffer the largest direct economic impacts may not necessarily suffer the largest total effects and vice-versa.

The total effect on SD regions has been estimated using general equilibrium modelling through a 'tops down' approach. This involved disaggregating the national, State and Territory results (chapter 6) down to the SD region level.[3] To illustrate the contribution of indirect effects, the Commission has examined the

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[3] An alternate approach would be a 'bottoms-up' method. This would involve estimating the direct loss in farm income for each region and then using these 'shocks' in a general equilibrium model or applying exogenous multipliers. The Commission has not adopted this approach for a number of reasons. First, it does not have reliable estimates of the aggregate loss in regional farm incomes. The Commission's cash flow model does not analyse changes in farm gate returns at the SD level, nor is it possible to aggregate up to the SD regional level using the results in section 7.3 for the average farm as this analysis is based on data for ABARE survey regions. These data differ in geographic coverage to SD regions. Second, the MMRF model cannot adequately capture the important economy-wide and macroeconomic shocks of an FMD outbreak and, at the same time, accommodate exogenous shocks to SD regional outputs. Finally, the use of exogenous or independent multipliers, while possibly useful in a partial equilibrium context, would be inappropriate for a shock of the size and scope of an FMD outbreak.

direct dependence of regions on livestock and subsequently, compared these results with the estimated total (direct and indirect) impact on regions derived from the MMRF model.

Direct dependence on livestock activity

A region's dependence on livestock production is a useful indicator of how it would be directly affected by an outbreak. The Commission has measured dependence as the proportion of local employment accounted for directly by livestock activities for each statistical division (box 7.1). The Commission's estimates are presented in appendix D, table D.1.

Box 7.1 **Estimating regional livestock employment**

In the absence of complete data on employment in livestock activities for all statistical divisions, the Commission used the following estimation:

TRLE = (GVRL/GVAR) x ARE, where

TRLE = total regional livestock employment

ARE = regional employment in agriculture

GVRL = gross value of regional livestock

GVRA = gross value of regional agriculture

The percentage of total regional employment accounted for by livestock employment (SLTRE) is estimated as (TRLE/TRE) x 100, where TRE = total regional employment.

The main focus of the estimates is not on their precise value, but rather the relative regional ranking. An implicit assumption is that the share of livestock employment in agriculture in each region is the same as the share of livestock output in the region's agriculture output. In practice, labour intensity will, of course, vary between agricultural activities within a region. However, such variation is unlikely to materially affect the general pattern of dependence.

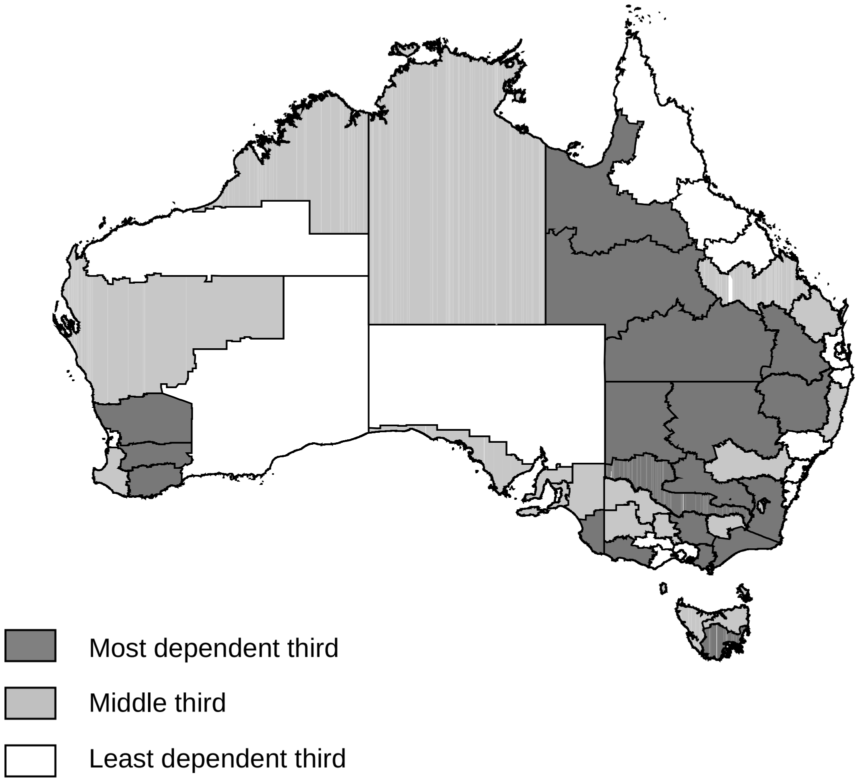
Livestock employment in Statistical Divisions

The estimated share of local employment in livestock activity ranged from less than 1 per cent for the capital city regions to 30 per cent for the Central West region of Queensland.

Figure 7.1 illustrates the pattern of dependence across the SD regions. For the one-third of regions where dependence was highest, 6 per cent or more of total regional employment was in livestock activities, with the majority of these having at least 10 per cent (table 7.1). For the one-third of regions where dependence was lowest,

Figure 7.1 Pattern of direct dependence on livestock employment, 1996

Share of total regional employment accounted for by livestock employment



Source: PC estimates.

Table 7.1 Regions with highest direct dependence on livestock, 1996

Livestock employment as a share of total regional employment

Statistical Division	*Estimate*	*Statistical Division*	*Estimate*
	%		%
Central West (Qld)	30	North West (Qld)	9
Western District (Vic)	20	North Western (NSW)	8
South West (Qld)	19	Far West (NSW)	8
Upper Great Southern (WA)	13	South Eastern (NSW)	7
East Gippsland (Vic)	13	Murrumbidgee (NSW)	7
Goulburn (Vic)	11	Murray (NSW)	7
South East (SA)	11	Darling Downs (Qld)	7
Lower Great Southern (WA)	11	Midlands (WA)	6
Gippsland (Vic)	10	Northern (NSW)	6
Southern (Tas)	10		

Source: PC estimates.

less than 4 per cent of total regional employment was in livestock activities, although for the majority, it was less than 2 per cent, and mainly in the capital cities and adjoining regions.

Relative versus absolute dependence within SD regions

The scale and scope of socioeconomic impacts on a region depend on the absolute number of affected individuals, as well as the proportion of the community affected. In this context, it is noted that of the 19 SD regions with the highest relative dependence, 10 were ranked in the top one-third in terms of total livestock employment (appendix D, table D.1).

The importance of livestock mix within a SD region

To further gauge the direct impact of an FMD outbreak on a SD region, it is necessary to account for the effects of FMD on the different livestock industries. As indicated in chapter 6, beef producers and, hence, predominantly beef producing regions, would be more adversely affected than dairy producers and predominantly dairy producing regions. For example, the Western District (Vic) had an overall dependency of 20 per cent on livestock employment, but includes significant dairy cattle and milk production. In contrast, the Darling Downs (Qld) had an overall dependency of 7 per cent, but beef cattle farms comprised 68 per cent of 'specialist' livestock farms and a further 13 per cent were sheep or sheep-beef farms. Thus, the difference in the size of the effects on the two regions would not be nearly as great as suggested by looking at aggregate livestock dependence alone.

Livestock employment in Statistical Local Areas

SDs cover relatively large areas — averaging over 150 000 square kilometres for regions outside the capital cities. Hence, analysis at this level can conceal considerable variability at the local district level — for example, while the Darling Downs SD had an estimated livestock share of employment of 7 per cent, the shares for the SLAs within it included Taroom (44 per cent) and Inglewood (36 per cent), where beef activity is prevalent, and Stanthorpe (2 per cent), where horticulture predominates.

The relative dependence on livestock employment at the SLA level is summarised in table 7.2. It excludes around 600 SLAs in the capital cities and a further 82 covering Wollongong, Newcastle, Gold Coast, Townsville and Cairns where livestock employment is insignificant. The table shows that, in 1996, 60 SLAs (out of 620 non-metropolitan areas for which complete data were available) had more than 30 per cent of their total employment directly involved in livestock activities. A further 56 SLAs had a livestock employment share of between 20 and 29 per cent. Thirty-five (30 per cent) of these 116 highest dependent SLAs were located in Queensland and 26 (22 per cent) in NSW. Importantly, some of the 116 highly dependent SLAs were in SDs with relatively low dependency — for example, Merriwa SLA had a livestock employment dependency share of 30 per cent, even though the Hunter SD region within which it is located had an overall livestock employment share of less than 3 per cent.

Table 7.2 **Dependence on livestock employment, by SLA, 1996**

Non-capital city areas

Share of all local employment	*NSW* [a]	*Vic*	*Qld* [b]	*SA*	*WA*	*Tas*	*NT*	*Australia*	
%	no.	no.	no.	no.	no.	no.	no.	no.	%
50 or more	2	0	5	3	1	0	0	11	2
40–49	1	3	3	0	3	0	0	10	2
30–39	8	4	17	6	4	0	0	39	6
20–29	15	12	10	6	8	5	0	56	9
10–19	42	18	24	19	25	8	0	136	22
under 10	64	66	72	62	65	20	19	368	59
Total	132	103	131	96	106	33	19	620	100
Incomplete data [c]	1	21	9	2	0	2	8	44	

[a] Excludes 9 SLAs covering Wollongong and Newcastle. [b] Excludes 73 SLAs covering the Gold Coast, Townsville and Cairns. [c] Examination of the incomplete data suggests there may be up to four SLAs in Victoria and one in NT in the top two categories. The remainder of SLAs with incomplete data appear to be in the lower categories.

Source: PC estimates.

Dependence of country towns on livestock farmers’ expenditure

Expenditure by farm families in country towns across Australia is an important source of income for many regional businesses. Local service industries like retail and wholesale trade, transport and storage, finance and machinery repairs are all affected by farmers’ spending patterns. The fortunes of these non-farm businesses may also have implications for off-farm employment opportunities of farm families.

An ABARE survey of farmer expenditure patterns revealed that a relatively low proportion of total farm expenditure was spent in small towns (box 7.2). However, many of these towns are likely to be highly dependent on this spending because they generally do not have a large services or industry base. Regional centres, whilst attracting more farm expenditure in aggregate, usually have a more diversified base.

Box 7.2 **Where farmers spend their income**

Farmers' expenditure can be divided into three components:

- household items — for example, food, clothing, furniture, entertainment, school fees and holidays;
- farm inputs — that is, non-capital farm inputs such as fertiliser, fodder, seed, chemicals, fuel, plant hire and repairs; and
- capital items — that is, high value items of plant and machinery.

Based on a 1998-99 ABARE survey of broadacre farmer expenditure, it was estimated that towns with more than 20 000 people attracted over half of the expenditure of a broadacre farmer (Levantis 2001). Towns with fewer than 1 000 people and towns with between 1 000 and 2 000 people each attracted less than 10 per cent of farmers' expenditure.

The survey also showed that the proportion of farm expenditure spent on each of the three categories — household items, farm inputs and capital items — varied according to town size. Thus, in towns with less than 1 000 people, about 15 per cent of total farm expenditure was on household items and almost 80 per cent on farm inputs. In contrast, in towns with over 50 000 people, around 35 per cent of farmers' expenditure was on household items, with a similar proportion on farm inputs. The remainder (30 per cent) was on capital items.

Source: Levantis (2001).

The sharp reduction in livestock cash receipts from an FMD outbreak is likely to result in a decrease in discretionary expenditure by farmers on household items and on farm inputs such as fertiliser and fencing materials. Reductions in discretionary expenditure are likely to be more significant for small towns. On the other hand, deferred expenditure on major capital items will primarily impact on suppliers located in larger centres.

Estimated total effect on regions

The MMRF model (described in chapter 6) provides for the indirect effects of an FMD outbreak to be incorporated with the direct effects to give, by region, the total effects over time of an outbreak. The regional impact of the 12 month scenario has been estimated, year by year, over a 10 year period from the beginning of the outbreak for 57 regions.[4] Details of the first year effect and of the cumulative effect over the 10 years for all regions are given in appendix D, table D.2.

Figure 7.2 illustrates the pattern of regional impacts according to the cumulative effect on the value of output over the 10 years. The most adversely affected regions, where the cumulative effect over 10 years is greater than 3 per cent of current output, occur predominantly in inland regions where the livestock industries are relatively important contributors to the regional economies. (At the national level, real gross domestic product is estimated to be about 1.2 per cent lower over the 10 years — almost one-third of regions are less affected than this.)

The 10 regions estimated to be the most adversely affected over the 10 year period are listed in table 7.3. The most affected region is estimated to be South West (Qld), for which the cumulative loss in the region's value of output over the 10 year period is equivalent to almost 20 per cent of the current annual output.

Table 7.3 **Estimated effect of the 12 month FMD scenario, 10 most adversely affected regions**

Reduction in regional value of output as a proportion of current annual output

	Cumulative reduction over 10 years	*Reduction after one year*
	%	%
South West (Qld)	-19.6	-6.6
Central West (Qld)	-13.2	-4.5
Darling Downs (Qld)	-7.8	-2.9
Fitzroy (Qld)	-6.7	-2.4
Kimberley (WA)	-6.7	-2.3
North West (Qld)	-6.2	-2.2
Wheatbelt (WA)[a]	-5.0	-2.2
Lower Great Southern (WA)	-4.7	-2.1
South East (SA)	-4.5	-1.8
Wide Bay-Burnett (Qld)	-4.5	-1.6

[a] The wheatbelt region is an amalgam of the Upper Great Southern and Midlands statistical divisions.

Source: MMRF model estimates.

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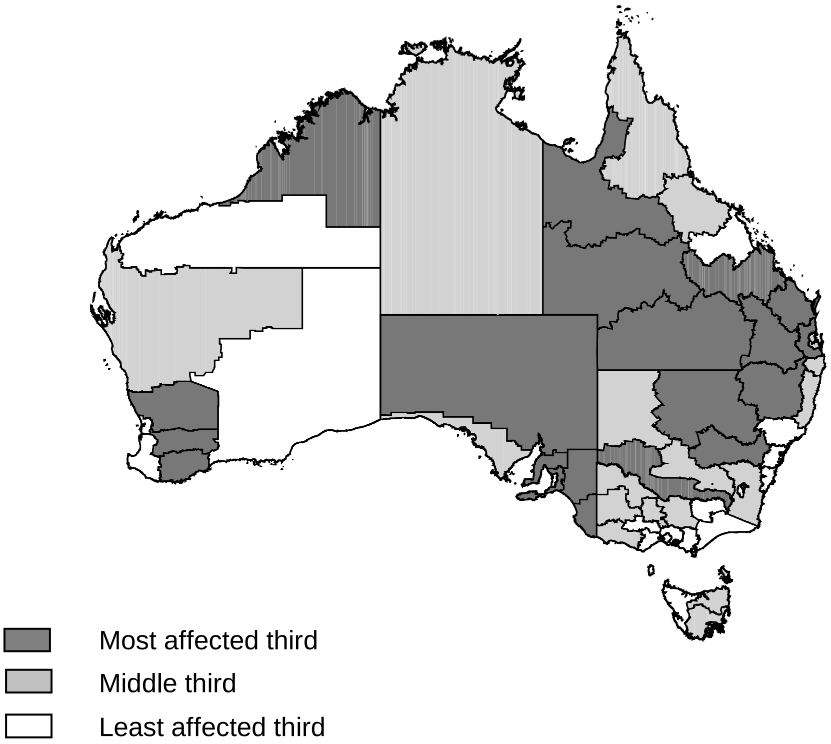
[4] The MMRF model recognises 57 regions compared with the 58 statistical divisions (SDs) used elsewhere in the regional analysis. The regions in the MMRF model match 53 of the SDs. The variations are explained in appendix D, table D.2.

Figure 7.2 **Estimated effect of the 12 month FMD scenario, regional pattern of cumulative reductions in the value of output over 10 years**



Source: MMRF model estimates.

Also listed in the table are the estimated reductions in regional output after the first year. As indicated, the cumulative effect over the 10 year period is some two to three times the first year effect for those regions.

More generally, the regional pattern of impacts in the first year confirms the earlier analysis relating to livestock dependence (see table 7.1). Eleven of the 19 regions with the highest relative dependence on livestock employment were in the top one-third of regions estimated to suffer the largest reduction in the value of output in the first year. In six of the remaining eight high livestock-dependent regions, the relatively high incidence of dairy activity moderated the losses in the first year.

