



Australian Government
Department of Agriculture
ABARES

Potential socio-economic impacts of an outbreak of foot-and-mouth disease in Australia

Benjamin Buetre, Santhi Wicks, Heleen Kruger, Niki Millist, Alasebu
Yainshet, Graeme Garner, Alixaandrea Duncan, Ali Abdalla,
Charlene Trestrail, Marco Hatt, Lyndal-Joy Thompson and Michael
Symes

Research by the Australian Bureau of Agricultural
and Resource Economics and Sciences

Research report 13.11
October 2013



© Commonwealth of Australia 2013

Ownership of intellectual property rights

Unless otherwise noted, copyright (and any other intellectual property rights, if any) in this publication is owned by the Commonwealth of Australia (referred to as the Commonwealth).

Creative Commons licence

All material in this publication is licensed under a Creative Commons Attribution 3.0 Australia Licence, save for content supplied by third parties, logos and the Commonwealth Coat of Arms.



Creative Commons Attribution 3.0 Australia Licence is a standard form licence agreement that allows you to copy, distribute, transmit and adapt this publication provided you attribute the work. A summary of the licence terms is available from creativecommons.org/licenses/by/3.0/au/deed.en. The full licence terms are available from creativecommons.org/licenses/by/3.0/au/legalcode.

This publication (and any material sourced from it) should be attributed as Buetre, B, Wicks, S, Kruger, H, Millist, N, Yainshet, A, Garner, G, Duncan, A, Abdalla, A, Trestrail, C, Hatt, M, Thompson, LJ & Symes, M 2013, *Potential socio-economic impacts of an outbreak of foot-and-mouth disease in Australia*, ABARES research report, Canberra, September. CC BY 3.0.

Cataloguing data

Buetre, B, Wicks, S, Kruger, H, Millist, N, Yainshet, A, Garner, G, Duncan, A, Abdalla, A, Trestrail, C, Hatt, M, Thompson, LJ & Symes, M 2013, *Potential socio-economic impacts of an outbreak of foot-and mouth-disease in Australia*, ABARES research report, Canberra, September.

ISSN 1447-8358

ISBN 978-1-74323-148-7

ABARES project 43344

Internet

Potential socio-economic impacts of an outbreak of foot-and-mouth disease in Australia is available at daff.gov.au/abares/publications.

Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES)

Postal address GPO Box 1563 Canberra ACT 2601

Switchboard +61 2 6272 2010|

Facsimile +61 2 6272 2001

Email info.abares@daff.gov.au

Web daff.gov.au/abares

Inquiries about the licence and any use of this document should be sent to copyright@daff.gov.au.

The Australian Government acting through the Department of Agriculture, represented by the Australian Bureau of Agricultural and Resource Economics and Sciences, has exercised due care and skill in preparing and compiling the information and data in this publication. Notwithstanding, the Department of Agriculture, ABARES, its employees and advisers disclaim all liability, including liability for negligence and for any loss, damage, injury, expense or cost incurred by any person as a result of accessing, using or relying upon any of the information or data in this publication to the maximum extent permitted by law.

Acknowledgements

The authors thank colleagues Sharon Turner, John Stratton, Sam Hamilton and Rhyll Vallis from the foot-and-mouth disease Task Force; Bob Biddle and Graeme Garner from the Animal Health Policy Branch of Animal Division; Ariella Hayek and Peter Hewitt from Animal Biosecurity Branch of Animal Division; Stephen Ottaway and Leone Basher from Export Standards Branch of Food Division; and Bill Matthews and Wendy Voss from Trade and Market Access Division. The authors also thank Lisa Ellison, Nyree Stenekes, Heather Aslin, Sally Thorpe, Edwina Heyhoe and Peter Berry. Thanks also to Robin Condron, Dairy Australia; Justin Toohey, Cattle Council Australia; Wayne Collier, LiveCorp/Meat and Livestock Australia; Sam Lawrence, Australia Pork Limited; the Federation of Australian Wool Organisations; the Sheep Meat Council of Australia and interview and focus group participants.

Foreword

In July 2010 the National Biosecurity Committee endorsed an initiative to apply the National Framework for Biosecurity Benefit Cost Analysis (BCA) to all BCAs that evaluate future biosecurity investments. It aims to ensure national consistency and transparency in BCAs to improve efficiency and timeliness of management decisions on biosecurity investments. A national core capacity for biosecurity BCAs has been created within ABARES as part of this initiative.

ABARES is undertaking BCAs on alternative options to manage selected potential or existing pest and disease incursions. ABARES consults with relevant experts and stakeholders and then communicates the results and policy implications to decision-making entities. These entities include consultative committees, the National Management Group and the National Biosecurity Committee.

Potential socio-economic impacts of an outbreak of foot-and-mouth disease in Australia has been prepared as part of a series of BCAs under the national core capacity.

Australia is free of foot-and-mouth disease, a highly contagious livestock disease. An outbreak is expected to have large economic and social consequences. In order to minimise these impacts, this report seeks to provide input into the policy decision-making process about future investments in preparedness and control policy measures.

This report assesses the economic and social impacts of a foot-and-mouth disease outbreak and presents a benefit costs analysis of three different eradication strategies based on hypothetical outbreak scenarios.

Paul Morris
Executive Director

Contents

Foreword.....	iii
Summary.....	viii
Economic impact	ix
Social impacts	x
Choice of eradication strategy	xi
Reducing market access losses.....	xiii
Response preparedness arrangements	xiii
Communication	xiv
1 Introduction.....	1
Report structure	1
2 The disease and its management	2
Methods of foot-and-mouth control.....	2
Australia's management of foot-and-mouth disease	3
Control strategy to minimise socio-economic impacts.....	4
3 Evaluating control strategies for disease outbreak scenarios.....	6
Outbreak scenarios.....	6
Eradication strategies.....	7
Modelling disease spread using AusSpread.....	7
AusSpread output for alternative control strategies	8
Control costs.....	12
Compensation costs	14
4 Modelling economic impacts of a disease outbreak.....	16
Economic impacts	16
Modelling the economic impacts of a foot-and-mouth outbreak	17
Modelling direct impacts.....	19
Modelling economy-wide impacts	20
Market access assumptions	21
5 Economic impacts of a disease outbreak	25
Large outbreak scenarios	25
Small outbreak scenarios.....	28
Uncertainty in the cost estimates.....	31
Sensitivity analysis	32
6 Social impacts of a disease outbreak	34
Factors affecting the scale of social impacts.....	34

	Social impacts of foot-and-mouth disease.....	38
	Choice of eradication strategy	45
7	Managing social impacts of a disease outbreak	47
	Build an effective response team.....	47
	Communicate effectively.....	47
	Engage local residents and producers	50
	Establish support services.....	50
8	Conclusion	52
	Prevention and early detection	52
	Market access.....	53
	Selection of eradication strategy	54
	Regions will be affected differently.....	56
	Measures to manage social impacts.....	56
	Communication	57
	Appendix A: Disease spread results from AusSpread.....	58
	Small hypothetical outbreak in North Queensland	58
	Small hypothetical outbreak in Victoria.....	59
	Large hypothetical multi-state outbreak	59
	Appendix B: Market access assumptions	61
	Potential cost of FMD in Australia.....	64
	Other livestock products.....	65
	Appendix C: Social impact analysis methods.....	66
	Interview questions	67
	Focus group questions	68
	Appendix D: Socio-demographic profile of the case study regions.....	69
	Victorian case study area profile	69
	Queensland case study profile.....	70
	Appendix E: Communication tools	71
	Appendix F: Participant comments on response strategy	73
	References.....	74

Tables

Table S1 Present value of total direct economic losses for livestock producers over 10 years.....	ix
Table 1 Impacts of FMD outbreak scenarios and alternative control strategies, Australia	10

Table 2 Total foot-and-mouth control costs by strategy and state	13
Table 3 Total compensation costs by strategy and state	15
Table 4 Australian production and exports of FMD-susceptible commodities, 2010-11	17
Table 5 Present value of direct costs of foot-and-mouth disease across 10 years.....	25
Table 6 Estimated regional, state and national impacts—large foot-and-mouth outbreak controlled using stamping out.....	30
Table 7 Change in revenue of other selected industries—large foot-and-mouth outbreak controlled using stamping out.....	30
Table 8 Estimated regional, state and national impacts, small foot-and-mouth outbreak controlled using stamping out.....	31
Table B1 Direct income losses for the livestock and meat processing sectors.....	65
Table C1 Interviews and focus group participants	66
Table D1 Overview of the towns visited in Victoria	69
Table D2 Overview of the towns visited in Queensland	70
Table E1 Overview of participant feedback about communication tools	71
Table F1 Participant comments about three disease control response strategies	73

Figures

Figure 1 Frequency distribution of time to eradicate the large foot-and-mouth outbreak	11
Figure 2 Frequency distribution of time to eradicate the small foot-and-mouth outbreaks	12
Figure 3 Economic impacts from a foot-and-mouth outbreak.....	16
Figure 4 Framework to estimate economic impacts of a foot-and-mouth outbreak	18
Figure 5 Domestic market response to a foot-and-mouth outbreak.....	19
Figure 6 Annual commodities exports following a large outbreak—5 months for eradication using stamping out.....	22
Figure 7 Annual beef exports for different outbreak scenarios and eradication strategies	22
Figure 8 Change in grass-fed beef production relative to the baseline.....	26
Figure 9 Change in grass-fed beef prices relative to the baseline price.....	27
Figure 10 Changes to market access time and market share for beef exports—small outbreak in Victoria controlled using stamping out	33
Figure 11 Framework for analysis of social impacts of a foot-and-mouth outbreak.....	35
Figure B1 Time to regain market access following an outbreak.....	61

Maps

Map A1 Small outbreak, North Queensland	58
Map A2 Small outbreak, Victoria.....	59
Map A3 Number and distribution of infected premises, multi-state outbreak.....	60

Boxes

Box 1 Description of AusSpread model.....	8
Box 2 Estimating control costs.....	14
Box 3 Australian production and trade of FMD-susceptible livestock, 2010–11	17
Box 4 Estimating economic impacts.....	19
Box 5 AgEmissions model	20
Box B1 Consumer preference	64

Summary

Australia is free of the highly contagious foot-and-mouth disease (FMD), which affects cloven hoofed animals including cattle, sheep, goats, pigs, deer, buffalo and camelids. This disease has serious economic and social implications for countries producing and exporting livestock and livestock products. When countries have an outbreak of FMD their livestock export products become subject to trade bans designed to reduce the risk of transmission of the disease to livestock in other countries. For exporters, this results in product being diverted to domestic markets where it sells at much lower prices (due to the increase in supply). Since Australia exports around 60 per cent of livestock production, mostly to markets sensitive to FMD, an outbreak would seriously affect our livestock producers, related agricultural business and other industries.

This report evaluates potential economic costs and identifies the social impacts of a hypothetical FMD outbreak in Australia. The findings will inform policy on future management strategies and help minimise the costs of an FMD outbreak.

ABARES modelled disease control strategies for three scenarios:

- A small outbreak in North Queensland, where most cattle are raised on extensive rangelands.
- A small outbreak in Victoria's Goulburn Valley, which has a high density of livestock and intensive dairy farms.
- A large multi-state outbreak that, by the time of detection, has spread from Victoria to all eastern states (New South Wales, Queensland, South Australia, Victoria and Tasmania).

Disease control strategies examined included:

- for the small and large outbreaks
 - stamping out, which involves destruction and disposal of animals in infected and dangerous contact premises
 - stamping out with extensive vaccination, which requires vaccination of all FMD-susceptible animals within a designated ring surrounding infected and dangerous contact premises; and removal of vaccinated animals once the disease is contained
- for the large multi-state outbreak (in addition to the above)
 - stamping out with targeted vaccination, which includes the vaccination of all cattle and sheep on mixed cattle and sheep farms within a designated ring surrounding infected and dangerous contact premises. In outbreak areas outside the high-risk ring, stamping out (without vaccination) is undertaken.

An outbreak of FMD in Australia would have adverse economic impacts on producers and other industries within and beyond the outbreak area. Financial losses and eradication activities would also have social impacts. Findings suggest these economic and social impacts can be reduced by the choice of eradication strategy. For example, vaccination could play a beneficial role in some outbreak situations. Impacts could also be reduced by resuming market access quickly (where feasible), response preparedness and use of communication before and during an outbreak.

Economic impact

An FMD outbreak would have large direct and indirect economic impacts. Producers of FMD-susceptible livestock would bear most of the revenue losses as a result of restrictions on imports. Flow-on effects to other industries would contribute to the regional and national impacts of an outbreak.

Direct impact

Loss of exports and depressed domestic prices would significantly reduce the revenues of producers. For the simulated examples of two small FMD outbreaks in Queensland and Victoria, assuming that export markets lift bans on Australian product quickly, modelling predicts revenue losses of between \$5.6 billion and \$6.2 billion (in present value terms) over 10 years, depending on the response strategy used (Table S1).

In the event of a large multi-state FMD outbreak, ABARES estimates revenue losses of between \$49.3 billion and \$51.8 billion (in present value terms) over 10 years (Table S1). These revenue losses account for around 99 per cent of direct economic costs, with the remaining 1 per cent being the cost of disease control. The cost of control increases with the size of an outbreak because more animals must be managed. Control costs are estimated at between \$60 million and \$373 million, with \$6.3 million to \$60.2 million required in compensation for animals destroyed during control procedures.

The estimated total direct impact does not take into account potential gains to Australia's domestic consumers from reduced prices for livestock products. Consumer gains would reduce the economic losses as discussed below. The ABARES estimates of total revenue losses include export market loss and loss from reduced domestic prices.

Table S1 Present value of total direct economic losses for livestock producers over 10 years

Scenario/strategy	Control costs (\$b)	Revenue losses (\$b)	Total direct cost (\$b)
Large multi-state outbreak			
Stamping out	0.37	51.84	52.21
Stamping out with extensive vaccination	0.35	49.54	49.89
Stamping out with targeted vaccination	0.32	49.29	49.62
Small outbreak in Victoria			
Stamping out	0.10	5.90	6.00
Stamping out with extensive vaccination	0.09	6.17	6.26
Small outbreak in North Queensland			
Stamping out	0.06	5.58	5.64
Stamping out with extensive vaccination	0.06	5.90	5.96

Note: Present value costs calculated at a discount rate of 7 per cent.