Not all regions are estimated to be adversely affected. The adjustment of the economy to the loss of meat exports produces a slight depreciation in the exchange rate which, in turn, leads to some expansion of other export and import replacement industries. Regions dependent on those other industries, such as the Pilbara in

Western Australia which has a relatively high dependence on the mining industry, could experience an expansion of output. In total, seven regions are estimated to have a net expansion in output over the 10 year period, although, in each case, the cumulative increase is estimated to be less than 1 per cent of current output.

As expected, the estimated effect on employment of the 12 month FMD scenario is closely linked with the effect on output. Thus, the one-third of regions which are estimated to experience the largest proportional reductions in employment are the regions that are estimated to experience the largest cumulative reduction in output.

South West (Qld) and Central West (Qld) are estimated to suffer the largest proportional reductions in employment in the first year — around 15 per cent, each. This equates to around 2 200 and 1 030 persons, respectively. Over the next nine years, employment levels in both regions gradually recover. However, over the period, employment levels are lower on average by about 500 and 250 persons, respectively.

Australia-wide, employment is estimated to decline by around 44 000 persons in the first year, or about 0.5 per cent. Brisbane suffers the largest absolute reduction in employment in the first year — around 9 300 persons, or 1.3 per cent of its workforce. Moreton (Qld) and Darling Downs (Qld) experience the next largest declines in the first year — around 4 500 persons, respectively.

7.2 The ability of regions to cope with an outbreak

The ability of a region and community to cope with the economic ‘shock’ from an FMD outbreak depends on a multitude of economic and social factors. Although a broad generalisation, a community performing well economically and having low levels of ‘social disadvantage’ is likely to cope better and recover more quickly from an outbreak than an economically and socially disadvantaged region.

There is no simple measure of ability to cope, in part, because ‘ability to cope’ has many dimensions — for example, it could be the capacity of displaced workers to quickly find new employment and/or it could refer to the attitude, morale and social cohesiveness of the community.

Notwithstanding this complexity, regions can be compared on the basis of a number of socio-economic measures and matched with those identified as likely to be most affected by the 12 month FMD outbreak scenario.

Socioeconomic profiles

Numerous socioeconomic variables have been used in social impact studies, particularly of resource and infrastructure developments (box 7.3). In this study, the Commission has profiled the SD regions according to the following three measures: recent employment growth; the unemployment rate for persons aged 15 years and over; and the ABS Index of Relative Socio-Economic Disadvantage[5]:

Profiles for all regions are presented in appendix D, table D.1. The national ranking of the 10 regions estimated to be most affected by the 12 month FMD scenario is given in table 7.4.

Table 7.4 **Ranking[a] of socioeconomic variables for regions estimated to be most adversely affected by the 12 month FMD scenario**

Regions with largest cumulative reduction in output over 10 years	*Employment growth*	*Unemployment rate*	*Index of social disadvantage*
	rank	rank	rank
1. South West (Qld)	45	3	45
2. Central West (Qld)	49	9	40
3. Darling Downs (Qld)	23	17	29
4. Fitzroy (Qld)	18	31	38
5. Kimberley (WA)	3	6	57
6. North West (Qld)	32	4	52
7. Upper Great Southern (WA)	38	1	10
8. Midlands (WA)	5	11	32
9. Lower Great Southern (WA)	20	21	27
10. South East (SA)	42	10	37

a A ranking of 1 (out of 58) is used for the highest employment growth, the lowest unemployment rate and the least relative socioeconomic disadvantage.

Source: PC estimates.

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[5] The use of such profiling to examine capacity to cope is subject to a number of qualifications. First, it cannot be concluded that a region has a high or low capacity to adjust by examining a single socioeconomic variable. As noted above, capacity to cope has many dimensions. Thus, it is necessary to examine a number of variables together to form an overall picture. Second, there is not necessarily a clear-cut relationship between a socioeconomic variable and capacity to cope, though some positive or negative relationship may emerge on average over large samples. For example, a low unemployment rate may not always indicate a high capacity to adjust. Third, because capacity to cope is a multi-dimensional issue, the importance of each variable could be different for each region. A technique such as principal components analysis may be required to disentangle the relative importance of the variables. Finally, it is not likely that capacity to cope can be measured in absolute terms by reference to socioeconomic variables. Rather, it may only be possible to compare the relative capacity as between regions, or over time for a single region.

Box 7.3 **Variables used in social impact analysis**

A variety of socioeconomic variables have been used in social impact analysis, primarily of resource and infrastructure developments (see, for example, Bowles 1981, Hindmarsh et al. 1988 and Burdge 1994). By measuring or predicting changes in the socioeconomic variables, as a consequence of a development, some indication of the scope and scale of the social impacts may be gained. Looked at another way, it may be hypothesised that the socioeconomic variables which have the greatest bearing on the scale and scope of the social impacts are the variables which indicate a community's capacity to cope with the shock. While there is no consensus as to which socioeconomic variables best measure social impacts (nor the capacity to cope), such variables could include the:

- growth or decline in regional output, employment and population;
- unemployment rate;
- degree of structural change from 'declining' industries to 'expanding' industries;
- median income relative to the national average;
- educational and skill profile of inhabitants;
- extent of housing ownership;
- ratio of 'younger' population to 'older' population;
- age of agricultural owner-operators and agricultural workers;
- degree of remoteness; and
- frequency and scale of 'shocks'.

The ABS Index of Relative Social Disadvantage incorporates income levels, unemployment, educational qualifications, housing ownership and occupational skills.

A number of these variables, and others, have been compared for regions of Australia (Haberkorn et al. 2000).

Employment growth 1986 to 1996

Regions which are growing are likely to provide greater opportunities for displaced workers. On the other hand, it needs to be recognised that regional employment growth could be mainly in industries which require different skills to those possessed by displaced livestock workers.

For Australia, employment growth averaged around 1.6 per cent a year between 1986 and 1996. At the regional level, employment growth ranged from a decline of 2.2 per cent a year in the Pilbara (WA) to an average increase of 6.1 per cent a year in Moreton (Qld).

Of the 10 regions estimated to be most affected by the 12 month FMD scenario, only two of these (both in Western Australia) had above average employment growth. This is reflected in the relatively low rankings in table 7.4.

Unemployment rate

Putting aside the issue of skill requirements, it is also important to recognise that high employment growth in itself is not a sufficient measure of a region's relative capacity to absorb displaced workers, since regions with high employment growth could also have high unemployment. For example, areas in south-east Queensland have experienced relatively high employment growth, but have also had relatively high unemployment rates. Generally, however, regions with relatively high unemployment rates are likely to have less capacity to absorb displaced workers.

At the regional level, unemployment rates in 1996 ranged from 4.3 per cent for the Upper Great Southern (WA) region to 14.9 per cent for Wide Bay-Burnett (Qld). One-third of regions had rates of 11 per cent and above. For Australia, the unemployment rate was 9.2 per cent in 1996. While the national rate of unemployment has reduced substantially since then, more recent data at the statistical division level are not readily available and it is believed that the regional pattern of unemployment remains similar to 1996.

All 10 of the regions estimated to be most affected by the 12 month FMD scenario had below average unemployment rates. This is reflected in the relative high rankings in table 7.4.

ABS Index of Relative Socio-Economic Disadvantage

Other things being equal, a region which is relatively socially disadvantaged may find it more difficult to cope with adverse economic events, such as a 'shock' of the size induced by an FMD outbreak.

The ABS has developed an index, with an average standardised at 1 000, of several census variables to represent the relative socioeconomic standing of regions (see, catalogue 2039.0). The lower the index value, the greater is the relative disadvantage. Areas with the greatest relative disadvantage have high proportions of low income families, unemployed people, people without educational qualifications, households renting public housing and people in low skilled occupations.

In 1996, the average index values for non-metropolitan regions and metropolitan regions were 972 and 1 021, respectively. Index values for remote areas tended to be lower than the non-metropolitan average, although some mining regions had higher values.

Of the 10 regions estimated to be most affected by the 12 month FMD scenario, nine of these had an index of relative social disadvantage below the Australian standard, with five of these below the non-metropolitan standard. This is reflected by the relative low rankings in table 7.4.

Overall comparison of regions and socioeconomic conditions

Overall, the 10 regions that could be most affected by an outbreak would not be in a strong socioeconomic position to absorb major shocks. Although these regions had below average unemployment rates a majority had below average employment growth and index of social conditions.

7.3 Farm level impacts

At the farm level, the initial or direct impact of an FMD outbreak would be a loss of livestock receipts. For farms outside the control area, the extent of the initial loss would depend on:

- the dependence of the farm and farm family on livestock activities;
- the mix of livestock activities, as beef, sheep, pigs and dairy activities would be affected differently (see chapter 6); and
- the timing of the closure of export markets compared with the ‘normal’ or ‘planned’ pattern of sales — this is more of an issue for short outbreaks than for long outbreaks.

The capacity of farm enterprises to cope with a downturn in livestock receipts depends, among other things, on their ability to avoid and defer expenditures, the capacity to diversify into other activities and the underlying financial strength of the farm enterprise, such as the debt-equity ratio. These circumstances differ widely between farms.

To illustrate the effect on farmers, the Commission has estimated the initial impact of an FMD outbreak on the ‘average’ farm, the characteristics of which have been determined by ABARE using farm level data (box 7.4). Separate profiles of average farms are available for:

- seven different farm industry types — wheat and crops, mixed livestock and crops, sheep, beef, sheep-beef, all broadacre and dairy;

- the six States and the Northern Territory;
- 32 broadacre survey regions;
- three agricultural zones — the high rainfall, wheat-sheep and pastoral; and
- four farm sizes, based on the value of production.

Cross tabulations are also available between certain of these categories. For the purposes of this study, the Commission has focussed on the differences in impact between farm industry types, States and farm sizes.

Box 7.4 **Profile of the 'average' broadacre farm**

ABARE's AgSurf database (ABARE 2002a) summarises data from its annual Australian Agriculture and Grazing Industries Survey (AAGIS). From this, the Commission has calculated the following averages for the years 1997-98 to 1999-00 for the average broadacre farm:

	$		$
Annual farm net cash	50 191	Total annual cash receipts	224 736
Annual family income	41 350	*including sales of:*	
of which: off-farm income	19 122	• Sheep	19 288
incl: off-farm wages	9 655	• Beef cattle	53 945
		• Livestock transfers	3 187
Debt	171 605	• Other livestock	1 458
Equity	1 133 501	• Wool	29 845
Liquid assets	71 112	• Wheat	52 982

In interpreting the estimated impacts of an FMD outbreak on the 'average' farm, it should be noted that there is considerable variability around these averages. For example, in the period surveyed, over 20 per cent of broadacre farms had no debt. On the other hand, almost 70 per cent of broadacre farms had less than average farm net cash income.

Source: PC estimates based on ABARE (2002a).

Estimates of the initial impact on farm cash receipts

The Commission has confined its analysis to the initial impact on livestock cash receipts in the first year following an outbreak. It has not sought to estimate changes in farm costs or account for farmer decisions about hold back, stocking rates and diversification.

The initial impact on farm cash receipts for the average farm has been estimated by assuming that, in the absence of FMD, receipts would have been the same as average annual receipts during the period 1997-98 to 1999-00. Receipts from the sale of beef cattle, sheep, other livestock and outward transfers of livestock in the first year after an outbreak have been estimated by reducing the base value by the estimated percentage reduction in total export and domestic returns attributable to FMD. Sales of dairy cattle, dairy products, wool and grains have been excluded.

Caution is required in interpreting the results, not only because of the simplifying assumptions, but also because the outcomes for individual farms could vary significantly from those estimated for the average farm.

Initial impact on cash receipts for different types of farms

The profile of different types of broadacre farms and the estimated losses in farm cash receipts is shown in table 7.5.

The profiles reveal quite a different pattern of reliance on livestock, for example:

- the average broadacre farm had average total annual cash receipts of around $225 000 over the 1997-98 to 1999-00 period, of which livestock receipts accounted for about $78 000 or 35 per cent, with beef sales representing almost 70 per cent of this;
- the average beef farm had average total annual cash receipts of around $160 000, of which livestock receipts accounted for about $141 000 or 88 per cent, with beef sales representing around 90 per cent of this; and
- the average wheat and other crops farm had average total annual cash receipts of around $396 000, of which livestock receipts accounted for about $44 000 or 11 per cent, with beef sales representing around half of this.

These differences in livestock receipts result in considerable differences in estimated financial outcomes between farms as a result of an FMD outbreak. For the 12 month FMD outbreak scenario, cash receipts for the average broadacre farm is estimated to decline, in the first year, by about $58 000 compared with the pre-FMD level. This represents about one-quarter of the total annual cash receipts of the average broadacre farm.

Table 7.5 Profile of farm cash receipts and the estimated initial impact of the FMD scenario, by broadacre farm type

Average per farm

	Average 1997-98 to 1999-00				*Estimated loss of farm cash receipts 12 month outbreak*	
	Farms	*Farm net cash income* [a]	*Livestock receipts*	*Total farm cash receipts*		
	no.	$	$	$	$	%
All broadacre	**69 730**	**50 191**	**77 878**	**224 736**	**58 200**	**26**
Wheat & crops	14 362	104 109	43 777	395 945	30 900	8
Mixed livestock & crops	17 489	54 153	61 472	244 989	43 000	18
Sheep	11 929	21 763	48 754	145 180	32 300	22
Beef	17 416	34 868	141 175	160 496	112 500	70
Sheep-beef	8 452	23 351	79 553	137 329	59 400	43

[a] Farm net cash income is measured as total cash receipts less total cash costs. Cash receipts include sales of products and other revenue such as rebates, insurance claims and government assistance payments. Cash costs includes payments for materials and services and other cash costs such as livestock purchases, lease payments and interest. It excludes capital and household expenditures (see ABARE 2001b, pp. 44–6).

Source: PC estimates based on ABARE (2002a).

In contrast, the initial impact of the 12 month outbreak scenario on cash receipts in the first year for the average beef farm is about double ($112 500) the broadacre average. In absolute terms, the fall in receipts is least in the case of the average wheat and other crops farm, with an initial reduction of about half the broadacre average ($30 900). In proportionate terms, the loss for the average beef farm is around 70 per cent of total farm receipts, compared with around 26 per cent for the average broadacre farm. (The average, excluding beef farms, is around 16 per cent.)

Although not shown in the table, the estimated impact on the average broadacre farm in the case of the 3 month and 6 month outbreak scenarios is a decline in first year cash receipts of around $40 000 and $48 000, respectively. As noted above, the ‘normal’ timing of sales relative to the specific months during which export markets are closed as a result of an FMD outbreak of 3 or 6 months duration would influence the outcome for any particular farm. As the Commission’s estimates assume ‘normal’ sales will be adversely affected to the full extent, they can be considered upper limits.

The estimated impact for the 3 and 6 month scenarios on the different farm types follows the pattern at the broadacre level. That is, losses under the 3 month scenario are about 70 per cent of the losses under the 12 month scenario while, for the 6 month scenario, the impact is about 83 per cent of the 12 month scenario.

Initial impact on cash receipts for farms in the States and Northern Territory

The estimated initial impact from the 12 month FMD outbreak scenario on cash receipts in the first year for the average broadacre farm in each State and the Northern Territory is shown in table 7.6. In absolute terms, the impact for both the Northern Territory ($647 400) and Queensland ($127 500) is significantly above the national average of about $58 000. This reflects the much larger size of properties and also the greater dependence on beef.

Table 7.6 **Profile of farm cash receipts and estimated initial impact of the 12 month FMD scenario, by State and Northern Territory**

Average per broadacre farm

	Average 1997-98 to 1999-00					
	Farms	*Farm net cash income* [a]	*Livestock receipts*	*Total farm cash receipts*	*Estimated loss of farm cash receipts 12 month outbreak*	
	no.	$	$	$	$	%
Australia	**69 730**	**50 191**	**77 878**	**224 736**	**58 200**	**26**
NSW	23 206	46 943	67 677	212 318	49 800	23
Vic	15 810	27 518	48 302	140 365	34 300	24
Qld	11 549	53 785	160 902	243 419	127 500	52
SA	8 479	60 524	49 489	217 189	34 600	16
WA	9 185	82 779	60 879	379 458	42 300	11
Tas	1 300	30 468	72 887	151 874	55 300	36
NT	201	185 017	810 012	902 756	647 400	72

a Farm net cash income is measured as total cash receipts less total cash costs. Cash receipts include sales of products and other revenue such as rebates, insurance claims and government assistance payments. Cash costs includes payments for materials and services and other cash costs such as livestock purchases, lease payments and interest. It excludes capital and household expenditures (see ABARE 2001b, pp. 44–6).