Source: ABARES

Other industry and regional impacts

Other industries may be positively or negatively affected by the outbreak, depending on their relationship with livestock industries. Selected input providers to FMD-susceptible livestock production (for example, transport, trade and feedstock suppliers) could see reductions in the present value of production of \$11.5 billion over 10 years. Some industries that are competitors in production—such as grain and horticulture and their downstream processors—are likely to benefit, with an estimated increase in the present net value of production of \$15 billion over 10 years, compared with no FMD outbreak. These increases are the result of resources, such as land, being diverted from livestock to other agricultural uses.

The large multi-state outbreak scenario would reduce Australia's gross domestic product by an estimated 0.16 per cent (\$23.6 billion in present value terms) over 10 years, while the small Victorian outbreak would result in a reduction of 0.03 per cent (\$4.6 billion). Regions, states and territories would be affected to varying degrees, with larger effects in regions more reliant on FMD-susceptible industries, even where they are outside the outbreak area. Some economies, such as in Western Australia, may benefit if the movement of resources lowers domestic costs of production in other industries (such as lower cost of labour for mining) and increases international competitiveness (Table S2). The regional analysis also accounts for the benefits to Australian consumers of lower prices for livestock products.

Table S2 Estimated regional, state and national impacts—scenarios using stamping out

Jurisdiction	Gross product—small outbreak		Gross product—large outbreak	
	(%)	(\$m)	(%)	(\$m)
New South Wales	-0.01	-605	-0.12	-5 794
Victoria control area	-0.28	-809	-0.92	-2 695
Rest of Victoria	-0.04	-1 207	-0.30	-9 336
North Queensland control area	-0.66	-315	-0.61	-293
Rest of Queensland	-0.18	-5 112	-0.31	-8 755
South Australia	0.01	100	0.01	116
Western Australia	0.14	3 345	0.14	3 395
Tasmania	-0.06	-163	-0.18	-464
Northern Territory	0.06	112	0.15	267
Australian Capital Territory	0.03	100	-0.01	-41
Australia	-0.03a	-4 554 b	-0.16 a	-23 600 b

a weighted total change in gross product **b** Change in gross domestic product.

Source: ABARES

Comparison with other studies

There have been several studies into the impacts of FMD outbreak in Australia undertaken in recent decades. The most comparable studies are those undertaken by the Centre for International Economics and Productivity Commission.

In its estimates of losses for the Australian livestock industry from FMD, the Centre for International Economics (2010) modelled two scenarios: a six-month contained outbreak and a one-year extensive outbreak. The losses under the one-year outbreak were around \$18 billion in which 100 per cent of export markets were closed in the first year. Market access losses represented 90 per cent of total losses with export markets taking between two to four years to fully recover, depending on the size of the outbreak.

The Productivity Commission (2002) estimated income losses to the Australian livestock and meat processing sector of a large FMD outbreak (12 months to eradicate) at \$12.8 billion to \$14.8 billion over 10 years (or \$17.3 billion to \$20 billion inflated to 2012–13 dollars), with around 75 per cent of this cost accounted for by export revenue losses. The study assumed recovery of access to all export markets in three months after the eradication of the disease. The higher estimates in the ABARES study reflect expected market access requirements from trading partners due to a longer time out of the market and a greater loss of market share. The ABARES assumptions are based on data from FMD outbreaks overseas and Australia's experience with other livestock diseases.

Social impacts

In the event of an FMD outbreak, social impacts will occur at the individual, household and community levels. Producers of FMD-susceptible livestock and anyone involved in the agricultural supply chain and the response staff may be affected. As a result, the cumulative

effects on individuals and households will be felt by communities, activities, services and social cohesion.

Many social impacts are generated by the loss of income—such as mental health issues, changed gender roles and reduced welfare. Other impacts may result from the control measures used to manage and eradicate FMD. For example, people living in control and restricted areas around an outbreak are more likely to experience mental health issues caused by movement restrictions, culling and vaccination. These conditions can contribute to feelings of loss of control, animal welfare concerns, uncertainty and social isolation.

The severity of these impacts will be influenced not only by the size of the outbreak and time out of export markets, but also the vulnerability of a community and its ability to recover. Communities with good economic performance and socio-advantage are likely to deal better and recover more quickly from an FMD outbreak.

Choice of eradication strategy

Historically, stamping out has been used to manage FMD outbreaks. It ensures disease eradication and a swift return to disease-free status and access to international markets. However, it involves the rapid destruction and disposal of large numbers of stock. This can be highly resource intensive and can also lead to criticism within the community. More recently several countries have combined vaccination with stamping out to achieve effective control of FMD. Removal of vaccinated animals can delay the time to regain market access after eradication is achieved. However, early vaccination may assist with or be essential for effective disease control (Matthews 2011). Targeted vaccination was examined to explore the effectiveness of control in a situation where resources to undertake widespread extensive vaccination may not be available.

The ABARES study did not examine the vaccinate-to-live strategy, where vaccinated animals are allowed to remain in the population and are not stamped out after the outbreak is controlled. This approach was adopted during the 2010–11 outbreak in the Republic of Korea. Two years later, the World Organisation for Animal Health has still not declared the country FMD-free and acceptability to trading partners remains unclear.

The rate of FMD spread during an outbreak is expected to vary depending on the virus strain, climatic conditions and type of livestock production system. When selecting the most appropriate eradication strategy for an FMD outbreak, factors to consider include likelihood of rapid containment, economic cost and social impact. Results of this study show that combining vaccination with stamping out is an important tool for eradication in some cases.

Least cost strategy

Determining which disease eradication strategy will have the least economic cost will depend on the initial conditions of the outbreak and the type of production system in the outbreak area. Under all the scenarios examined, total direct economic costs were minimised by the eradication strategy that restored market access fastest.

Stamping out is shown to be the most cost-effective strategy for smaller outbreaks in extensive livestock production systems, such as the hypothetical outbreak in North Queensland's cattle producing rangelands. In extensive production areas, rates of disease spread are expected to be low, requiring fewer resources for culling and disposal. For smaller, slower-spreading outbreaks, resources are likely to be adequate to find and remove infected herds using stamping out.

For the outbreak scenario in the extensive production area of North Queensland, ABARES compared stamping out only and vaccination with stamping out. Vaccination provides no reduction in the expected time to eradicate the outbreak. The additional time required to remove vaccinated animals from the population means delays in regaining an FMD-free status and market access. Using vaccination adds to the time out of export markets and increases expected revenue losses from export bans from \$5.6 billion to \$6 billion (in present value terms) over 10 years (Table S1).

For the small outbreak scenario in Victoria's Goulburn Valley intensive high density production area, combining vaccination with stamping out was shown to reduce eradication time compared with stamping out only. Vaccination also reduced the variability in time to eradicate the disease and reduced the chance of an extended outbreak occurring. However, on average, the reduction in eradication time was not sufficient to offset the delay in market access associated with the removal of vaccinated animals. The use of vaccination therefore increased the expected cost of an outbreak from \$6 billion to \$6.3 billion (in present value terms) (Table S1).

For potentially larger, fast-spreading outbreaks, resources may not be adequate to keep up with stamping out requirements, with the risk that the outbreak will not be adequately controlled. In the large multi-state outbreak scenario, vaccination allowed earlier return to trade, even when taking into account the need to remove vaccinated animals from the population in order to regain disease-free status from the World Organisation for Animal Health. For the large outbreak, the reduction in eradication time with vaccination more than offset the additional time required to deal with vaccinated animals, allowing a quicker resumption of trade. As a result, the total direct cost of combining targeted vaccination with stamping out is estimated at \$2.6 billion less than with using stamping out alone (Table S1). Under these circumstances, vaccination is likely to be an effective disease management tool, offering greater certainty in reducing the time taken to contain and eradicate the disease.