Source: PC estimates based on ABARE (2002a).

In proportionate terms, the average broadacre farm in the Northern Territory is estimated to suffer the greatest impact, with total farm receipts falling by 72 per cent. Queensland and Tasmania are the other States where the proportionate fall is greater than the national average of 26 per cent. The share of total farm receipts accounted for by livestock receipts is higher in these States and Territory.

Initial impact on cash receipts for different size farms

The estimated initial impact on cash receipts, in the first year, for different size broadacre farms, is shown in table 7.7.

While, as expected, the absolute impact is greater for the larger farms, the smaller farms suffer more in relative terms. This is because a greater proportion of total receipts on smaller farms are accounted for by livestock receipts. For example, for the average broadacre farm earning less than $100 000 in total cash receipts, livestock receipts accounted for 54 per cent, while the average broadacre farm in the largest category derived only 27 per cent from livestock receipts. Two-thirds of all broadacre farms in Australia were in the two smallest categories.

Table 7.7 **Profile of farm cash receipts and estimated initial impact of FMD, by broadacre farm size**

Average per farm

	Average 1997-98 to 1999-00					
Farm size [a]	*Farms*	*Farm net cash income* [b]	*Livestock receipts*	*Total farm cash receipts*	*Estimated loss of farm cash receipts 12 month outbreak*	
	no.	$	$	$	$	%
All farms	**69 730**	**50 191**	**77 878**	**224 736**	**58 200**	**26**
< $100 000	32 414	3 453	29 108	53 560	21 900	41
$100 000 – $200 000	14 670	30 012	56 979	146 818	41 400	28
$200 001 – $400 000	12 527	72 039	84 969	287 476	61 600	21
> $400 000	9 318	194 925	199 491	746 726	149 700	20

a Farm size is measured as annual cash receipts plus build-up in trading stocks. **b** Farm net cash income is measured as total cash receipts less total cash costs. Cash receipts include sales of products and other revenue such as rebates, insurance claims and government assistance payments. Cash costs includes payments for materials and services and other cash costs such as livestock purchases, lease payments and interest. It excludes capital and household expenditures (see ABARE 2001b, pp. 44–6).

Source: PC estimates based on ABARE (2002a).

Financial strength of farms and capacity to cope

The ability of farm enterprises and farm families to cope with the impact of an FMD outbreak on farm cash receipts depends on the capacity to draw from other sources of finance and income and to adjust (discretionary) farm and household expenditure.

The main sources of cash in lieu of livestock receipts are debt financing, liquid assets and off-farm income. Diversified enterprises may be able to bring forward some sales, but this would be at the expense of future receipts. Revenue from diversifying into activities would only be available in the medium to longer term, and would generally involve increased operating costs and some establishment costs.

Rather than seek ways of replacing the loss of livestock receipts, some farmers may decide to exit. However, any short-term decline in property value may constrain the option of exit.

Comparison of farm debt and family income across farm types

The financial strength of different farm types and the associated farm family is profiled in table 7.8.

Debt and equity

The average debt level for broadacre farms was about $172 000 over the period 1997-98 to 1999-00, or over three times the average annual net cash income for broadacre farms. The average equity was over $1 million and the average debt to equity ratio was around 20 per cent. Many broadacre farms were better placed than this — more than half of broadacre farms had debt to equity ratios of less than 12 per cent, including more than one-fifth which were debt free. At the other extreme, around 7 per cent of farms had debt to equity ratios of over 65 per cent.

The farm type estimated to suffer the largest impact on cash receipts from an FMD outbreak — beef — had the lowest average level of debt (around $114 000) and a debt-equity ratio slightly less than the broadacre average. The farm type estimated to suffer the least impact on cash receipts from an FMD outbreak — wheat and other crops — had the highest average level of debt (around $255 000) and the highest debt to equity ratio (31 per cent).

Overall, this broad profile suggests that a number of broadacre farms have equity holdings which could permit increased borrowing, if necessary, although debt-equity positions would be set-back. For example, assuming no change in the capital value, the debt to equity ratio of the average broadacre farm would increase from around 20 to 27 per cent if the level of debt was extended in the first year to fully cover the estimated impact on cash receipts of a 12 month outbreak. For those farms with debt to equity ratios significantly higher than the average and/or experiencing cash flow reductions much greater than the average, farm long-term viability could become more precarious.

Table 7.8 Profile of debt and income, by farm type

Average per farm

	Average 1997-98 to 1999-00							
				Off-farm income				
Farm type	*Debt*	*Debt to equity ratio*	*Farm liquid assets* [a]	*Total* [b]	*Wage*	*Total family income* [c]	*Farm net cash income*	*Estimated loss of farm cash receipts 12 month outbreak*
	$	%	$	$	%	$	$	$
All broadacre	**171 605**	**20**	**71 112**	**19 122**	**51**	**41 350**	**50 191**	**58 200**
Wheat and other crops	254 988	31	81 087	17 126	50	65 071	104 109	30 900
Mixed livestock and crops	203 176	18	63 600	15 091	58	39 088	54 154	43 100
Sheep	140 917	20	62 203	18 017	56	26 730	21 763	32 300
Beef	114 053	19	71 900	26 329	45	41 251	34 868	112 500
Sheep-beef	126 366	18	79 474	17 729	47	27 577	23 351	59 400

[a] Farm liquid assets are defined as assets owned by the farm enterprise which can be readily converted to cash (such as savings bank deposits and shares). It excludes real estate, life assurance policies and other farms or businesses. [b] Off-farm income is defined as income of the owner manager and spouse from wages, other businesses, investment and social welfare payments. [c] Total family income is the family share of farm cash income (less depreciation) plus off-farm income. The family share of farm cash income is the ownership share of the owner manager, spouse and dependent children.

Source: PC estimates based on ABARE (2002a).

In practice, the option of extending debt depends upon the attitude of finance providers (such as banks), particularly their perception of long-term viability. In this context, any decline in property values in the short term because of an FMD outbreak will increase existing debt-equity ratios. However, in principle, anticipated long-term cash flow and debt servicing capability should be more important to prospective lenders.

Farm family income and liquid assets

The income of farm families comes from both farm and non-farm sources. Annual family income for the average broadacre farm was $41 350 for the period 1997-98 to 1999-00. Annual off-farm income averaged about $19 100, or about 46 per cent of total family income.

The impact of an FMD outbreak on farm family income depends upon the split between farm and off-farm sources and the extent to which an outbreak adversely affects these two sources. Total family annual income varies significantly between farm types, ranging from about $26 700 for sheep farms to about $65 000 for wheat-crops farms. However, off-farm income is very similar across the farm types — in the range $15 000 to $18 000, except for beef (about $26 000) — suggesting that most of the variation in family income is due to differences in farm performance. Thus, beef farm families are likely to be the most exposed to an FMD outbreak because beef enterprises are estimated to be affected most in terms of cash receipts.

About half of off-farm income is earned from wages. Whether this income is at risk during an outbreak of FMD would depend upon the regional flow-on effects to non-livestock industries from which wages are drawn and whether employment is on a permanent or temporary basis. An FMD outbreak could reduce some local job opportunities — for example, a decline in business could force local suppliers of farm inputs to lay-off staff. On the other hand, employment opportunities in some other activities could rise, especially in the infected regions. For example, in the UK, farm families in the infected zones were offered payment to assist with eradication and control, while the short-term influx of emergency personnel may stimulate additional employment in accommodation and food supply activities. In uninfected regions, such short-term opportunities do not arise and increased employment opportunities may only emerge over the longer-term — for example, the exchange rate is estimated to depreciate slightly under the 12 month FMD scenario, and this may increase employment in local export and import competing activities.

To the extent that family cash income from the farm enterprise and off-farm employment is insufficient to meet needs, families may have to draw upon reserve assets. Assets owned by the farm such as savings bank deposits and shares averaged about $71 000 a year for the period 1997-98 to 1999-00 for the average broadacre farm. There was little variation across farm types.

8 Social impacts

The previous chapters have focussed on outlining the economic impacts of an FMD outbreak. This chapter outlines the social impacts.

At the individual and family level, the social impacts could range from strains on family relationships that are normally associated with adverse events and loss, through to severe mental disorders. At the community level, the impacts could range from a breakdown of normal community activities in the midst of quarantine and movement restrictions, to the changes in interpersonal relationships affecting the longer-term cohesion of the community.

Social impacts are, by their nature, difficult to quantify, even when the scope and scale of an FMD outbreak and the necessary control measures are known. However, evidence from previous livestock disease outbreaks, and natural and other disasters suggests that there would be significant social impacts. In outlining and discussing these impacts, the Commission has drawn on evidence from previous experiences, in particular:

- the 1999 Newcastle Disease outbreak in the Mangrove Mountain area of NSW;
- the mid to late 1990s outbreak of Ovine Johne's Disease (OJD) in south east Australia;
- the 1997 outbreak of anthrax in Victoria; and
- the outbreak of FMD in the UK during 2001.

A summary of these outbreaks is provided in appendix B.

While many social impacts would flow from the pervasive effects associated with the loss of export market revenue, others would result directly from the measures undertaken to control the spread of FMD within Australia and its elimination. As indicated in chapter 2, those control measures would divide the population and country into three areas, namely:

1. restricted areas: These would be areas containing all properties with known infections, properties that had contact with them either directly or indirectly through transfer of personnel, animals, etc and properties within a buffer zone around infected properties, whether or not they were involved in livestock production. The people on these properties would be directly affected by strict

quarantine restrictions which would apply until all susceptible animals and animal products were destroyed, infected properties decontaminated and there was no longer any evidence of the disease. The number of people in such areas is not likely to be large, but the control measures are likely to have significant effects on them and on those involved in applying the quarantine measures;

2. control areas: In these areas, people would be affected by movement restrictions designed to control the movement of susceptible livestock and by epidemiological surveillance undertaken to confirm the disease–free status of flocks and herds within them. Until the restricted areas are more accurately delineated, the number of people initially affected could be quite large. The movement controls would mainly affect livestock producers and others involved in the transport of livestock and livestock products, but all travel into and out of the area would be affected. However, the effect on individuals would be small relative to quarantine measures; and
3. balance of Australia: Most people in the remainder of Australia would be largely unaffected by FMD control measures. However, in the first instance, all people involved in the livestock industries would be directly affected by the trade effects of the disease. To some extent, those in the related upstream input supply and downstream processing industries would also be affected. As outlined in chapter 3, the loss of export markets which would accompany an outbreak of FMD would sharply lower livestock prices and have pervasive effects on the livestock industries in all regions of Australia. This would be a distinguishing feature of an FMD outbreak relative to other disease outbreaks that have occurred previously in Australia. It would also be a distinguishing feature of an FMD outbreak in Australia relative to many other countries where there is less dependence on FMD-free export markets.

The next section outlines the impact of lower livestock prices and FMD control measures on different groups in the community. This is followed in the second section by an outline of factors influencing individual responses and mental health effects.

8.1 Lower livestock prices and FMD control measures

The social impacts of lower livestock prices and FMD control measures vary between groups in the community. Livestock producers are clearly the most affected by the fall in livestock prices. The FMD control measures also affect a wider range of groups, including: farm families; other businesses; and the personnel implementing the control policy and delivering support. The functioning of local communities would also be impacted by the control measures and, more generally, uncertainty would be pervasive (box 8.1).

An indication of the social impacts on each of these groups follows.

Box 8.1 **Uncertainty in an FMD outbreak**

Uncertainty increases stresses and impedes an individual's ability to cope with traumatic events. Uncertainty was pervasive in the OJD outbreak:

> Uncertainty about the disease, uncertainty about diagnosis and uncertainty about the future are all factors that make OJD distressing. One witness described it as 'living on the knife's edge'. The situation is particularly difficult for those under suspicion and surveillance. It is also stressful for those restocking. Farmers fear that, 'If we missed the signs of OJD the first time, how can we guarantee that we will not miss them again and start the whole cycle all over?'. (ENRC 2000, p. 249)

In an FMD outbreak, uncertainty would relate to:

- market effects — eg, how long will markets be closed and how reflective of next seasons prices are current prices;
- income effects — eg, the availability of short-term cash flow and the duration of expected impacts on cash flow from market closures;
- scientific aspects of the disease — eg, how it started, how it spreads, the possibility of recurrence, the role of livestock farmers in the initial outbreak, and the role of livestock farmers and public authorities in the spread and elimination of the disease; and
- governmental effects — eg, the timing and extent of Government financial assistance and the effectiveness and consistency of policy interventions designed to control the spread of the disease.

Uncertainty would be highest early in the outbreak prior to knowledge about the extent of the outbreak and control measures being established.

Impact of lower prices on livestock producers

An indication of the impact of lower livestock prices on farm cash receipts and of the financial capacity of farmers to withstand adverse short-term events has been provided in chapter 7. The available information suggests that there would be significant financial impacts for all livestock producers. The size of the impact would call into question the continued viability of some farmers. This is particularly likely to be the case where an FMD outbreak exacerbates existing longer-term trends.

For some producers, the financial impacts will be ameliorated by compensation. The AUSVETPLAN provides for compensation for farmers whose livestock are slaughtered for control purposes. A similar policy applies in the UK. In reviewing the recent UK FMD outbreak, the Haskins Committee found that farmers whose stock were eradicated and who received compensation were often in a better financial position than those farmers with healthy herds, but who were unable to trade. It said:

> For those who have lost their stock, there has been an emotional as well as an economic impact — though the latter has been mitigated by the Government's compensation scheme ... They are using the [compensation] for a variety of purposes — to restock, to modernise assets, and to reduce stretched balance sheets. They have also been paid for the lengthy clean-up of their premises after the disease.
>
> The essential restriction on livestock movements has created problems for those livestock farms in affected areas which were not culled-out. Economically, those farmers who have not lost their stock, but are unable to move them for sale or to other grassland, have probably suffered more — and their situation is now precarious as the winter approaches. (Haskins 2001, pp. 5–6)

For farmers whose livestock are slaughtered, the compensation arrangements would not offset all the additional costs incurred, nor the other social impacts.

Doubts concerning the continued viability of farming operations would increase demands for financial advice, and farm advisory and agricultural counselling services. The lower property prices would most likely occur concurrently with the lower livestock prices, which would add to the difficulty of those contemplating leaving agriculture.

Impact of control measures on farm families

Farm families in the restricted area would have their everyday lives severely affected by the quarantine measures imposed to contain FMD. All travel from the restricted area would involve passing through quarantine barriers. The measures would effectively separate them from the balance of the community until there was no longer any sign of the disease. If the infection was discovered on their property, or if there had been contact with infected animals or premises, all of the farm family's susceptible livestock would be destroyed. This would be followed by extensive decontamination procedures.

Previous studies of disease outbreaks have highlighted the social impacts of control measures resulting from the nature of the livestock eradication; the loss of control experienced; and any associated stigma and loss of sense of purpose.

Nature of livestock eradication

Eradication involves the elimination of herds and flocks which farm families have established and improved over many years. As reported to the Northumberland Foot and Mouth Inquiry about the recent UK FMD outbreak:

> The Foot and Mouth outbreak was a traumatic time for farmers. Farming is generally a family business, which has been passed from father to son for generations. Because of this crisis, many farmers have lost all their lives' work. Farmers and their families were devastated when they were told that their animals were to be slaughtered. (Dower 2001, p. 85)

Witnessing the destruction of livestock could add to the distress for some. As reported to the Victorian Parliamentary inquiry into the control of OJD:

> The most shattering time of all was when the lambs that were too young to go to slaughter had to be destroyed on the farm. The [Victorian Department of Natural Resources and Environment] arranged for a dead stock removalist to come and destroy them and cart them away. We were horrified to see them herded into a small pen and then shot. There was blood everywhere and the poor lambs were climbing over the dead ones stacked five deep. It was heartbreaking to see our sheep treated in such a way. We could hear the lambs bleating even after leaving the sheep yards, no longer able to watch. (ENRC 2000, p. 244)

In its review of the UK FMD outbreak, the Northumberland Foot and Mouth Inquiry was given evidence indicating that the manner in which the decision to eradicate was taken sometimes added to farmer distress:

> The distress was increased by the way that decisions were made, the uncertainties involved and (for some farmers) the sense that their sacrifice of animals was unnecessary … There were cases when farmers were coerced into allowing a cull before test results came through, they were told that if they resisted the farm would be declared an "Infected Premises" and their neighbours would then be culled too … To many farmers it was heartbreaking to have their animals culled. Most would agree that if infection was present, this had to be done, but to discover afterwards that there was no infection made it a doubly cruel blow. (Dower 2001, p. 86)

Loss of control

Adding to the distress for farmers in the restricted areas would be the loss of control of operations on their farm. Decisions would be made about their livestock and property with little, if any, consultation with them. In addition to feelings of anxiety and grief, personal lack of control can lead to feelings of hopelessness, anger, frustration and injustice, often directed at individuals and institutions implementing the control strategy. For example, as the Victorian Parliamentary inquiry into the control of OJD reported:

> I was really feeling as if I had got on top of the worst things that have ever happened to me in my 45 years on the farm — that was the drought and the flood and the sickness — and then came OJD. I found that was the most stressful thing in my life — not the OJD but the monster that was handling it and what it had turned into. It was like big brother telling you that you were under his control, and I could not handle that. I had had enough. (ENRC 2000, p. 247)

This suggests that the manner with which authorities approach control can have a significant impact on the stress it creates.