Of the two vaccination strategies examined for the large multi-state outbreak, targeted vaccination was shown to reduce the time for eradication. Extensive vaccination requires a large diversion of resources from stamping out to vaccination, increasing the chances of the disease escaping containment. With targeted vaccination, the significantly fewer animals vaccinated require less time for removal, meaning that trade access is regained more quickly.

Social impact of eradication strategies

Impacts of an eradication strategy on communities in affected regions need to be considered in evaluating different control options. The social impact analysis found that participants were confused about the different response strategies available, how and when they should be used and their impacts. The study found a general preference for stamping out among commercial livestock producers, who believed it was the fastest option for removing an FMD threat. However, if stamping out was seen to be failing, vaccination was preferred. Uncertainty about the use of a strategy could lead to frustration and delayed or inappropriate responses by producers, reducing the effectiveness of an eradication strategy. In the event of an FMD outbreak, producers and members of the supply chain should be provided with information on the response strategies and their implications. This will ensure cooperation and reduce confusion and uncertainty.

In selecting a control strategy, the wider community should also be considered. Members of the public are likely to prefer the method that provides greatest perceived animal welfare benefits. Internationally, government policies perceived to have adverse animal welfare implications are attracting public outcry. This includes the use of stamping out strategies, especially where large

numbers of animals are culled. For example, in the United Kingdom and the Netherlands, the mass culling and images of burning pyres and burials in 2001 shocked the public on animal welfare grounds. In 2010–11 the slaughter of apparently healthy animals and the methods used during an FMD outbreak in the Republic of Korea attracted criticism globally. Using vaccination for large outbreaks would avoid large-scale, pre-emptive destruction and disposal of animals and the resulting social and environmental costs.

Reducing market access losses

Most of the economic costs from a hypothetical FMD outbreak arise from revenue losses caused by immediate and prolonged export bans by Australia's FMD-sensitive markets. This study has taken a more comprehensive approach than previous studies in estimating revenue losses from lost export earnings in the event of an FMD outbreak. Advice from the Department of Agriculture and the industry suggests that, for most FMD-sensitive markets, regaining market access and market share will take much longer than the time required for the World Organisation for Animal Health to restore Australia's FMD-free status. This is because importing countries will need to satisfy themselves that Australian livestock and livestock products are safe.

This study highlights the potential cost of prolonged restrictions to access of export markets. Over 10 years, minimal trade restrictions following a small outbreak would result in expected revenue losses of around \$6 billion, compared with losses of up to \$52 billion (in present value terms) with extended trade restrictions following a large outbreak (Table S1).

Re-establishing market access quickly is vital in reducing the impact of an outbreak. Partnerships between industry and government could help prioritise negotiations with key markets and products, address biosecurity risk mitigation requirements for each partner and help reach agreement to restore market access. In preparation for an outbreak, these partnerships could develop strategies to meet certification requirements and commodity specific measures such as FMD treatments for wool and dairy products; they could also establish pre-agreed trading arrangements with trading partners, such as the Australia–New Zealand trans-Tasman FMD Action Plan.

Although not examined in this study, zoning may allow trade to recommence faster and mitigate losses from closed market access. It would be beneficial to identify the conditions under which zoning may be considered acceptable to trading partners, ensuring that diversion of resources to establish and maintain FMD-free zones in Australia is possible. Examining the potential for importing countries to accept exports from countries declared FMD-free using vaccination-to-live could help alleviate public pressure against FMD eradication programs and allow markets to reopen quickly.

Domestic consumer responses in the event of an FMD outbreak were not examined in this study. It was assumed that domestic consumers will respond to lower domestic prices by consuming greater quantities of meat and other livestock products. However, if product diverted to the domestic market was rejected by consumers due to misconceptions about food safety, the market losses would be greater than those estimated in this study. Maintaining consumer confidence during an outbreak will help prevent greater economic and social impacts.

Response preparedness arrangements

Given the large economic cost and associated social impacts of both small and large FMD outbreaks, biosecurity efforts aimed at reducing the likelihood of an FMD outbreak are

fundamental. The Department of Agriculture's ongoing biosecurity efforts help keep Australia free from FMD by managing controls at the border.

Resourcing of surveillance (to allow early detection) and emergency response (to allow rapid eradication) are necessary to prevent the spread of FMD to multiple regions or states and reduce the possibility of economic and social impacts of an outbreak escalating. Preparation for an outbreak could reduce resource constraints, allow more rapid control of an outbreak and reduce outbreak impacts. Preparation includes simulation exercises, arrangements for producers to participate in control activities and improvements for tracing at-risk livestock.

Further investment in a standardised system of national livestock traceability could also aid the technical response to an FMD outbreak and the capacity for Australian industries to regain market access. Successful implementation of the livestock standstill with reliable livestock tracing will provide accurate and timely information on the extent of the disease spread. Decision-makers need this information to identify at-risk animals, choose optimal response measures and manage vaccinated animals. Reliable livestock traceability could enhance trading partner confidence in Australia's ability to control an outbreak and in claims of FMD-free status and proof that FMD-free requirements have been met.

An outbreak of FMD involving feral animals in Australia was not considered in the ABARES study. Such an outbreak might delay detection of disease, increase the extent of an outbreak, complicate and delay disease eradication and compromise demonstration of being disease free. Where feral animal populations are assessed as posing an unacceptable risk, resources may be required to implement control programs under the Australian Veterinary Emergency Plan (AUSVETPLAN) Wild Animal Response Strategy.

Communication

Communication, pre and post-outbreak, can reduce the social impact of an FMD outbreak. This will require a communication strategy that is well understood by the livestock industry, government agencies and support staff involved in a response strategy. Few case study participants were aware of current communication protocols between state agency staff and support staff. Communication about the roles and responsibilities of those involved in the response team is essential to reduce confusion. A clear communication strategy explaining financial compensation policies would alleviate stakeholder concerns and build confidence in the government's ability to respond to an FMD outbreak.

An FMD response plan and its implementation present opportunities to manage the social impacts of an FMD outbreak. Social impacts in the control area could be reduced by engaging local residents and producers, giving producers the option to participate in eradication activities and providing mental health support from response staff with people skills.

Online information about FMD does not appear to be reaching its target audience. Some producers, stock agents and livestock transporters are unaware of FMD implications and associated response plans. Producers do not actively seek FMD-related information; they are more concerned about common diseases and have difficulty justifying the time required to research a disease they consider less likely to occur.

Some businesses may require financial support during an outbreak and recovery. Additional support identified by the social impact analysis includes direct compensation or financial support from government and indirect support from banks holding loans. Engagement by the

Department of Agriculture with agencies and institutions able to provide support (for example, Centrelink and charity organisations) would alleviate the financial and social impacts.

1 Introduction

Australia is free of foot-and-mouth disease (FMD), a highly contagious viral infection of cloven hoofed mammals, including cattle, sheep, goats, pigs, deer, buffalo and camelids. FMD outbreaks in the United Kingdom, Japan and the Republic of Korea show the disease can enter and spread in FMD-free countries with sophisticated biosecurity systems. And it can impose significant economic and social costs.

An FMD outbreak results in trade restrictions on an exporter's livestock products as importing countries try to minimise the risk of introducing the virus. For Australia, a large exporter of FMD-susceptible products, the loss of export markets is likely to increase the supply of livestock products onto the domestic market. This would significantly reduce domestic prices and result in large losses in producers' revenue. An outbreak can also lead to significant social disruption in the surrounding communities.

This report evaluates potential economic costs and identifies the social impacts of a hypothetical FMD outbreak in Australia. The findings will inform policy on future management strategies to minimise the costs of an FMD outbreak. In evaluating potential economic costs of an FMD outbreak, ABARES applied the National Framework for Biosecurity Benefit–Cost Analysis (BCA). This framework was endorsed in 2010 by the National Biosecurity Committee to ensure national consistency and transparency in undertaking BCAs designed to improve the efficiency and timeliness of management decisions on biosecurity investments.

To examine the costs and benefits of FMD management strategies in Australia, plausible disease outbreak scenarios were developed and simulated using the AusSpread epidemiological disease spread model. The scenarios are for hypothetical small outbreaks in North Queensland and in Victoria and a large multi-state outbreak originating in Victoria and spreading to other eastern states. ABARES identified two main control strategies to control and ultimately eradicate the disease—stamping out and combining stamping out with ring vaccination. These were evaluated against each outbreak scenario. Two options were tested for the stamping out with vaccination strategy: in the first option, only at-risk cattle were targeted for vaccination; in the second option, all animal types were vaccinated.

To estimate the economic impacts of an FMD outbreak, results from the spread modelling were used as input into two separate models, AgEmissions and AusRegion (ABARES 2011). AgEmissions estimated direct revenue losses for affected producers and AusRegion estimated economy-wide impacts of an FMD outbreak. Potential social impacts for individuals, households and communities in Australia from an FMD outbreak were assessed through a literature review and discussions with focus groups in Victoria and Queensland.

Report structure

Chapter 2 explores FMD and its management internationally and in Australia. Chapter 3 discusses the outbreak scenarios and control strategies considered in this analysis. Estimated operational costs of implementing alternative response strategies are also examined. Chapter 4 details the economic impacts of an FMD outbreak and the methods used for estimating direct and indirect costs. Chapter 5 presents the results of the economic modelling. Chapter 6 highlights social impacts that may result from an FMD outbreak and the consequences of implementing control measures. Impacts on producers and other stakeholders at a personal, family and community level are discussed. Chapter 7 examines ways to minimise the social impact of an outbreak.

2 The disease and its management

FMD is a highly contagious viral disease of cloven hoofed animals, including cattle, sheep, goats, pigs, deer, buffalo and camelids. Human infections are rare and do not result in serious disease (DAFF 2011). In livestock, FMD has high rates of morbidity but mortality rates, particularly in adult animals, are low. Animals can spread the FMD virus for several days before showing clinical signs of the disease, and the virus can remain for long periods after clinical recovery (DAFF 2011). Despite anecdotal reports, carriers (other than African buffalo) do not appear to have infected susceptible animals (DAFF FMD Taskforce, pers. comm., 14 June 2013).

Various measures can be used to control and eradicate FMD, including:

- imposing movement restrictions on livestock and livestock products
- quarantine of premises that are infected, suspected to be infected or that tracing has deemed at-risk of infection
- destruction and disposal of infected and at-risk livestock; disinfection of contaminated materials on infected premises and of materials that have had high-risk contact with infected premises
- vaccination to increase the resistance of susceptible animals and to reduce their infectiousness should they become infected.

Under World Organisation of Animal Health guidelines, to regain FMD-free status for trade, a country must wait a designated period after the last infected case was removed and submit supporting documentary evidence. The waiting period depends on the control strategy implemented (OIE 2011a). Eradication measures that may be taken and the waiting periods are:

- Stamping out—mandatory slaughter of all susceptible animals on infected properties and burning or burial of carcasses. Animals in other herds that have been either exposed to the infection through direct contact with an infected animal or the pathogen must be slaughtered and disposed of appropriately. Free status without vaccination is reinstated after a minimum waiting period of three months after the last case was eradicated.
- Stamping out with ring vaccination of all susceptible animals and subsequent removal of vaccinated animals from the population. An FMD-free status is reinstated after a minimum waiting period of three months when all vaccinated animals have been slaughtered.
- Vaccination without slaughter of all vaccinated animals. Free status is reinstated after a waiting period of six months after the last case or the last vaccination (whichever event occurs last), provided a serological survey based on the detection of antibodies to non-structural proteins of FMD virus demonstrates the absence of infection in the remaining vaccinated population.

Methods of foot-and-mouth control

The Organisation for Economic Co-operation and Development (OECD) countries have used stamping out to manage FMD outbreaks. This is to ensure quick eradication, a swift return to disease-free status and access to international markets (Junker et al. 2009). However, the destruction and disposal of large numbers of infected and at-risk stock can lead to public outcry. For example, large-scale culling in the United Kingdom in 2001 led to widespread criticism of the government for not using vaccination as part of its control measures (Anderson 2002; Campbell & Lee n.d.).

In some circumstances, early vaccination may assist with or be essential for effective disease control (Matthews 2011). The use of vaccination may be particularly effective in areas of high cattle density and when resources for surveillance and stamping out are limited (Matthews 2011). Several countries have combined vaccination with stamping out to achieve effective control of FMD after stamping out alone failed, such as the Netherlands in 2001 (Bouma et al. 2003) and Japan in 2010. The Republic of Korea adopted a vaccinate-to-live policy in 2011 after 3 million animals had been culled using vaccination with stamping out strategy and a stamping out only strategy (Hagerman et al. 2011). Governments in Japan and the Republic of Korea have overcome their initial concerns that vaccination would delay regaining FMD-free status.

Australia's management of foot-and-mouth disease

In Australia, the Council of Australian Governments recently endorsed the Model Arrangements for Leadership during Emergencies of National Consequence. The arrangements provide a framework to guide government decisions and coordination at the national and state and territory levels during an FMD outbreak (AGD 2009). Together with the Australian Government's Agricultural Incident Plan, a coordinated response can be established for agricultural incidents such as FMD that may impact on Australia's agricultural production industries (DAFF 2012).

In the event of an FMD outbreak, response management will initially rely on the emergency animal disease response plan drawn up by the affected jurisdiction's chief veterinary officer and approved by the Consultative Committee on Emergency Animal Disease and National Management Group in line with policy in the Australian Veterinary Emergency Plan (AUSVETPLAN) (AHA 2012).

The *AUSVETPLAN FMD Disease Strategy Manual* details the policy and management response for emergency animal diseases in Australia. The policy response involves:

- stopping the spread of the disease by imposing animal movement restrictions
- stamping out and/or vaccination
- minimising the time to acquire FMD-free status through the implementation of a response plan capable of achieving quick eradication
- reducing social and financial disruption (AHA 2011).

The National Biosecurity Committee of the Primary Industries Standing Committee has developed a National FMD Action Plan to guide collaborative national action to improve Australia's FMD preparedness.

Movement restrictions on animals, people and equipment is a key feature of Australia's planned response. In the event of a detection or strong suspicion of FMD, a temporary national standstill of all susceptible animals will be immediately implemented for at least 72 hours. During this time the tracing of animals, people and products will be conducted to identify routes of transmission and locate suspect premises where infected animals are yet to show clinical signs of FMD. An inner restricted area will be established around infected properties and movement of livestock to and from these properties restricted. An outer control area may be established based on proximity to an infected property.