Stigma and loss of sense of purpose

Some of the effects of FMD on farmers and their families would be of an intangible and personal nature. For example, the Victorian Parliamentary Committee found that a common theme in the testimonials to the OJD inquiry was the ensuing sense of personal failure, the sense of isolation (for example, either self-initiated social withdrawal or withdrawal in response to community tensions), the sense of injustice (usually related to eradication and financial compensation issues), some loss of reputation and/or the loss of identity and dignity. For example, it reported that:

> A powerful theme to emerge from the transcripts was the profound sense of stigma associated with identification of farmers who test positive to OJD or who are 'suspect' and put 'under surveillance' for the disease. One farmer spoke of feeling like a "leper", another "a criminal" and another a sense of being put under "house arrest". (ENRC 2000, p. 246)
>
> Farmers and farming families identify themselves strongly with their farms. In some cases these farms have been in the family for generations. As one community counsellor said, the loss of their flocks or quarantine can destroy 'The meaning in people's lives — people who have put their whole lives into the development of their flocks and so on, their whole purpose of being and living'. (ENRC 2000, p. 247)
>
> A normally jovial friend of mine said it was embarrassing to go into town as people would take a wide berth around him as though he had the disease. (ENRC 2000, p. 261)

Impacts of control measures on other businesses

The financial stresses from an FMD outbreak would be felt by many others as farmers responded to an FMD outbreak by reducing investments and expenditures. In relation to the UK outbreak of FMD, the Institute of Rural Health's survey of service providers, undertaken roughly two months after the initial outbreak, found that:

- the situation is having a health impact not only on farmers and their families, but other rural businesses and the staff that are dealing with practicalities of the situation; and

- for non-farming businesses the majority of enquires are for advice related to a loss of income and this is causing stress. (Deaville and Jones 2001, p. 8)

It considered that:

> For non-farming small businesses … This includes worries about existing debts, preventing debt, meeting mortgage and other loan repayments. (Deaville and Jones 2001, p. 3)

Later, the Haskins Committee reported that:

> The agricultural service industries, including transport, engineering and supply, have been hit hard by the outbreak, but they, too, have found short-term work opportunities in cleaning up premises on behalf of the Government.
>
> The tourist trade, after the dreadful experience of the spring and early summer, have benefited from a recovery in business during the past three months, except, of course, for those in areas where visitor movements are still restricted.
>
> The substantial influx of government employees has boosted parts of the local hotel and restaurant trade.
>
> As a result, unemployment levels in the county remain low, and there appears to have been no significant increases in social security claims. (Haskins 2001, p. 6)

The effects on the Australian tourism industry could be relatively minor. It is not as integrated with the agricultural industries as occurs in the UK. However, the location of any outbreak and its associated control measures in relation to the normal movement of people to popular destinations would be influential to any associated social, as well as economic impacts (see section 5.3).

An associated downturn in many rural and regional businesses would create adjustment difficulties similar to those faced by farmers. This could increase demands on existing social welfare programs and agencies.

Impacts of control measures on those implementing the control strategy and delivering support

In an FMD outbreak, the demands on emergency service personnel (for example, veterinarians, police, etc) and others responding to the outbreak would be driven by the needs of the control strategy. Reflecting the need to move quickly to control the spread of the disease, much of this would be associated with implementing movement controls, setting up quarantine barriers and eradication work of known and suspected infected flocks and herds.

In reporting on the conduct of the UK FMD outbreak, the Institute of Rural Health observed that:

> These agencies [Farming Unions, the Country Landowners Association, the Royal Agricultural Benevolent Institution and veterinary surgeons] have noted that staff are working very long hours often 7 days per week (and in many cases have been doing so for the last 8 weeks). Office staff in one veterinary practice are regularly working 8am to 6:30pm, 7 days per week. (Deaville and Jones 2001, p. 3)
>
> … there are real concerns regarding the work pressure on staff such as veterinary surgeons, farming union officials and others involved in tackling this situation. Long hours combined with very stressful situations and responsibilities is having an impact which may become more evident once the immediate situation is over. (Deaville and Jones 2001, p. 8)

In a submission to the Victorian OJD inquiry, the Victorian Department of Natural Resources and Environment highlighted the pressures on its staff. It said:

> The enormity of the responsibility for delivering bad news and terminating farm enterprises, has had an effect … A major issue for staff was the loss of esteem and respect of farm families and communities. That extended in some cases to the loss of professional relationships or personal friendships that had existed for decades. (ENRC 2000, pp. 253–4)

The Department noted that people implementing or enforcing the control strategy may have limited ability to control outcomes, and may experience intensely emotional situations when carrying out their responsibilities:

> Another issue was the shared trauma and emotional pain of implementing policy, of repeatedly observing the affects such as anxiety, tears, depression, anger, the disruption of family and neighbourly relations, witnessing and/or conducting the mass destruction of lambs on some farms was an added stress … The stress has resulted from the conflicting pressures of attempting to implement policy and at the same time minimise the damage to farm enterprises. (ENRC 2000, pp. 253–4)

Indeed, the Institute of Rural Health's survey found that staff of agencies offering practical support were inevitably required to offer emotional support:

> While some farmers are contacting helplines such as the Community Advice and Listening Line and the Samaritans it appears that it is the agencies offering practical information and support … that are receiving the most calls and are then finding themselves offering emotional support. (Deaville and Jones 2001, p. 6)

In the event of an outbreak, added financial stress would be placed on many volunteer organisations in the vicinity of the outbreak. In addition, their capacity to hold functions to raise money, at a time when there would be increased demand for their services, would be restricted.

Impacts on families

An FMD outbreak would increase stress on both parents and children. For example, in their consultancy report to the Victorian Parliamentary inquiry into the control of OJD, Hood and Seedsman observed that:

> … we see families splitting up, people not allowed on their properties for fear of spreading OJD, attempted suicides, children singled out at school and families having uncertain times. (Hood and Seedsman 2000, p. 15)

Previous disease outbreaks indicate that the aspects of an FMD outbreak most likely to disrupt the lives of children living on infected properties could be:

- the process of eradication (possibly including pet animals);
- quarantine and movement restrictions which interrupt normal activities (for example, reduced attendance at school or reduced participation in recreational activities with other children);
- potential conflict with other children, especially where those children reflect parental conflict in the community (for example, where infected farmers are blamed for the outbreak and the impacts on the rest of the community); and
- parental stresses.

For other children, the cancellation of recreational activities and parental stresses could be the most prominent sources of disruption.

FMD control measures could disrupt learning, even where schools are not formally closed. During the UK FMD outbreak, for example, few schools were closed, but during the height of the outbreak farmers' children often stayed away from school as children themselves, their parents and teachers were all anxious to avoid the risk of spreading the disease. The effects of stresses on children were often witnessed by teachers. For example, the Northumberland Foot and Mouth Inquiry reported that:

> Teaching staff were expressing concerns about the emotional trauma and stress the children were experiencing as a result of Foot and Mouth Disease … Teachers were concerned by what children had witnessed … some had experienced the trauma of having their pet animals culled, the social isolation of families and the high levels of stress that the adults were experiencing. In one school, children were burying the toy farm animals in the sand tray. …
>
> I think for all the children who were affected it was the level of anxiety, the bad dreams, the nightmares, the need for physical comfort, a hand to hold, reassurance. They became more clingy. Some needed to talk, some would not talk, their insecurity was evident and it affected their ability to learn. (Dower 2001, p. 99)

In comparative studies of children following the Ash Wednesday Bushfires, the Mental Health Research and Evaluation Centre of the South Australian Health Commission reported that:

> There were nearly twice as many children with major problems 8 months after the fire in contrast to the 2 month study when no gross effect on behaviour could be shown. … in the 2 month study, the children’s disturbances appeared to manifest as physical symptoms such as headache and abdominal pain. There was little understanding of the psychological relevance of these symptoms.
>
> … Most of the children who had significant problems at 8 months after the fire continued to have them 2 years later. The teachers were generally unable to identify these children, although their psychological difficulties were a major source of absenteeism from school. … Thus many of the problems do not simply resolve with time.
>
> … The psychological impact of the disaster on the child’s parents was the strongest predictor of problems in the children. Post-traumatic disorder in the parent, present in 32 per cent two years after, has substantial adverse effects upon the child, emphasising the importance and early detection and treatment of disaster related psychological morbidity in adults. (Clayer et al. 1985, pp. 31–2)

For children, particularly, it appears that the effects of the control measures could persist long after the disease has been eliminated.

Impacts on communities

Types of impacts

The controls associated with an FMD outbreak could result in significant disruptions to community activities in and around the restricted areas. For example, in previous disease outbreaks the disruptions included:

- cancellation of recreational activities;
- increase in travel times and frustration;
- delays in the provision of care and other services provided in-home;
- reductions in normal social interactions; and
- impacts on the quality, quantity and timeliness of the provision of education, health, child care and other services.

Such disruptions could create new divisions and alliances within communities and exacerbate old tensions. In the OJD and Newcastle Disease outbreaks, new or increased tensions were evidenced between:

- infected farmers and other farmers;

- farmers and others in the community; and
- those exercising government policy, farmers and the remainder of the community.

The conflict and tensions could have many dimensions and be pervasive. For example, in reporting on the control of OJD, the Victorian Parliamentary inquiry observed that:

> The hostility and suspicion to which some farmers were subjected because of OJD has impacted on other community members and their families. The Committee was given anecdotal evidence of children being harassed at school because their parents' sheep had OJD. (ENRC 2000, p. 252)

It reported a witness as stating that:

> The large number of my cases have been about depression and anxiety for the future. It does not only concern farmers; it concerns other business people in the community. As you would appreciate, anxiety in families reaches down to the children, which in turn reaches out into the schools. (ENRC 2000, p. 253)

Discussions with the NSW Farmers Federation and Chicken Growers Council Limited elicited the view that, even though the effects of the Newcastle Disease outbreak could be small compared to an FMD outbreak, the impacts on the Mangrove Mountain community were substantial. For example:

- movement restrictions made movements of other products (such as citrus) more difficult, causing friction amongst farmer groups;
- there were conspiracy theories within the community and a degree of paranoia. Actions such as confiscating chicken sandwiches from kids at school bus checkpoints fuelled these emotions;
- farmer's kids were bullied at school and spat on in the playground; and
- the outbreak left significant divisions within the community. Two years later the Government is still assisting with efforts to 'heal' community divisions.

Many examples of this type of conflict were reported by the NSW Department of Community Services:

> Why should chicken farmers who appear to be wealthy, get special assistance when the rest have to suffer? … The farming community has for years lived with natural disasters which destroy weeks/years of work and income and yet when it happens to chicken growers it is somehow so much more of a disaster. Welcome to the real world, why don't we all get this support when it hails? (NSW Department of Community Services 2000, p. 40)

When the Mangrove Mountain community was surveyed and asked about the biggest impacts on the community, two main themes emerged: firstly, the importance of the financial impact on those directly affected, and the flow-on of the impact to other businesses and individuals in the local area; and, secondly, the development of divisions within the community.

The Victorian Parliamentary inquiry reported that:

> One farmer summed up the effects of the Victorian OJD Control Program on his community, and the consequences of the loss of social cohesion, “With regard to the social impacts of the strategies implemented from December 1996 I can only say that there would be no other issue that has virtually destroyed the unity of our rural community [in East Gippsland]. Families have been shamed and farming groups and regions bitterly divided … Without social cohesion communities become unworkable and fail”. (ENRC 2000, p. 261)

Factors underlying conflict

The effects of an outbreak on individuals, both lasting and transitional, could put strains on community relationships, particularly where there are pre-existing tensions. Some conflict following major traumatic events is not unexpected and is part of the psychological processes which individuals and communities go through in response to the event (box 8.2).

There can be tension between pre-existing and emerging relationships and institutions as recovery from the traumatic event requires adaptation to the ‘new reality’. Conflict is abetted by a lack of understanding of the event and its causes, uncertainty for the future, and a reduced sense of control over one’s life. The observed divisiveness in the OJD and Newcastle Disease outbreaks may also be the result of a lack of understanding of the diseases and their effects. For example, the Victorian Parliamentary inquiry reported that:

> In some districts the Victorian OJD Control Program has caused social division. This has been, in part, because of different attitudes to destocking. As staff of the Department of Natural Resources and Environment said, “Those who had experienced clinical effects of the disease … were more prepared than those who had not [to eradicate] because the latter group could not yet see the impact of the disease on the viability of their sheep enterprise. This led to affected producers having had two distinct but opposite views, each valid [for them]”. (ENRC 2000, p. 260)

Box 8.2 Community responses to natural disasters

Impact phase. The network of relations and bonds that exist before the disaster, provide the infrastructure for absorbing and responding to warnings. The first effect is an intensification of [existing] bonds … When the disaster strikes, however, this usually gives way to simple survival … The relationships that existed before, disappear momentarily … this moment of impact involves a generalised suspension of bonds, or in other words, there is a short period in which a process of *de-bonding* occurs.

Response phase. Almost immediately, however, the community fabric reasserts itself … as soon as de-bonding is experienced, the response is a massive drive to re-establish bonds … Because everyone has been through the same experience, they all have something in common that they previously did not have. Intense camaraderie develops … It has been variously described as euphoria, a high or honeymoon phase … Unfortunately this does not take account of pre-disaster history, where many people neither liked, respected nor cared for each other … [the honeymoon phase lasts for a short period of time before] the natural requirement for all human groups to structure themselves as a set of complex sub-systems asserts itself. This can be called a process of *differentiation* since it involves the break-up of the previously undifferentiated group.

Recovery phase. The process of differentiation indicates the onset of the recovery phase proper. The community is no longer functioning on an emergency basis. It is often a period of turmoil and confusion … the pre-disaster community structures naturally reassert themselves … However, the situation is radically changed by the disaster. Every element of the community is challenged with the task of adaptation to the new circumstances. Some will be well-suited, others not. A variety of new tensions will rise.

People bond more closely to those who have had similar experiences and feel somewhat alienated from those who have not … The need for people to differentiate from each other is served by negative emotions such as anger, envy, resentment, competition, and these can all be seen in the post-disaster community … However, these feelings serve the essential purpose of differentiation leading to reorganisation of community structures.

Source: Wraith and Gordon 1988.

It also reported that inadequate consultation appeared to have contributed to a culture of blame:

> Lack of, or inadequate, consultation with most of those affected, while a few were more thoroughly consulted, has added to this source of division … The ‘culture of blame’ described earlier as affecting individuals also has an impact on communities. It affects the trust and goodwill between people that has been shown to be particularly important to communities. (ENRC 2000, p. 261)

Similarly, in the UK FMD outbreak the Institute of Rural Health reported that:

> Interviewees expressed a concern related to the ‘blame culture’ that is emerging. There appears to be increased conflict within the farming community but also between farming and non-farming organisations affected by this situation. (Deaville and Jones 2001, p. 4)

Positive community impacts

While the significant negative community impacts have been highlighted, there is also evidence from previous outbreaks of communities being strengthened. For example, respondents to the survey of the Mangrove Mountain area following the Newcastle Disease outbreak indicated a range of positive impacts, such as:

> For one thing I think it brought the community closer, people were just amazing at how they helped … [The outbreak caused total] disruption to normal life and a general feeling of apprehension, however since this was generally universal it tended to bring people together through discussion. (NSW Department of Community Services 2000, p. 42)

In the UK FMD outbreak it was also observed that:

> The whole rural community became involved in the crisis, sharing its impact and striving to help those who were suffering. (Dower 2001, p. 7)

There is some evidence that the outbreaks provided the opportunity for needed changes to institutions, improvements in public sector service delivery, and improvements in regulatory and industry policies.