AUSVETPLAN states that the default policy for an FMD response is to 'contain, control and eradicate the disease to re-establish the FMD-free status of Australia as quickly as possible, while minimising social and financial disruption' (AHA 2012). The primary strategy involves

stamping out and can be supported by other strategies including vaccination, which may be approved to assist control of an outbreak under some circumstances (AHA 2012). Vaccination may be considered from day one of an emergency response to FMD, according to a recent endorsement by the Standing Council on Primary Industries (SCoPI 2012). A more detailed set of guidelines is being developed for the use of vaccination in the event of an FMD outbreak in Australia (SCoPI 2012).

Control strategy to minimise socio-economic impacts

FMD management strategies should also seek to minimise the overall socio-economic impact on the Australian community. Different control strategies will affect different elements of the total disease cost, including economic impacts, social impacts and operational control costs.

Economic impacts

Most impacts resulting from FMD incursions are attributed to sales revenue losses from the loss of major export markets for livestock and livestock products and, to a lesser extent, to declines in prices of these products in the domestic market. While lower prices in the domestic market will benefit consumers, these would not be sufficient to offset the losses to producers. The length of time export markets remain closed could be significantly influenced by the type of measures used to control disease, depending on the nature and location of an outbreak.

Historically, most livestock producing and exporting FMD-free countries (including Australia) have used stamping out to reduce losses and ensure swift eradication and an early resumption of trade. Stamping out may only be effective where available resources to contain and eradicate the outbreak are sufficient and/or the outbreak occurs in a location where the disease is expected to spread at a low rate, with much less demand on resources for its management.

In situations where management of high rates of disease spread put greater demands on resources, a stamping out only strategy could result in the outbreak overwhelming available resources and rapidly spreading in an uncontrolled manner. Lessons from the 2001 UK outbreak indicate that the limiting factor in fighting a fast spreading disease like FMD is likely to be the capacity to destroy and dispose of infected animals.

In such situations vaccination can be used to slow the spread of the disease to ensure eradication success. Vaccination significantly reduces the number of herds that need to be slaughtered to control disease spread, enabling available resources to deal with infected herds. Resources could be diverted from slaughtering and disposal to vaccination, which would generally require less labour.

Each management strategy has different human and operational resource implications. Selecting the best strategy for a successful and cost-effective eradication will depend on knowledge of available capacity at the time of the outbreak and the epidemiology of the virus in the affected environment.

Social impacts

The alternative strategies considered in this analysis have social impacts on producers and their families in the affected regions. Some of these social impacts are common to all strategies and are less relevant for selecting a management option.

An example of a source of social impact is community concern about mass culling and disposal of animals for containment and eradication. Such sentiments may have increased since the highly

publicised control operations during the 2001 UK FMD outbreak. Consideration of community concern when formulating control policies and strategies may result in the selection of a solution that involves less animal culling or less intensive animal culling.

Social impacts are difficult to estimate in monetary terms because they cannot be determined by market operations. An approximation of their cost would require a comprehensive and costly population survey to establish the average monetary value each individual is prepared to forgo in order for animals not to be culled. However, it is unlikely that this method could be used to estimate the non-monetary personal and household consequences and outcomes of a potential FMD outbreak event.

Operational control costs

Each of the alternative control strategies contains a different mix of operational activities, with each mix requiring a certain level of investment for its implementation. Control costs for each strategy represent a minor proportion of the total disease cost. Where there is an insignificant difference in the impact of each strategy differences in costs could influence the choice of strategy.

3 Evaluating control strategies for disease outbreak scenarios

The size of an outbreak must be identified in order to assess its socio-economic impacts and test the cost effectiveness of alternative control strategies. In an actual outbreak situation, even though the size of an outbreak is unknown when it is first detected, an eradication strategy has to be selected. Eradication is then attempted in accordance with the AUSVETPLAN and using available resources.

An eradication approach must consider many factors that will be known only at the time of the outbreak. These include early reports of the initial infection area, the rate of spread, anticipated resources and other supporting epidemiological data. This information can be used to assist in decision-making during the outbreak and will influence which eradication approach is selected.

In this socio-economic assessment, ABARES used the AusSpread epidemiological model (described later in this chapter) to simulate different types of outbreak scenarios and determine the cost of successfully eradicating such outbreaks through the use of stamping out or a combination of stamping out and vaccination. Output from AusSpread was then used to:

- assess the costs of eradicating these hypothetical foot-and-mouth (FMD) outbreaks
- quantify the economic costs (Chapter 4)
- assess the social impacts of FMD disease spread for comparison of the control strategies (Chapter 5).

Outbreak scenarios

The rate of spread of FMD would vary depending on virus strain, climatic conditions and the physical characteristics of livestock production systems. For example, FMD is likely to spread more rapidly in the more intensive livestock production systems of temperate southern Australia than under the more extensive pastoral grazing systems of northern Australia. The size of a potential outbreak would depend on external factors such as availability of resources to combat the disease and the time elapsed before the disease was detected. The rate of spread would influence the effectiveness and direct control costs of strategies adopted to combat the disease.

Outbreak scenarios were selected to assess the differences in economic and social impacts that may occur between different regions. Biosecurity Animal Division of DAFF developed hypothetical outbreak scenarios for this analysis (Appendix A):

- A small outbreak in North Queensland, where production is predominantly extensively raised cattle on rangelands.
- A small outbreak in Victoria's Goulburn Valley, which has a high density of livestock and a large number of intensive dairy farms.
- A large multi-state outbreak that, by the time of detection, has spread from Victoria to all eastern states (New South Wales, Queensland, South Australia, Victoria and Tasmania).

This multi-state outbreak would take longer to control and eradicate than the smaller outbreaks.

Eradication strategies

It is assumed that FMD in all three outbreak scenarios can be controlled and eradicated using stamping out only and vaccination with stamping out and the subsequent decontamination of the farm. Stamping out combined with ring vaccination involves the vaccination of animals on premises within a designated radius of infected and dangerous contact premises. Following control of the outbreak all vaccinated animals are removed.

Two approaches to vaccination were examined:

- extensive vaccination—vaccination of all susceptible animals (cattle, sheep and pigs) in the designated vaccination rings
- targeted vaccination—within designated high-risk vaccination rings, all cattle are vaccinated and sheep on mixed cattle and sheep farms are also vaccinated. In other outbreak areas outside this high-risk ring, stamping out (without vaccination) is undertaken.

For all outbreak scenarios stamping out only and stamping out with extensive vaccination were evaluated. For the large multi-state outbreak scenario the stamping out with targeted ring vaccination strategy was also considered. This strategy represents a more selective approach to vaccination that may be considered where supply of vaccine and/or resources to administer it are limited, such as in a rapidly spreading multi-state outbreak. Accordingly a targeted vaccination program is applied based on epidemiological advice, in which only cattle in high-risk areas of Victoria are targeted, with sheep in these areas only vaccinated on mixed cattle–sheep farms. This area represents the main focus of disease spread and the greatest risk of rapid spread given high farm and animal densities.

The use of zoning to attempt to establish an FMD-free zone for international trade purposes was not considered in this study because of uncertainties about its possible impact on eradication effort and acceptance by trading partners. Australia’s national policy on the use of zoning in emergency animal disease outbreaks such as FMD is unclear on how zoning might be implemented and whether it would divert significant resources from the response to an outbreak. Diverting resources from controlling the disease to establishing a zone could be counterproductive, as it would increase the likelihood of the disease escaping containment. It is also unclear whether zoning would be accepted by trading partners. Any agreement would require significant bilateral negotiations between Australia and the trading partner (DAFF FMD Taskforce, pers. comm., 14 June 2013).