Cumulative effects

Some rural communities face significant long-term challenges from technological change, the movement of people to regional centres and cities, and other factors. An FMD outbreak could accentuate those challenges, for example, by triggering population threshold effects (where a further small reduction in population makes the provision of certain services at pre-FMD levels unsustainable). As observed by the Cumbria FMD Strategy Group in relation to the UK FMD outbreak:

> Marginal rural services such as village shops, post offices, filling stations and some pubs are threatened with closure. Once gone, the businesses will not be restarted and this will accelerate the existing trend in the decline of rural services. (Carr 2001, p. 77)

However, just as individuals can respond very differently to a similar set of adverse circumstances, so too can communities. Thus, predictions of wide ranging adverse social impacts on all affected communities, made on the basis of traditional indicators such as loss of income and rates of unemployment, need to be treated with caution. In practice, there is likely to be significant variation in social outcomes between affected communities.

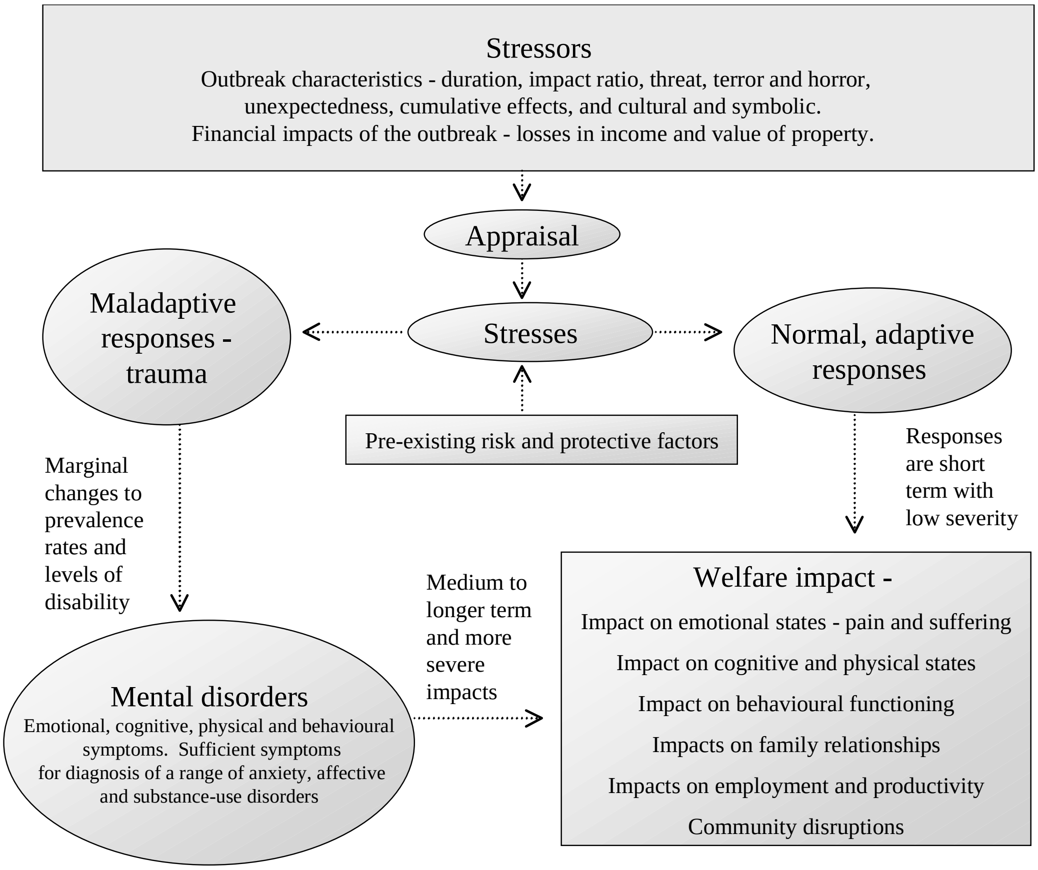
8.2 Factors influencing individual responses and mental health effects

The discussion thus far has highlighted a large range of social outcomes experienced during previous outbreaks. To understand the widely different responses of individuals to similar pressures requires an understanding of the underlying psychological processes involved.

Psychological processes

An outline of the psychological processes involved in responding to an adverse event, such as FMD, is illustrated in figure 8.1. These include pressure from a range of factors (stressors) in addition to the financial impact. While individuals can respond very differently to similar sources of stress, the vast majority of people respond adaptively to the everyday stresses of normal life, and when necessary, to significant adverse events.

Figure 8.1 **Stresses and welfare impacts**



Box 8.3 considers the stresses which would be created by an FMD outbreak based on characteristics commonly used by psychologists to examine the potential of major adverse events to cause disruption and harm.

Box 8.3 **Stresses created by FMD**

Psychologists have identified a number of aspects of adverse events that contribute to the level of trauma created by such events:

- duration: a long duration, such as for an extensive FMD outbreak, prolongs the stresses involved, akin to some periods of enduring drought;
- terror and horror: these add to the stresses arising from livestock slaughter and disposal;
- impact ratio: the impact ratio has been used to refer to the proportion of a given population affected. The trade effects of an FMD outbreak would cause it to have a high impact ratio on the livestock industries, especially the beef industry. For farmers whose livestock are slaughtered for eradication and control purposes, compensation would act to reduce the severity of the stresses otherwise involved. Movement restrictions extend significantly the number of people affected by the control strategy;
- threat: upon detection of the disease in Australia, stresses from this source would be widespread. However, it would be amenable to reduction with dissemination of knowledge about the disease and its distribution;
- unexpectedness: notwithstanding the efforts of governments to prevent and prepare for such an eventuality, an outbreak of FMD would have a high unexpectedness factor, especially for those whose herds are identified as being infected; and
- cultural and symbolic aspects: this refers to the stresses caused by the disruption to family and community participation, and to personal losses of a non-tangible nature, such as loss of personally bred bloodlines and pets.

Notwithstanding the stresses from an FMD outbreak, any impairments to individual emotional, cognitive, and physical states and behavioural functioning are likely to be short lived and involve relatively minor costs. However, in the face of the added pressures (financial and other) from an outbreak, there is likely to be an increase in the proportion of people struggling to cope and experiencing trauma. Trauma responses that result in recognisable mental conditions would be more long lasting and costly to treat.

The prevalence of recognisable mental disorders in the community is given in table 8.1, based on the study, *The burden of disease and injury in Australia*, (Mathers et al. 1999). The study used data from the ABS National Survey of Mental Health and Wellbeing 1997 (MHS-97), the National Drug Strategy Household Survey 1998, and reviews of epidemiological studies. The data indicate that, during

1996, some one in six adults exhibited sufficient symptoms for the diagnosis of a mental disorder.

Table 8.1 **Prevalence of mental disorders in Australia, 1996**

Per cent of adult persons

Anxiety disorders* [a] *-		***Substance-use disorders -***	
Generalised anxiety disorder	1.6	Alcohol dependence/ harmful use	4.0
Post-traumatic stress disorder	0.5	Heroin or polydrug dependence and harmful use	0.2
Agoraphobia	0.4	Sedative dependence/abuse	0.1
Obsessive-compulsive disorder	0.2	Cannabis dependence/abuse	0.9
Panic disorder	0.7	Other drug dependence/abuse	0.2
Social phobia	1.6	*sub-total*	*5.4*
Separation anxiety disorder	0.6	***Affective (or mood) disorders -***	
sub-total	*5.6*	Depression [b]	2.9
Other disorders -		Bipolar affective disorder	0.7
Schizophrenia	0.4	*sub-total*	*3.6*
Childhood conditions	1.1		
Other disorders	0.7	***Total mental disorders***	***16.7***
sub-total	*2.1*		

[a] People with dysthymia or experiencing major depressive episode in 1996. [b] People experiencing symptomatic episodes in 1996.

Source: Mathers et al. 1999, annex table D.

The study also utilised information on the severity distribution of many of the disorders presented in the table. For example, of those persons included in the prevalence statistics for depression, 9 per cent had no associated disability, 57 per cent mild disability, 21 per cent moderate disability and 14 per cent severe disability.

Mental health effects

As stresses increase, so does the possibility of maladaptive responses. The primary categories associated with an FMD outbreak would be anxiety disorders, affective disorders and substance-use disorders (box 8.4). Anxiety disorders are characterised by feelings of tension, distress or nervousness, whereas affective disorders are characterised by a mood disturbance.

Box 8.4 **Mental health problems and mental disorders**

> Mental health problems and mental disorders refer to the spectrum of cognitive, emotional and behavioural disorders that interfere with the lives and productivity of people at school, at work and at home, and impact upon their interpersonal relationships. (DHAC and AIHW 1999, p. 7)

A mental disorder implies ‘the existence of a clinically recognisable set of symptoms or behaviour associated in most cases with distress and with interference with personal functions’ (WHO 1992, cited in DHAC and AIHW 1999, p. 7). Mental health problems refer to common mental complaints and symptoms in response to normal life stresses.

Acute stress disorder — involves intense fear, helplessness, and/or horror often resulting from a traumatic event. The response to the traumatic event will usually be managed by the body’s psychological defences against stress, with responses to the event generally not lasting more than a month. Persistent stress can result in anxiety.

General anxiety disorder — involves excessive anxiety and worry occurring more often than not for at least a six month period, difficulty in controlling the worry, and a range of other symptoms. The anxiety, worry, or physical symptoms cause clinically significant distress or impairment in social, occupational or other important areas of functioning.

Post-traumatic stress disorder (PTSD) — involves a person being exposed to a traumatic event where the person experienced, witnessed, or was confronted with an event that involved actual or threatened death or serious injury, or a threat to the physical integrity of self or others. In addition, the person’s response involved intense fear, helplessness and/or horror. PTSD involves responses to a traumatic event which are so severe that they overwhelm the body’s defence mechanisms leading to permanent changes to a person’s physical and psychological responses to stresses.

Major depressive disorder — is one of a number of affective or mood disorders. Depressive disorders are a group of symptoms that reflects a sad mood exceeding normal sadness or grief. Biochemical changes in the brain lead to major symptoms of depression, such as negative thoughts, moods and behaviours, accompanied by changes in bodily functions (for example, sleeping and eating).

Evidence from previous livestock disease outbreaks

Information provided earlier cites instances of anger, grief, hopelessness and of other signs of stress. There is the perception, held by many of the people involved, that these types of feelings and effects were pervasive. ‘Normal’ responses were widely observed.

There is also anecdotal evidence of trauma. Hood and Seedsman (2000) undertook a review of the evidence received by the Victorian Parliamentary Committee inquiry into the control of OJD. Farmers and woolgrowers accounted for approximately 60 per cent of the submissions. The effects of OJD were found to produce significant levels of trauma:

> The evidence clearly identifies that the majority of farmers and communities associated with OJD have experienced major trauma. This trauma has emerged from the impact of the program on their individual and community lives … Experiences of depression are reported by both farmers and professionals working within their communities. (Hood and Seedsman 2000, p. 18)

There is also qualitative evidence of people experiencing long recovery processes, suggesting more severe initial impacts:

> The evidence received by the Committee about the Victorian OJD Control Program was distressing. Even where the direct impact on farmers and their families occurred a number of years ago, the anguish caused by the financial and especially the social impacts of the Program is still evident today. (ENRC 2000, p. 283)
>
> The social impact from FMD has had an equally devastating effect, with calls to the farm crisis network increasing twenty-fold. Isolation from community life in infected areas had been severe … Many families and communities are in need of support and help and will be so for a considerable time to come. (Dower 2001, p. 87)

The survey of those people living in the Mangrove Mountain area at the time of the Newcastle Disease outbreak provides some indicative data on impacts (table 8.2). The most significant data relate to the overall effect of Newcastle Disease on people's lives and a lack of support for a high percentage of those people affected.

Table 8.2 **Survey[a] of the mental health impact on the Mangrove Mountain community**

	Question	*Responses*
10.1	Unable to work	3 respondents were unable to work (1 indicated for three months, 1 for six months, and 1 did not indicate the period of time). Of chicken farmer respondents, 15 indicated they were unable to work for periods ranging from three to eight months. 90% of survey respondents did not answer this question.
10.8	Overall effect on life	For non-chicken farmers, 12% indicated Newcastle Disease affected their lives a lot, 10% somewhat affected, 35% were affected very little and 43% affected not at all. For chicken farmers, 88% indicated their lives had been affected a lot, and 12% said their lives had been affected somewhat.
18	I have family etc to support me while I recover from the outbreak	70% of respondents either agreed or strongly agreed that they had support while they recovered. 20% of respondents disagreed and 10% strongly disagreed. 72% of survey respondents did not answer this question.
19	How long do you think it will take for you to recover from the outbreak?	69% of respondents to this question indicated 2 years or more before they recovered, 20% indicated 1-2 years and 11% indicated within twelve months. 75% of survey respondents did not answer this question.

a Based on 184 survey responses (including 25 of 70 chicken farmers affected).

Source: NSW Department of Community Services 2000.

The transcripts of the OJD inquiry provided some evidence of thoughts of suicide and suicide attempts:

> Reports of both suicidal ideation and suicide events are evident in the hearing materials. Whilst OJD is not described as being the sole causative factor the program is seen to have been a significant stressor impacting on individual's sense of hopelessness. (Hood and Seedsman 2000, p. 19)

Table 8.3 provides information on the health effects of the 1974 Brisbane floods and the 1983 Ash Wednesday bushfires.

Table 8.3 **The health effects of selected Australian natural disasters**

Outbreak study	*Key findings*
Abrahams et al. (1976)	Study of the 1974 Brisbane flood found that the number of visits to general practitioners, hospitals and specialists were all significantly increased for flooded persons in the year following the flood. Persistent psychological symptoms, which included irritability, nervous tension and depressed mood, predominated in those seeking medical care.
Chamberlain et al. (1981)	14 months after the 1974 Brisbane flood, 23 per cent of respondents to the survey indicated they had not recovered from the effects of the flood.
McFarlane, AC, Policansky, SK and Irwin, C (1987), and McFarlane, AC, Clayer, JF and Bookless, CL (1997)	Lasting and significant morbidity associated with the 1983 Ash Wednesday bushfires. Doubling of psychiatric morbidity in adults and children as a result of the disaster. Child responses were closely dependent on parental interpretation of disaster. A high rate of continued symptoms twenty months after event.
Clayer JR, Bookless-Pratz, C and McFarlane, AC (1985)	28 fatalities resulted from the 1983 Ash Wednesday bushfires. Of a range of conditions, the prevalence of mental illness, alcoholism and drug problems increased the most. Survey responses indicated bushfires had a significant effect upon the mental health of approximately 30% of the affected population. 10% of respondents with pre-existing conditions reported an increase in the severity of those conditions.

While many of the impacts considered in this chapter cannot be costed in the normal manner, the impacts would clearly be significant. In some cases, they could be a reflection of the economic losses. In other words, a larger outbreak, producing larger economic losses, would also be expected to generate larger social impacts. The impacts would entail costs well beyond the length of the outbreak for the individuals and communities concerned, and indirectly for governments through the health and welfare systems.

9 Environmental impacts

Eradication and control of FMD potentially has a number of adverse impacts on the environment, primarily associated with the disposal of animal carcasses. Other environmental impacts could arise from:

- the disposal of other livestock products (such as milk);
- widespread use of disinfectants to decontaminate infected properties; and
- a reduction in on-farm environmental improvement measures such as soil conservation, tree planting and salinity reduction arising from decreases in farm cash flow.

9.1 Carcass disposal

During an outbreak of FMD, there is a potential conflict between the need to dispose of infected animals urgently and doing so in a way that does not raise undue animal welfare issues or create long lasting environmental problems.

Options for carcass disposal include: burial; pyre burning; rendering (boiling); and, potentially, a range of composting and incineration methods. The first three methods were those most widely used in the UK outbreak and are also likely to be the most widely used if there were an outbreak in Australia. The AUSTVETPLAN endorses burial as the preferred method, but also allows for burning or rendering. A number of the other methods require further research and refinement before they could be widely applied.

Burial

Burial can take place either on farm or at mass burial sites. In each case it involves digging large pits, at least five metres deep, and covering carcasses with sufficient soil to prevent wild animal incursions (as specified in the AUSVETPLAN).

The greatest potential environmental concern with burial is contamination of surface and ground water by leachates from the disposal pit. In the UK, there were 212 reported water pollution incidents, most minor, of which 24 per cent were related to carcass burial (Environment Agency 2001). In some cases, animals subsequently were dug up after burial because they had initially been buried too close to a water table or spring (The Countryside Agency 2001). The necessity of disposing of large numbers of animals rapidly meant that possible environmental impacts did not initially figure high in decision making:

> The extremities of the emergency decreed that operational needs had to be met and little advance consultation or reference to stakeholders and environmental bodies could be made if the objective of preventing a public health or animal health disaster due to failure to dispose of carcasses was to be avoided. (Trevelyan 2002, p. 4)

Intially mass burial sites in the UK were large holes in the ground, but were:

> successively engineered with increasingly sophisticated liners and leachate collection systems to minimise risk to groundwater. (Trevelyan 2002, p. 4)

The Commission understands that some burial and pyre sites have required significant subsequent remediation work to meet environmental standards. However, monitoring of burial sites in the UK, to date, has found that there is no ongoing affect from FMD disposals on water sources used for public or private supply (although two private water supplies were temporarily affected during the outbreak) (PHLS 2001 and Environment Agency 2001). Indeed, ‘any environmental impacts have been short-term and localised; much smaller than the day-to-day impacts of current farming practises’ (Environment Agency 2001).

The UK experience indicates that burial would not be suitable in some areas where there is a high water table or aquifers close to the surface. However, in other areas, with appropriate monitoring, burial would have a minimal impact on the environment.

The Mangrove Mountain Newcastle disease outbreak in Australia necessitated the burial of over 1.5 million chickens. Protecting the water table from possible contamination was a high priority. As at sites in the UK, a monitoring program is now in place to ensure there is no unexpected impact on the local environment.

The NSW Government is coordinating a project, funded jointly with Animal Health Australia, to develop a decision-making framework for determining the appropriate means of carcass disposal during animal emergencies. This work will significantly advance Australia’s preparedness to deal with disposal issues in a way which minimises environmental costs. One outcome will be an update of the disposal procedures contained within the AUSVETPLAN. For example, in relation to burial, one of the project’s findings is that the current pit specifications in the AUSTVETPLAN proved unsuitable for use in the UK and it is unlikely that they would be approved by State environmental agencies. Using designs developed during the UK outbreak would be more likely to meet environmental specifications.

Experience from the UK also suggests that the improved designs of disposal pits involve greater expenditure. They are not only more costly to build, but require long-term monitoring. Thus, whatever form burial takes, it would involve long-term costs to ensure the adverse impacts on the environment are minimised.

Burning

Burning options are also possible under the AUSTVETPLAN, and include on-farm burning and mass pyre burning. From an environmental perspective, burning can raise concerns about visual pollution and emissions (particularly of dioxins). During the UK outbreak, the Department of Health issued guidelines that pyres should not be used without offering alternative accommodation to anyone living within four kilometres of a pyre site. That said, monitoring in the UK has not shown any ongoing air quality deterioration and concentrations of dioxins in soil samples close to pyres are within the range previously found in the rural environment.

The Northumberland Foot and Mouth Inquiry concluded that the impacts of pyre burning were mostly of a short-term nature which will mainly be reversed over the longer term (Northumberland City Council 2002). However, during the outbreak, some ash was buried without authorisation and further risk assessments of ground water and private water supplies has led to the removal of ash from 20 sites in Wales due to unacceptable risks to the environment (Environment Agency 2001).

Rendering

Rendering is the third disposal option that was widely used in the UK. Rendering involves cooking ground-up carcasses in large boilers under pressure for a certain period of time. Trevelyan (2002), notes that rendering is a relatively environmentally benign form of disposal:

> Tallow (fat), meat and bone meal and steam [which is condensed] are the end products of the process. [The tallow produced by rendering can be burned to generate steam to heat the cookers.] Meat and bone meal can be incinerated to produce heat and electricity. The process therefore involves a degree of recycling and energy recovery. (p. 3)

For this reason rendering was the preferred disposal method in the UK. However, rendering capacity in the UK was limited to around 15 000 tonnes a week (not all of which was available for FMD disposal), whereas at the outbreak’s peak FMD required the disposal of around 70 000 tonnes (Trevelyan 2002, p.14). Australia would face similar capacity constraints and, like the UK, would be forced to rely on alternative methods.

Summary

Given the different impact of each of the disposal options, and the outbreak-specific nature of these impacts, the Commission has not attempted to cost the likely environmental impact of an FMD outbreak. However, to date, the UK appears to have avoided significant environmental problems.

The key to avoiding potential problems is good preparation. Given the lessons from the UK and the considerable work on carcass disposal that is being coordinated by New South Wales for a possible Australian outbreak, the Commission considers that significant environmental problems could be avoided if there were an outbreak in Australia. However, achieving such outcomes would involve significant ongoing monitoring and remediation costs by government.

9.2 Other impacts

On a smaller scale, the disposal of other animal products could, in some instances, cause environmental concerns. For example, the dairy industry has drawn the Commission’s attention to the problem of disposing of milk during the standstill period when an outbreak first occurs. During the standstill period regular milk collections from farms are unlikely to occur. The necessity of continuing to milk herds and the limited storage capacity on dairy farms could force farmers to dispose of milk on farms.

There might also be some impacts on the environment or on emergency workers from the large scale use of disinfectants to decontaminate properties. During the Newcastle disease outbreak at Mangrove Mountain around 14 million litres of disinfectant were used on the 70 farms affected. Good preparation may be the key to overcoming any effects that might occur from use of disinfectants. For example, citric acid is an effective disinfectant for FMD and would have potentially less environmental effects than a range of other disinfectants commonly used.

Finally, large reductions in farm incomes owing to the loss of export markets may indirectly have an impact on the environment. On-farm expenditure on soil conservation, salinity reduction or general environmental preservation may be reduced as farmers face increased financial pressure and seek to reduce shorter term ‘discretionary’ expenditures.

APPENDIXES

A Conduct of the research paper

This appendix outlines the report process and lists the organisations which have participated to date. Although the project is a commissioned research report rather than a traditional public inquiry, consultation with, and feedback from, industry and government stakeholders has formed an important part of this study.

The Commission held a number of informal discussions with relevant bodies in Canberra, Sydney, Melbourne, Adelaide and Brisbane, and via teleconferences, with Western Australia, Northern Territory and Tasmania. The purpose of these visits was to gain a greater understanding of the issues involved in determining both the economic and social impacts of an FMD outbreak in Australia. A list of the organisations consulted by the Commission are provided below.

In March 2002, the Commission held a workshop as part of the consultation process. The workshop aimed to provide a forum for the Commission to expose its methodology and assumptions for determining the trade and production effects of an FMD outbreak, and to provide some preliminary results for comment. Attendees at the workshop are listed in table A.1.

The Commission's trade and production modelling were reviewed by an external referee, Professor Ron Duncan. A copy of the referee's comments is provided in section A.1.

Meetings with individuals and organisations

Informal discussions were held with the following interested parties.

Australian Capital Territory

- Agriculture, Fisheries and Forestry - Australia
- Animal Health Australia
- Australian Bureau of Agriculture and Resource Economics (ABARE)
- Australian Cattle Council
- Australian Pork Limited
- Australian Quarantine and Inspection Service
- Bureau of Rural Sciences
- Centre for International Economics

- Department of Foreign Affairs and Trade
- Department of Prime Minister and Cabinet
- Government Epidemiologists – AFFA
- Sheep Meat Council of Australia
- Wool Corporation of Australia (now Wool Producers)

New South Wales

- Australian Chicken Growers Council
- Australian Chicken Meat Federation
- Australian Lot Feeders Association
- Australian Poultry Industries Association
- Meat and Livestock Australia
- National Meat Association of Australia
- NSW Farmers Federation
- NSW Government
- Wool Innovation

Victoria

- Australian Dairy Industry Council
- Australian Dairy Council
- Australian Farmers Federation
- Australian Quarantine Inspection Service
- Bill Sykes (Consultant)
- Dairy Technical Services
- Dairy Research and Development Corporation
- Emergency Services
- Environment Protection Authority
- Murray Goulburn
- Premiers Department
- United Dairyfarmers of Victoria (UDV)
- Victorian Government

South Australia

- Department of Human Services
- Premiers Department
- South Australian Government
- State Emergency Services

Table A.1 **Attendees at workshop**

Attendees	*Department or organisation*
Dr Roger Mauldon	Chairman for workshop
Dr Peter Thornber	Animal Health Australia
Dr David Chaffey	Association of Cattle Veterinarians
Mr Nico Klijn	Australian Bureau of Agriculture and Resource Economics
Mr Ali Abdalla	Australian Bureau of Agriculture and Resource Economics
Mr Bill Sykes	Australian Dairy Industry Council
Mr Peter Hetherington	Australian Meat Council
Mr Chris Ambler	Australian Pork Limited
Dr John Plant	Australian Sheep Veterinary Society
Dr Kevin Doyle	Australian Veterinary Association
Mr Scott Williams	Australian Wool Innovation
Mr David Cunningham	Bureau of Rural Sciences
Mr Stefan Fabiansson	Bureau of Rural Sciences
Mr Michael Hartmann	Cattle Council of Australia
Mr Tony Bryce	Centrelink
Mr David Ingham	Dept of Agriculture, Fisheries and Forestry – Australia
Mr Habibur Rahman	Dept of Agriculture, Fisheries and Forestry – Australia
Ms Virginia Perkins	Dept of Agriculture, Fisheries and Forestry – Australia
Mr Rob Newman	Dept of Agriculture, Fisheries and Forestry – Australia
Mr Mike MacNamara	Dept of Agriculture, Fisheries and Forestry – Australia
Mr Colin MacGregor	Dept of Agriculture, Fisheries and Forestry – Australia
Mr Graeme Garner	Dept of Agriculture, Fisheries and Forestry – Australia
Ms Kylie Oakes-Ati	Dept of Foreign Affairs and Trade
Mr Philip Buckle	Dept of Human Services – Vic
Mr Dick Rubira	Dept of Natural Resources and Environment
Mr Bruce Stewart	Dept of Premier and Cabinet – Qld
Ms Mandy Wallace	Dept of Premier and Cabinet – SA
Dr John Switala	Dept of Primary Industries – Qld
Mr Rod Gobbey	Dept of Primary Industries, Water and Environment – Tas
Ms Dorothy Terwiel	Dept of Prime Minister and Cabinet – Commonwealth
Mr Andrew Coghlin	Emergency Management Australia
Mr Trevor Roche	Emergency Management Australia
Mr Peter Koob	Emergency Management Australia
Mr Matthew Munro	Grains Council
Mr Terry Larkin	JT Larkin & Associates
Mr Bruce Standen	Livecorp
Mr David Skerman	Meat and Livestock Australia
Mr Peter Weeks	Meat and Livestock Australia
Prof Ron Duncan	National Centre for Development Studies – ANU
Mr Bruce Christie	NSW Agriculture – Menangle
Mr Kevin Cooper	NSW Agriculture – Menangle
Mr Scott Hansen	Sheepmeat Council of Australia

A.1 Report of the referee

Crawford Building
Ellery Crescent
The Australian National University,
ACT 0200

Mr Herb Plunkett
Assistant Commissioner
Productivity Commission
Canberra, ACT

Dear Herb,

Re: Foot and Mouth Disease Study – Review Report

I have carefully reviewed the assumptions underlying the Productivity Commission's (PC) trade and production model developed to estimate the production and revenue impacts of the three foot and mouth disease (FMD) outbreak scenarios. My review was carried out during the time the modelling was being undertaken. Suggestions that I made during discussions with PC staff were incorporated in the study.

Given the period of time available in which to carry out the study, it is obvious that development of a full behavioural model of the livestock industries and markets involved could not be undertaken. The "cash-flow" approach adopted, involving adjustments in order to achieve convergence between supply and demand, appears to be a sensible "second best" technique for estimating the likely magnitudes of the impact of the FMD scenarios on industry revenues and livestock numbers.

I have reviewed the various assumptions made about herd inventory impacts, as well as the various demand and supply elasticities. These all appear consistent with my understanding of the production and demand characteristics for these industries.

In summary, I believe that the PC's modelling work provides defensible estimates of the production and revenues impacts of the defined FMD scenarios.

Yours sincerely,

(Prof) Ron Duncan
Director
Asia Pacific School of Economics
and Management

B Description of previous disease outbreaks

This appendix outlines the history of four recent disease outbreaks. These are: the mid to late 1990s outbreak of Ovine Johne's Disease (OJD) in south east Australia; the 1999 outbreak of Newcastle disease in New South Wales; the FMD outbreak in the UK during 2001; and the 1997 outbreak of anthrax in Victoria.

B.1 Ovine Johne's disease in south east Australia

Johne's disease is a slow-developing, infectious disease that affects a wide range of animals. In Australia it has been found in cattle, sheep, goats, deer, alpaca and Llama. The disease is caused by bacteria that live in the animal's intestines damaging the gut and impairing the absorption of nutrients. The result is wasting and, ultimately, death of the infected animal. The bacteria can survive outside of host animals for several months. The disease is not currently curable.

While cross-infection between animals species can occur, different strains of the bacteria usually infect only selected animal species. The strain of bacteria which mainly affects cattle, goats, camelids and deer in Australia is known as Bovine Johne's disease. The sheep strain of the bacteria, which also affects goats, is OJD.

OJD was first diagnosed in Australia on the NSW Central Tablelands in 1980, with few infections reported elsewhere in Australia until late 1995. A large scale outbreak of OJD began in East Gippsland in December 1995. While many more flocks were infected at the time in New South Wales than in Victoria, Victoria adopted an aggressive two-year eradication strategy seeking to eliminate the disease before it became endemic.

A control program was devised and put into place. It involved quarantining all properties with infected animals, eradicating all sheep and related animals from the properties and paying compensation to the affected producers for the animals destroyed. The program included comprehensive investigation of flocks linked to the infected sheep, including blood testing and quarantining of flocks suspected of carrying infection. After the inception of the Victorian OJD Control Program, OJD was later found elsewhere in East Gippsland, southern and central Gippsland, and central Victoria, with isolated pockets elsewhere in the State.

In late 1999, the Victorian Government announced a moratorium on the destocking and compensation elements of the program, pending an inquiry into the program and its impacts, and consideration of alternative approaches to the management of the disease. The inquiry report was a comprehensive review of the economic and social impacts of the OJD outbreak. The findings of the report provide an important input into the consideration of the social impacts of FMD undertaken in chapter 8.

By early 2000, 1 287 flocks had been investigated, with 175 infected flocks detected across the State (table B.1). Most of the infected flocks had been destroyed or were in the process of being destroyed. By the end of 2000, 863 flocks (about 1.0 per cent of Australian flocks) were detected as infected with OJD between 1996 and 2000, with the disease concentrated in south-eastern Australia and mainly in New South Wales. Prior to 1996, 224 flocks had been detected, bringing the total number of infected flocks since 1980 to 1 087 flocks, or 1.3 per cent of Australian flocks.

Table B.1 **Cumulative number of known infected flocks between 1996 and 2000**

31 December each year

	Cumulative number of infected flocks recorded					*Total flocks*
State	*1996*	*1997*	*1998*	*1999*	*2000*	*2000*
NSW	158	226[a]	440	499	598	31 875
Vic	33	66[a]	97	175	204	30 000
SA	0	1	20	31	35	8 500
Tas	6	8	19	21	23	2 050
ACT	0	0	2	2	2	85
Qld	0	0	0	0	0	3 215
WA	0	0	0	0	1	8 727
Total	197	301	578	728	863	84 362

[a] Data as at 31 January 1998.

Source: Sergeant (2001), cited in AUSVET Animal Health Services 2001.

At 30 September 2001, 689 flocks were still classified as infected across Australia that had not been destroyed. In addition to identified infected flocks, a further 3 673 flocks (4.4 per cent of Australian flocks) were under investigation as either suspect or under surveillance flocks.

OJD has not been eradicated. In addition to state policies, a National Ovine Johne’s Disease Control and Evaluation Program was established in 1998. This program is managed by Animal Health Australia and is funded by industry and Commonwealth and State Governments. The program seeks to identify infected flocks, put restrictions on movements from infected flocks and flocks suspected of infection, undertake relevant research and trails, and manage a zoning policy which requires testing of flocks trading to higher status zones. The aim of the program is to recommend the optimal method of dealing with OJD in Australia.