Analysis of the potential costs and benefits of establishing FMD-free zones to mitigate market access costs is outside the scope of this study.

Modelling disease spread using AusSpread

The establishment and spread of hypothetical FMD incursions for each of these outbreak scenarios and eradication strategies were modelled using DAFF’s AusSpread regional FMD simulation model (Garner & Beckett 2005; Beckett & Garner 2007) (Box 1). As the model is stochastic, 100 simulation runs for each eradication strategy and each outbreak were completed (Appendix A). A stochastic model accounts for random effects in forecasting. AusSpread generates a range of epidemics each time it is run, even with the same parameter settings and produces a probability distribution of likely outbreak durations for each scenario. The output of each variable used in the estimate of economic cost is the average of the spread model outputs from all simulations.

Box 1 Description of AusSpread model

AusSpread is a stochastic spatial simulation model developed to study spread and control of FMD in livestock populations. It simulates disease spread at the farm level in daily time steps, allowing for interactions between farms with different animal species and different production types. Seven different default farm types are identified—specialist beef, dairy, sheep, pig, mixed beef–sheep, smallholders and feedlots. The model allows for the spread of disease through animal movements, local spread, indirect contacts, saleyards and by windborne spread. The attributes and spatial location of individual farms, saleyards, weather stations, local government areas and various other features of the regional environment are incorporated into the model (Appendix A).

An outbreak can be considered in two phases. First, before the first reporting of FMD (pre-detection or silent phase), the disease can readily spread with the normal pattern of animal movements and other forms of interaction within a region. Hence the size and impact of a potential outbreak will depend on external factors such as the time elapsed before the disease is detected. Second, once the disease has been confirmed, a control and eradication program is initiated (response phase) and disease spread will be hampered by, for example, restrictions on the movement of livestock and reductions in inter-farm contact, by the identification and culling of animals on affected farms or by vaccination.

AusSpread is configured to support the range of mitigation measures described in Australia's veterinary AUSVETPLAN for FMD (AHA 2012). This includes quarantine and movement restrictions, stamping out, surveillance, tracing, pre-emptive culling options and vaccination strategies. Users can select mitigation options from within this range to suit any particular response strategy. The efficacy, efficiency and eventual success of any control operation are determined in part by the balance between demand for, and availability of, resources.

AusSpread is parameterised such that the application of mitigation measures on each day of the simulation is implemented only to the level of available resources. The user can specify the availability of teams over time to undertake surveillance, culling and vaccination. If available resources are insufficient to accommodate all the operational activities scheduled for a given day, a backlog builds up and is carried over to the next day.

Allowing likely duration of outbreak, number of infected and destocked farms, dangerous contact premises and number of animals culled and vaccinated to be estimated—FMD spread is simulated 100 times for each of the eradication strategies and for each outbreak scenario (Appendix A).

AusSpread output for alternative control strategies

Results from AusSpread—the epidemiological model used to study the spread and control of FMD in livestock populations—show that the eradication time and number of animals culled vary with the control strategy implemented. The effect of the control strategy on these two variables differs depending on the potential size and location of an outbreak and the production system affected.

Effect of production system

Outbreaks in extensive production areas (such as the North Queensland outbreak scenario) are likely to experience lower rates of virus dissemination and require limited control resources. The use of vaccination in this scenario had little effect in reducing the number of animals culled or the time taken to eradicate the disease.

However, in the Victorian small outbreak scenario (where production is largely intensive), vaccination reduced the number of animals culled by, on average, about 21 per cent and the duration of the outbreak by, on average, 6 per cent compared with the stamping out strategy (Table 1). This demonstrates the difference in effectiveness of vaccination in a high density livestock production system (Victoria) compared with a less intensive system (North Queensland). In situations where disease spreads rapidly, particularly where resources to identify and remove infected herds may be limited, vaccination can be effective in containing an outbreak.

Effect of the size of outbreak

Increased effectiveness of the use of vaccination with potentially larger outbreaks is demonstrated by simulation results for Victoria of small and large outbreak scenarios.

Combining stamping out with targeted vaccination in the large outbreak reduced the number of animals culled in Victoria by 81 per cent, and the outbreak duration by, on average, 30 per cent compared with stamping out. This reduction is significantly greater than that for the small Victorian outbreak. Previous research has shown that mass culling could be demanding in terms of overall resource requirements if vaccination is not used to ease the pressure on resources, especially in a fast and widespread outbreak.

Supporting evidence from earlier research

ABARES earlier research, using the same epidemiological model, found the stamping out strategy to be the higher cost option in eradicating an outbreak in Victoria, particularly where the virus was initially widespread and availability of resources needed to manage containment through culling and disposal of infected and at-risk animals was uncertain. That analysis found that a 20 per cent reduction in availability of resources to combat the disease could more than double the expected cost of an outbreak under a stamping out strategy. By contrast, the expected cost of the combined stamping out with extensive vaccination strategy is estimated to increase by only 6 per cent, indicating that this would be a preferred management strategy under a situation where adequate capacity for successful culling and disposal operations is not certain (Abdalla et al. 2005).

The Abdalla study also tested the effect of increasing the time assumed to elapse between incursion and first detection on the potential cost of the outbreak. With an assumed one-week delay in detecting the disease, the estimated probability of containment became very low under the stamping out strategy, resulting in substantial expected costs, with the vaccination strategy likely to be the least-cost option under these circumstances. Nonetheless, the escalation in expected costs of a disease outbreak as a result of late discovery could be considerable under both strategies, suggesting that early detection would be paramount if disease costs were to be significantly curtailed.

Table 1 Impacts of FMD outbreak scenarios and alternative control strategies, Australia^a

Scenario/state/strategy	Eradication time (days)	Animals culled (no.)	Animals vaccinated (no.)	Decrease eradication time (%) ^c	CV for days ^b
<u>Large multi-state outbreak</u>					
New South Wales					
Stamping out	64	5 405	–	–	0.10
Stamping out with extensive vaccination	71	5 282	61 895	–10.9	0.11
Queensland					
Stamping out	61	2 465	–	–	0.14
Stamping out with extensive vaccination	67	2 251	5 703	–9.8	0.10
Victoria					
Stamping out	155	114 665	–	–	0.57
Stamping out with extensive vaccination	113	40 402	403 591	27.1	0.15
stamping out with targeted vaccination	109	41 802	135 788	29.7	0.17
South Australia					
Stamping out	63	4 227	–	–	0.40
Stamping out with extensive vaccination	66	3 530	80 041	–4.8	0.23
Tasmania					
Stamping out	57	418	–	–	0.10
Stamping out with extensive vaccination	62	484	21 014	–8.7	0.04
National subtotals					
Stamping out	155	127 180	–	–	–
Stamping out and extensive vaccination	113	51 949	572 244	27.1	–
National total	109	54 316	135 788	29.7	–
<u>Small outbreak in Victoria</u>					
Stamping out	103	48 812	–	–	0.35
Stamping out with extensive vaccination	97	38 624	269 065	5.8	0.14
<u>Small outbreak in North Queensland</u>					
Stamping out	68	18 703	–	–	0.07
Stamping out with extensive vaccination	68	18 650	9425	–0.3	0.09

^a Values are averages estimated from 100 simulations. ^b Coefficient of variation for eradication time. ^c Relative to stamping out.