Additional information on Johne’s disease can be obtained from Animal Health Australia’s web site at http://www.aahc.com.au/jd/.

B.2 Newcastle disease in the Mangrove Mountain area, NSW

Newcastle disease is a highly contagious, generalised viral disease of domestic poultry, cage and aviary birds and wild birds. Clinically, the effects of the disease ranges from showing no symptoms to a rapidly fatal condition characterised by gastrointestinal, respiratory and/or nervous signs. The disease has the potential to damage significantly the export, import and domestic trade in poultry, other birds and their products. An outbreak in chickens may be so severe that almost all of an affected flock die within 72 hours without noticeable signs.

Overseas experience has shown that Newcastle disease can spread very rapidly and can be carried over long distances by transport of contaminated materials, such as, bird cages, pallets etc. As it is very easily transmitted, strict control of movement of anything that may have become contaminated with the virus and immediate imposition of tightly controlled quarantine on all places suspected of being infected, is essential to a successful eradication program.

Newcastle disease has serious effects on the international trade of animals and animal products. It is subject to the Australian Veterinary Emergency Plan (or AUSVETPLAN). Under AUSVETPLAN, the present policy is to eradicate the disease as soon as it is confirmed. This involves the immediate isolation of infected birds, followed as rapidly as possible by slaughter and sanitary disposal of carcasses. It also involves control or destruction of other animals or birds that could transmit the disease, as well as through cleaning and decontamination of the infected sites.

AUSVETPLAN requires that all farms on which infection is either known or suspected be quarantined. This places severe restrictions on the movement of people and goods from the properties. For example, no one, including the owners, their friends and staff, can leave quarantined premises without changing clothes and footwear. Also, service vehicles on the premises at the time quarantine is imposed must be disinfected as they leave the premises.

On 1 April 1999, an outbreak of the virulent form of Newcastle disease was confirmed in the Mangrove Mountain area of New South Wales. In accordance with AUSVETPLAN, strict quarantine measures were instigated. By 13 May 1999, on the 30 commercial poultry farms in the Restricted Area some 1.9 million meat chickens, 13 000 laying hens, 5 000 ducks, 3 000 meat pigeons, 60 000 started pullets, 17 ostriches and over 2 000 domestic birds had been slaughtered. For roughly 40 other chicken farmers in the Control Area, meat chickens were processed as they reached market age, but restrictions disallowed the introduction of new chickens into the area for growing.

The NSW Department of Community Services undertook a project to assess the impact of the disease on the community. The project culminated in the report *Mangrove Mountain Disaster Recovery Project, Final Impact Report*. Included in the report were the results of a survey sent to the people who lived in the Mangrove Mountain area during the outbreak. The survey provides one of the few sources of data available on the social impacts of livestock disease outbreaks.

B.3 Foot and mouth disease in the UK

On 19 February 2001, a routine inspection at an abattoir in Essex uncovered highly suspicious signs of FMD, which were subsequently confirmed. The source of the infection was traced to Northumberland. Shortly thereafter, further cases were found across England, Wales and Scotland. Also, a small number of cases were detected in Northern Ireland and continental Europe.

The last outbreak of FMD had been in 1967-68. It had lead to the destruction of roughly 434 000 animals. From 1951 to 1967, the UK had suffered 17 occurrences of FMD, averaging about 225 outbreaks (farms affected) per year. There were only two years with no recorded outbreaks of foot-and-mouth during this period. Most were rapidly contained, but in the early 1950s there was also a substantial epidemic. Periods of freedom from foot-and-mouth outbreaks before 1967 were measured in months not years. At the time, the disease was endemic throughout Europe.

In response to the 2001 outbreak, the UK Government introduced measures to seek to control the spread of the disease and eradicate the disease as soon as possible. A ban on meat and live animal exports was imposed on 21 February, followed by the introduction of restrictions on the movement of animals on 23 February. A total ban on livestock movement was in place for ten days. On 27 February, local authorities were given additional powers to close public rights of way.

Over the following 11 months, 2 030 cases of FMD were confirmed with over 4 million animals slaughtered (roughly 595 000 head of cattle, 3.3 million sheep, 142 000 pigs and 4 000 other animals). On 22 January 2002, the Office International des Epizooties restored the UK's international FMD-free status.

A large number of survey, research and inquiry reports have been prepared on the impacts of the outbreak. Some of these provide useful insights into the social impacts, and are utilised in chapter 8. In addition, a number of forthcoming reports are likely to contain information useful in considering the potential social impacts of FMD in Australia, including:

- a second report by the Institute of Rural Health to the National Assembly for Wales. This report is a follow-up to their May 2001 report and is intended to provide information on whether the many health concerns expressed by service providers in the Institute's 2001 survey have eventuated. The report is expected to be released in July 2002;
- a report by the UK National Audit Office into the handling of the FMD outbreak by government departments and other agencies. It will address a range of questions, including the cost of the outbreak in terms of both public expenditure and wider economic and environmental costs. The report is expected to be released in the middle of 2002; and
- the report of the independent UK inquiry into the lessons to be learned from the foot and mouth disease outbreak of 2001. The final inquiry report is expected to be completed by mid-2002.

It became evident at an early stage that the measures to control the spread of the disease were having a major impact industries other than livestock farming, principally countryside recreation and inbound overseas tourism. Subsequent analyses have shown that the effects on those industries had a greater effect on the economy than the effect of FMD on the livestock industries. Analysis has also shown that there was a wide range of impacts related to the health and wellbeing of individuals, families and communities.

B.4 Anthrax outbreak in Victoria

Anthrax has been recognised in Australia for over 150 years as a cause of sudden death in farm animals, particularly sheep and cattle. Animals die within a few hours to a few days. The spore-forming bacteria, *Bacillus anthracis*, which causes the disease, was probably introduced into Australia by contaminated fertiliser imported from the Indian sub-continent.

There have been many outbreaks of anthrax in Victoria and New South Wales that were localised and quickly controlled. In 1997, an outbreak of anthrax in Victoria was detected concentrated in the vicinity of Tatura. This outbreak was different than earlier ones as it occurred almost simultaneously on a number of unconnected properties, and it involved many more properties than previously. The outbreak lasted 62 days with 84 properties confirmed as infected. Vaccinations totalled 78 663 cattle and 2 653 sheep on 631 farms.

As the disease is ineradicable, the control strategy was to limit the occurrence of the disease to a defined area (eg by establishing a buffer zone), prevent the occurrence of further infections within and without of the control area (eg by complementing vaccination with antibiotic therapy); and minimise the impact of the disease, particularly by employing sound hygiene practices.

One human was infected in the outbreak. A knackery worker became infected from contact with an infected carcass and developed the cutaneous (or skin) form of the disease. The worker was treated for 11 days at the Goulburn Valley Hospital and was discharged fully recovered.

The Victorian Department of Natural Resources and Environment undertook a review of the response to the outbreak by the Department. The review highlighted the role of information in responding effectively to the outbreak, and in meeting the needs of industry, the media and the broader community.

C Revenue losses to the livestock industries for each outbreak scenario

The following tables provide a breakdown by jurisdiction and by product of the export and domestic revenue losses to the livestock industries for the 3 month, 6 month and 12 month FMD outbreak scenarios.

Table C.1 **Revenue losses to the livestock industries for the 3 month outbreak**

Net present value of revenue losses at wholesale level

Products	*NSW*	*Vic*	*Qld*	*WA*	*SA*	*Tas*	*NT*	*Aust*
	$m	$m	$m	$m	$m	$m	$m	$m
Export Losses								
Beef	-421	-26	-1 212	-94	-18	-52	-61	-1 882
Sheepmeat	-76	-117	-14	-126	-64	0	0	-398
Pigmeat	-127	-107	-149	-27	0	0	0	-410
Others	-98	-400	-29	-63	-45	-10	0	-643
Total	-721	-649	-1 403	-309	-128	-62	-61	-3 333
Domestic Losses								
Beef	-394	-290	-132	-64	-73	-35	-11	-999
Sheepmeat	-257	-53	-31	-89	-103	-30	0	-563
Pigmeat	-271	-142	-212	-106	-69	-10	-1	-812
Others	0	0	0	0	0	0	0	0
Total	-922	-484	-376	-258	-246	-75	-12	-2 373
Total Revenue Losses								
Beef	-814	-316	-1 344	-158	-91	-87	-72	-2 881
Sheepmeat	-333	-170	-45	-214	-168	-30	0	-960
Pigmeat	-398	-249	-361	-133	-70	-10	-1	-1 222
Others	-98	-400	-29	-63	-45	-10	0	-643
Total	-1 643	-1 134	-1 779	-568	-373	-136	-73	-5 706

Source: PC estimates

Table C.2 **Revenue losses to the livestock industries for the 6 month outbreak**

Net present value of revenue losses at wholesale level

Products	*NSW*	*Vic*	*Qld*	*WA*	*SA*	*Tas*	*NT*	*Aust*
	$m	$m	$m	$m	$m	$m	$m	$m
Export Losses								
Beef	-697	-42	-1 992	-132	-29	-85	-77	-3 054
Sheepmeat	-98	-152	-17	-142	-84	0	0	-494
Pigmeat	-130	-110	-153	-28	0	0	0	-420
Others	-98	-400	-29	-63	-45	-10	0	-643
Total	-1 022	-704	-2 190	-365	-158	-95	-77	-4 611
Domestic Losses								
Beef	-602	-445	-81	-96	-119	-45	-13	-1 402
Sheepmeat	-272	-73	-26	-100	-117	-30	0	-618
Pigmeat	-322	-183	-264	-119	-73	-11	-3	-974
Others	0	0	0	0	0	0	0	0
Total	-1 196	-701	-371	-315	-309	-86	-16	-2 994
Total Revenue Losses								
Beef	-1 298	-488	-2 073	-228	-148	-130	-90	-4 455
Sheepmeat	-370	-225	-43	-242	-201	-31	0	-1 112
Pigmeat	-452	-293	-416	-147	-73	-11	-3	-1 394
Others	-98	-400	-29	-63	-45	-10	0	-643
Total	-2 218	-1 405	-2 561	-680	-467	-181	-93	-7 605

Source: PC estimates

Table C.3 **Revenue losses to the livestock industries for the 12 month outbreak**

Net present value of revenue losses at the wholesale level

Products	*NSW*	*Vic*	*Qld*	*WA*	*SA*	*Tas*	*NT*	*Aust*
	$m	$m	$m	$m	$m	$m	$m	$m
Export Losses								
Beef	-1 578	-95	-4 486	-256	-63	-192	-131	-6 801
Sheepmeat	-255	-366	-47	-299	-192	-1	0	-1 161
Pigmeat	-191	-162	-225	-41	0	0	0	-620
Others	-92	-631	-38	-69	-52	-17	0	-899
Total	-2 114	-1 249	-4 793	-662	-306	-209	-131	-9 480
Domestic Losses								
Beef	-240	-10	-22	-70	-86	-31	0	-460
Sheepmeat	-763	-637	-15	-128	-183	-58	-14	-1 798
Pigmeat	-354	-200	-288	-131	-85	-12	-3	-1 074
Others	0	0	0	0	0	0	0	0
Total	-1 357	-848	-326	-329	-354	-101	-17	-3 332
Total Revenue Losses								
Beef	-1 818	-105	-4 508	-326	-149	-223	-131	-7 261
Sheepmeat	-1 018	-1 004	-63	-426	-375	-59	-14	-2 959
Pigmeat	-545	-362	-513	-173	-86	-12	-3	-1 694
Others	-90	-626	-36	-66	-50	-16	0	-899
Total	-3 472	-2 097	-5 120	-991	-660	-309	-148	-12 812

Source: PC estimates

D Regional and farm analysis

Table D.1 **Livestock dependency and socioeconomic profile of statistical divisions**

	Estimated livestock employment				
	Share of total employment	*Persons*	*Unemployment rate 1996* [a]	*Employment growth 1986–1996* [b]	*Relative socioeconomic disadvantage 1996* [c]
	%	no.	%	% per year	index
New South Wales					
Sydney	0.2	4 020	7.4	1.4	1027
Hunter	2.4	5 010	11.3	1.5	970
Illawarra	1.4	1 890	11.7	1.7	979
Richmond-Tweed	3.9	2 690	15.1	3.6	960
Mid-North Coast	4.8	4 080	16.6	2.6	947
Northern	6.0	4 190	10.4	0.0	978
North Western	7.7	3 540	10.3	0.7	952
Central West	5.9	4 080	8.8	0.8	982
South Eastern	7.0	5 560	8.9	2.0	1004
Murrumbidgee	7.1	4 400	7.7	0.9	989
Murray	7.5	3 440	8.7	0.6	994
Far West	7.8	670	13.5	-1.6	919
Victoria					
Melbourne	0.3	3 930	9.1	1.0	1025
Barwon	3.1	2 800	11.3	1.1	995
Western District	20.1	8 130	8.8	-0.3	1001
Central Highlands	3.7	1 830	11.5	1.0	989
Wimmera	5.9	1 240	7.2	-0.5	1005
Mallee	5.1	1 770	8.1	0.2	983
Loddon	4.5	2 590	11.8	1.4	998
Goulburn	10.6	7 790	8.6	1.1	992
Ovens-Murray	5.7	2 330	8.2	1.6	1007
East Gippsland	12.8	3 700	11.9	0.2	985
Gippsland	10.0	5 500	12.3	-0.6	983
Queensland					
Brisbane	0.6	3 680	8.8	3.0	1010
Moreton	1.7	4 250	12.9	6.1	979
Wide Bay-Burnett	5.7	4 420	14.9	2.7	926
Darling Downs	6.6	5 330	7.6	1.4	982
South West	19.4	2 430	6.3	-0.2	960

(continued on next page)

Table D.1 **continued**

	Estimated livestock employment				
	Share of total employment	*Persons*	*Unemployment rate 1996* [a]	*Employment growth 1986–1996*	*Relative socioeconomic disadvantage 1996* [b]
	%	no.	%	% per year	index
Fitzroy	4.0	3 060	9.1	1.6	972
Central West	29.9	1 820	6.6	-0.5	969
Mackay	1.8	1 030	7.7	2.7	984
Northern	0.8	690	8.7	1.9	981
Far North	1.5	1 490	8.1	4.8	978
North West	9.4	1 710	6.0	0.9	940
South Australia					
Adelaide	0.3	1 220	10.6	0.5	991
Outer Adelaide	5.7	2 350	8.9	2.2	1002
Yorke and Lower North	4.0	600	11.0	-0.8	958
Murray Lands	5.3	1 450	9.0	0.3	939
South East	11.3	3 040	6.9	0.2	977
Eyre	4.4	570	10.4	-0.9	964
Northern	3.2	1 030	13.1	-1.2	936
Western Australia					
Perth	0.5	2 740	8.3	2.6	1020
South West	5.1	3 270	9.4	3.2	965
Lower Great Southern	11.1	2 250	7.9	1.5	982
Upper Great Southern	12.7	1 170	4.3	0.6	1005
Midlands	6.1	1 370	6.7	3.3	980
South Eastern	2.7	780	5.9	1.8	981
Central	4.4	1 210	8.8	-2.2	960
Pilbara	2.3	500	5.4	-0.6	995
Kimberley	4.6	620	5.8	3.7	913
Tasmania					
Greater Hobart	0.5	370	9.7	0.7	1001
Southern	10.1	1 250	12.5	1.1	942
Northern	4.5	2 280	11.3	0.7	966
Mersey-Lyell	4.6	1 860	12.4	-0.5	945
Northern Territory					
Darwin	< 1.0	< 360	7.7	} 2.0	1027
NT – Balance	< 5.0	< 2 070	7.2		909
Australian Capital Territory					
Canberra	0.2	260	7.3	} 1.3	1091
ACT – Balance	5.1	10	8.3		1038

[a] Persons 15 years and over. [b] ABS Index of Relative Social Disadvantage. A lower index value means a greater disadvantage (see ABS Cat. no. 2039.0 for further details).

Sources: ABS *(Integrated Regional Database 1998, Cat. no. 1353.0),* PC (1999*),* ABS *(1996 Census of Population and Housing: Socioeconomic Indexes For Areas, unpublished data)* and PC estimates.

Table D.2 Impact of the 12 month FMD scenario on regional output and employment

MMRF model regions [a]

	Change in value of regional output			*Change in employment*	
Region	*First year*	*Cumulative 10 years*		*First year*	
	%	% of current output	$m	persons	%
New South Wales					
Sydney	0.24	0.07	60	4 240	0.24
Hunter	0.04	-0.36	-48	0	0.00
Illawarra	0.28	0.21	18	560	0.34
Richmond-Tweed	-0.58	-1.62	-75	-860	-1.14
Mid-North Coast	-0.55	-1.59	-88	-980	-1.03
Northern	-1.51	-3.57	-199	-2 380	-2.69
North Western	-1.55	-4.02	-165	-1 750	-3.18
Central West	-1.41	-3.47	-176	-2 000	-2.56
South Eastern	-1.02	-2.59	-133	-1 540	-1.85
Murrumbidgee	-1.02	-2.45	-117	-1 430	-2.00
Murray	-1.21	-3.19	-127	-1 380	-2.55
Far West	-0.73	-2.62	-54	-390	-3.13
Victoria					
Melbourne	0.44	0.29	189	7 020	0.51
Barwon	0.09	-0.37	-25	70	0.06
Western District	-1.17	-2.91	-99	-1 150	-2.12
Central Highlands	-0.04	-0.62	-27	-110	-0.14
Wimmera	-1.07	-2.75	-62	-700	-2.42
Mallee	-0.44	-1.38	-40	-410	-0.92
Loddon	-0.41	-1.47	-81	-730	-0.72
Goulburn	-0.58	-1.73	-87	-920	-1.04
Ovens-Murray	-0.27	-1.06	-36	-310	-0.55
East Gippsland	-0.11	-0.55	-16	-140	-0.38
Gippsland	-0.32	-1.11	-68	-630	-0.69
Queensland					
Brisbane	-0.64	-2.36	-676	-9 330	-1.25
Moreton	-1.08	-3.42	-317	-4 540	-1.89
Wide Bay-Burnett	-1.56	-4.50	-168	-2 250	-2.84
Darling Downs	-2.92	-7.77	-345	-4 590	-5.00
South West	-6.64	-19.55	-270	-2 220	-15.39
Fitzroy	-2.37	-6.71	-296	-3 200	-3.75
Central West	-4.45	-13.23	-129	-1 030	-15.66
Mackay	-0.26	-1.22	-39	-490	-0.87

(continued on next page)

Table D.2 **continued**

Region	*Change in value of regional output*			*Change in employment*	
	First year	*Cumulative 10 years*		*First year*	
	%	% of current output	$m	persons	%
Northern	-0.97	-3.02	-131	-1 740	-1.86
Far North	-0.41	-1.59	-68	-930	-1.01
North West	-2.16	-6.22	-115	-840	-4.25
South Australia					
Adelaide	-0.03	-0.60	-126	-1 020	-0.16
Outer Adelaide	-1.19	-3.22	-72	-1 080	-2.04
Yorke and Lower North	-1.31	-3.17	-39	-660	-3.09
Murray Lands	-1.20	-3.12	-52	-810	-2.32
South East	-1.84	-4.51	-72	-1 140	-3.38
Eyre	-1.21	-3.00	-34	-560	-3.03
Northern	-1.21	-3.57	-74	-950	-2.16
Western Australia					
Perth	0.50	0.68	184	2 610	0.54
Peel	-0.02	-0.33	-4	-30	-0.20
South West	-0.34	-1.02	-29	-260	-0.69
Lower Great Southern	-2.07	-4.65	-67	-650	-3.92
Wheat-belt	-2.21	-5.03	-120	-1 060	-4.32
Goldfields-Esperance	0.19	0.06	2	70	0.28
Gascoyne	-0.77	-2.23	-15	-120	-2.36
Midwest	-0.90	-2.73	-49	-340	-1.85
Pilbara	0.47	0.65	13	160	0.85
Kimberley	-2.32	-6.71	-72	-440	-4.17
Tasmania					
Greater Hobart	0.16	-0.06	-2	60	0.07
Southern	-0.48	-1.69	-14	-140	-0.99
Northern	-0.38	-1.43	-35	-360	-0.64
Mersey-Lyell	-0.36	-1.30	-26	-280	-0.63
Northern Territory	-0.36	-1.87	-83	-410	-0.55
Australian Capital Territory	0.17	0.22	21	380	0.25

[a] The regions identified by the MMRF model differ from the Statistical Divisions in a number of cases. In Western Australia, the South West SD has been split into Peel and South West, the Central SD has been split into Gascoyne and Midwest; the Upper Great Southern SD and the Midlands SD have been combined into Wheat-belt, and the South Eastern SD has been renamed Goldfields-Esperance. In addition, there is one region covering each of the Territories.

Source: MMRF model estimates.

E Economic welfare effects on consumers and producers

This appendix presents a partial equilibrium analysis of the welfare effects on consumers and producers of a potential FMD outbreak in Australia. Partial equilibrium analysis allows an assessment (under certain assumptions) of the net economic impact of policies or events that lead to changes in price and levels of production. Key to such analysis are the concepts of consumer and producer surplus.

The consumer surplus from the purchase of any quantity of a product is the difference, in expenditure, between the amount which the consumer pays for the product and the maximum amount which the consumer would be prepared to pay rather than do entirely without the product.

For a group of consumers, this can be understood by observing that at a given price, a certain quantity of a product will be sold in the market. If the price falls, more of the product is sold, and both the original and new customers who purchase at the new lower price are better off. The original consumers, who had been willing to pay the higher price, have gained a consumer surplus equivalent to the difference between the old and new price.

Producer surplus is analogous to consumer surplus. It is the difference between the amount producers' receive for a commodity and the minimum amount they would accept to produce it.

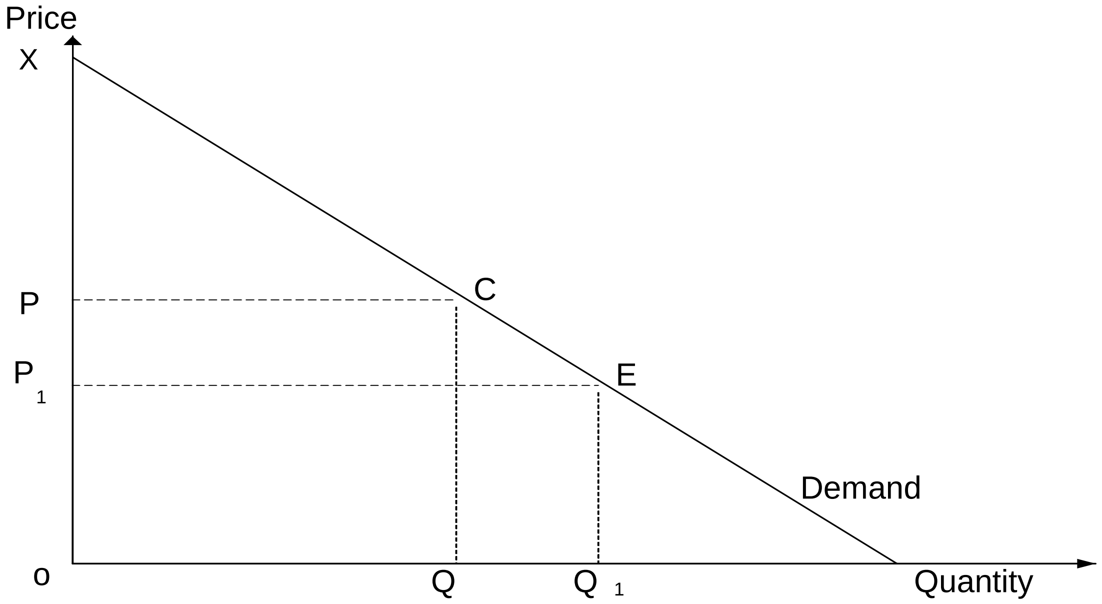
E.1 The welfare changes due to an FMD outbreak

Consumer surplus

In an FMD outbreak the quantity of meat supplied to the domestic market would increase as producers would divert meat to the domestic market which can no longer be sold in some export markets. The increase in quantity supplied would lead to a decline in the price of livestock products. Once consumers realise that FMD does not affect meat quality, consumer surplus would increase because of the increased quantities of meat available at the lower price.

The change in consumer surplus associated with an FMD outbreak is illustrated in figure E.1. Initially P is the price consumers pay and Q is the quantity demanded by consumers and consumer surplus is defined as the area enclosed by XCP. When price falls to P_1 and quantity increases to Q_1, consumer surplus increases by the area $PCEP_1$.

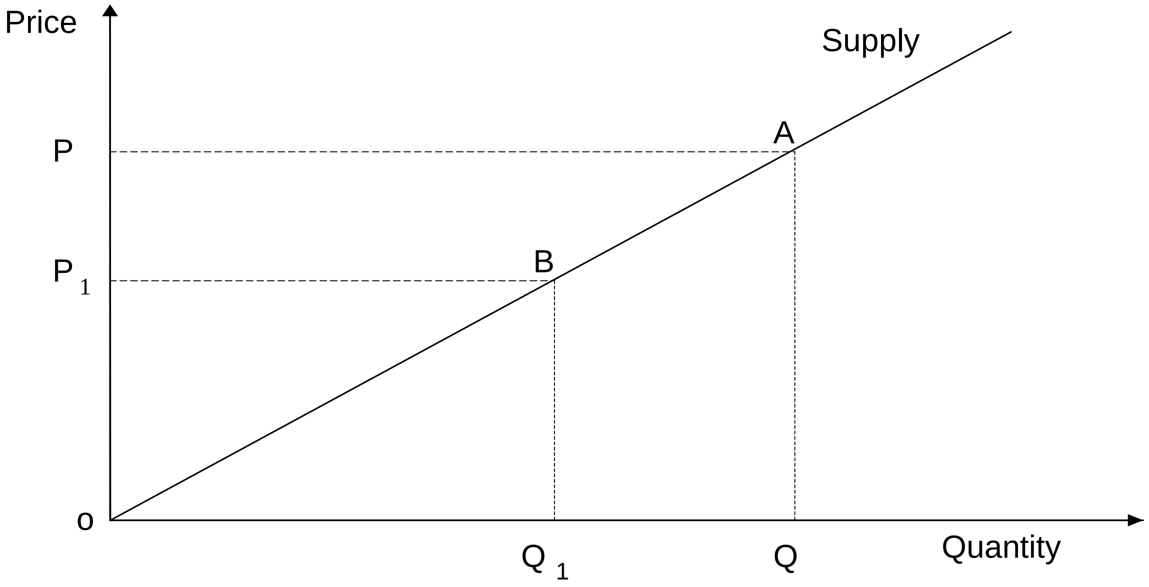
Figure E.1 **Consumer surplus**



Producer surplus

The change in producer surplus arising from an FMD outbreak can also be illustrated diagrammatically. In figure E.2, P is the price charged by producers and Q is the quantity supplied by producers. The supply curve represents the amount of product producers would be willing to produce at different prices for the product. Producer surplus is defined as the area between the price line and the supply curve — initially, the triangle area enclosed by PAO.

Figure E.2 **Producer surplus**



An FMD outbreak would reduce producer surplus. The closure of many export markets would reduce the prices farmers receive and limit the quantity they could sell. Some of the product meant for export will be diverted to the domestic market. The resulting oversupply of meat in the domestic market would lead to price falls, thus reducing returns to production in the market.

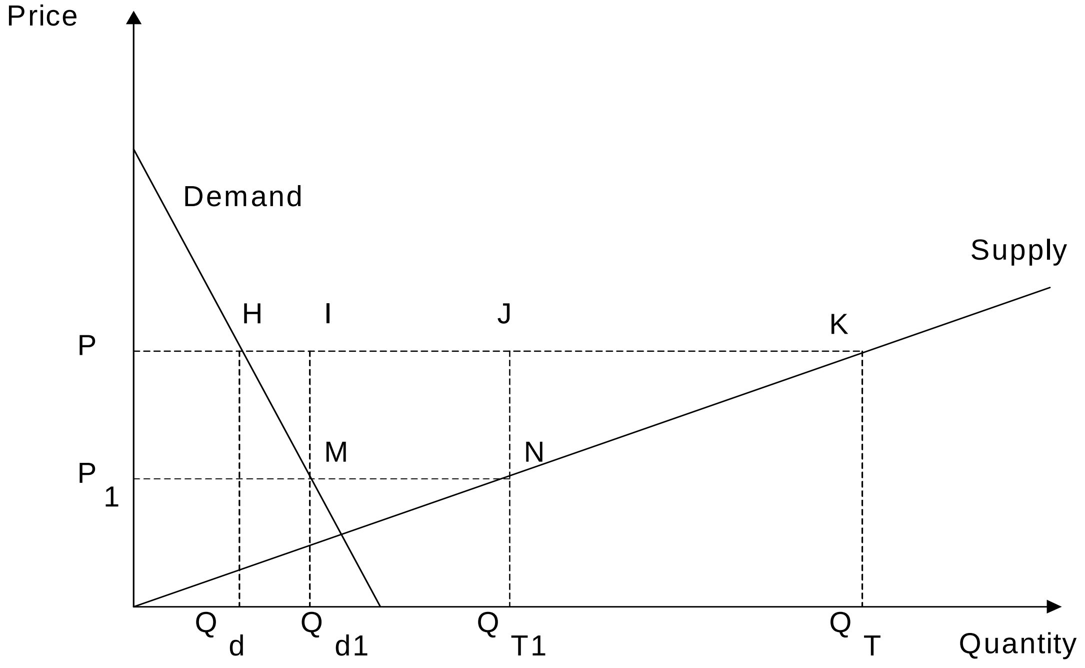
In figure E.2, producers are faced with the lower price, P_1 and, after adjustment, would sell a lower quantity Q_1. The producer surplus under the new price and quantity demanded is the area enclosed by P_1BO. Producer surplus has declined by the area $PABP_1$. The actual loss of revenue experienced by producers would be $PAQO – P_1BQ_1O$, which is considerably greater than the loss of producer surplus.

E.2 Net welfare effect of an FMD outbreak

The net welfare effect for the community, by this analysis, is the sum of the change in consumer and producer surpluses.

Figure E.3 combines the change in consumer and producer surpluses into a single diagram. Area $PHMP_1$ is equivalent to the change in consumer surplus in figure E.1. Area $PKNP_1$ is equivalent to the change in producer surplus in figure E.2.

Figure E.3 **Net welfare effect of an FMD outbreak**



In figure E.3, the price for meat is initially at P and Q_d is consumed locally and $Q_T – Q_d$ is exported. In an FMD outbreak, export markets are significantly reduced and some products diverted from the export to the local market. With the increase in domestic supply, prices would fall, At price P_1, producers would divert $Q_{d1} – Q_d$ of production from the export to the local market. The level of exports will decline by $Q_T – Q_{T1}$. The FMD outbreak equilibrium would be at a price of P_1 with Q_{d1} consumed in the local market and $Q_{T1} – Q_{d1}$ exported.

The loss in producer surplus is the area enclosed by $PKNP_1$. The increase in consumer surplus is the area $PHMP_1$. This increase in consumer surplus represents a transfer from producers to domestic consumers. The area IJNM represents a transfer from producers to foreign consumers which is regarded as a loss in Australian welfare. The areas enclosed by HIM and JKN are losses in producer surplus that are not transferred to other parties.

The net welfare effect of an FMD outbreak (the change in producer surplus less the change in consumer surplus) is represented by the area HKNM.

The Commission has used its trade and production model to estimate the size of the welfare effects of an outbreak lasting 12 months. It estimates that, in net present value terms:

- the loss in producer surplus would be in the order of $7.5 billion;
- the gain in consumer surplus would be in the order of $5 billion; and
- the net welfare loss would be around $2.5 billion.

The estimated welfare losses are significantly lower than the revenue losses to the livestock industry set out chapter 6. Estimates of revenue losses tend to overstate the welfare cost because they do not take account of the transfers to consumers or the ability to redirect resources saved from reducing livestock production to other activities.

However, the estimated loss in producer surplus could understate the welfare costs arising from an FMD outbreak. While the partial equilibrium analysis provides a convenient before and after comparison, it does not capture the costs of adjustment from one equilibrium to another. For example, in the case of an FMD outbreak, a sudden reduction in livestock industry returns and production is not likely to lead immediately to a full redirection of resources to other activities, as is assumed in the analysis. Therefore, the estimate of the net welfare loss should be interpreted as a lower bound to the welfare effect of an FMD outbreak.

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