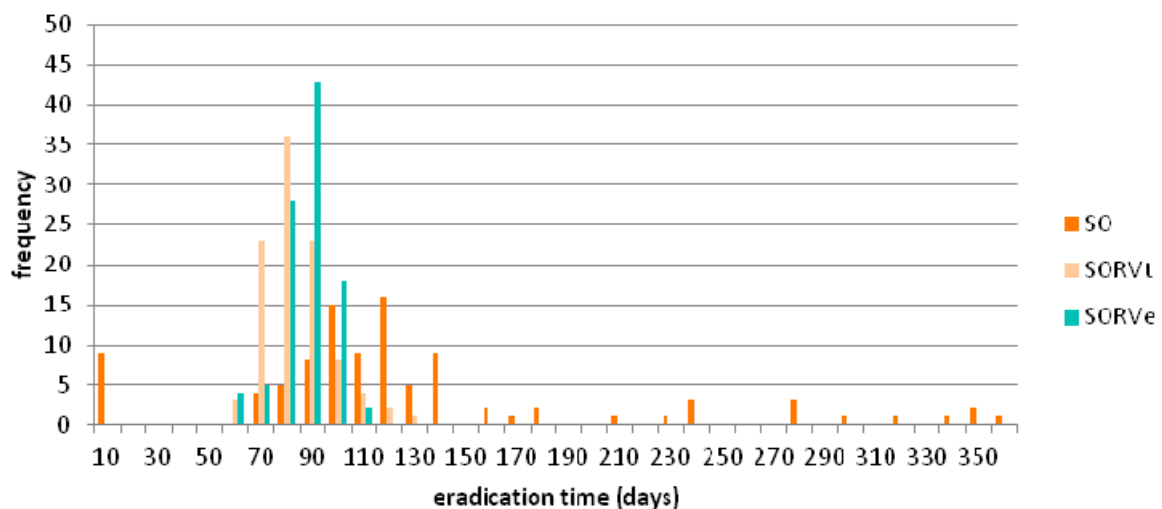
Source: ABARES estimate; Garner 2012

Other factors for choosing between strategies

The results with all strategies showed a degree of variability. Vaccination was the most effective at reducing the variation in outcome, especially in intensive production systems or with large outbreaks. This is reflected by the small coefficients of variation in the duration of eradication for strategies involving vaccination (Table 1). This shows that very large outbreaks are most likely to occur when stamping out on its own is used—these large outbreaks occur when resources are inadequate to rapidly find and decontaminate infected premises. The findings suggest that vaccination is likely to be useful when resources to effectively implement stamping out are stretched (due to the size of the outbreak or high rates of spread) and risk mitigation is prioritised to reduce the likelihood of a large outbreak occurring.

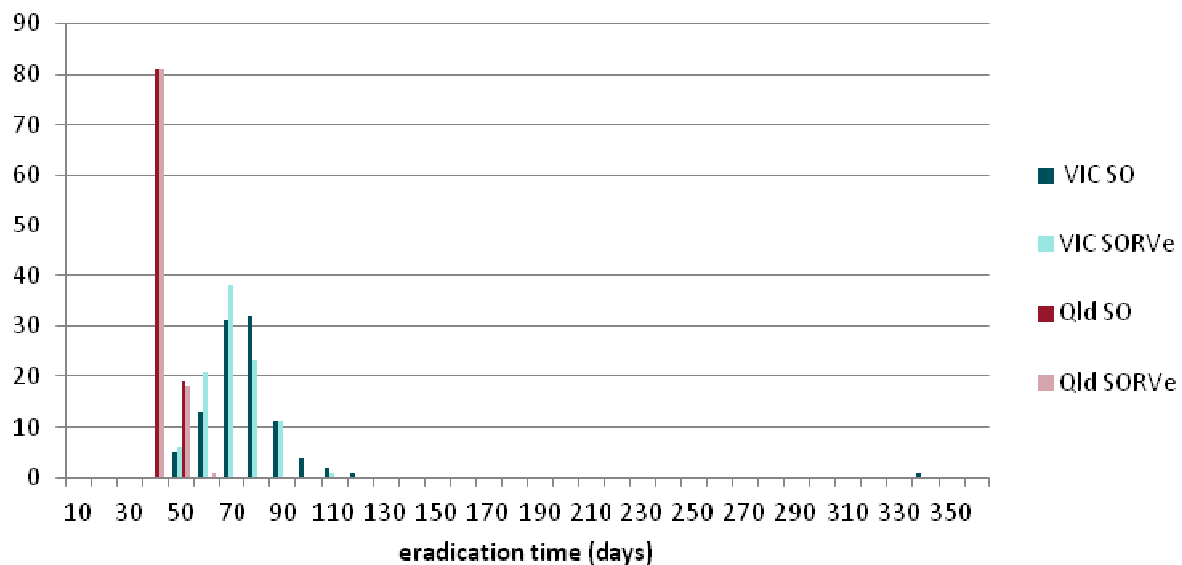
The model results suggest that, with the stamping out policy, there is a chance the disease could get out of control for extended periods, as shown by the right-hand tail of outbreak duration under this strategy (Figure 1; Figure 2). By contrast, using vaccination would reduce the chances of the disease escaping containment and delaying eradication. The reduced frequency of extended eradication time with vaccination is a key benefit of implementing this strategy.

Figure 1 Frequency distribution of time to eradicate the large foot-and-mouth outbreak



SO = stamping out. SORVe = stamping out with extensive vaccination. SORVt = stamping out with targeted vaccination

Note: Frequency of eradication based on 10-day intervals.

Figure 2 Frequency distribution of time to eradicate the small foot-and-mouth outbreaks

SO = stamping out. SORVe = stamping out with extensive vaccination.

Note: Frequency of eradication based on 10-day intervals.

The study has also clearly shown that, in a large outbreak, targeting vaccination to higher risk species and areas is a better approach than vaccinating all susceptible species in all infected areas. In Victoria, the total number of animals vaccinated in the extensive vaccination is triple that of the targeted vaccination, while the total number culled during extensive vaccination is estimated to be twice as large as during targeted vaccination. Modelling suggested it takes longer to eradicate the disease using extensive vaccination. This is due to the size of the vaccination program and diversion of resources from culling infected animals to vaccination.

Control costs

In this analysis, the cost of eradication for each scenario is broken into cost of labour, decontamination, slaughter and disposal, hire of equipment and facilities, stores and laundry. Values are estimated from spread model results and previous studies (Abdalla et al. 2005; Garner, Roche & Wicks 2011) (Box 2). This approach provides a more accurate representation of the potential costs for an outbreak in Australia than using aggregate cost estimates for outbreak experiences elsewhere.

Control costs for each scenario by control strategy were estimated for affected states and nationally (Table 2). In all scenarios and strategies, estimated control costs are highest in Victoria. This is not surprising since Victoria was the worst affected state and had the highest infection rate in the hypothetical scenarios examined. Victoria was also the only state where the use of vaccination reduced control costs when compared with using stamping out only. On average the percentage reductions in costs are estimated at 5.2 per cent for the small outbreak and over 30 per cent for the large outbreak.

For the large multi-state outbreak, nationwide control costs could vary depending on what type of strategy, or combination of strategies, is adopted to control the disease:

- If a stamping out strategy was adopted in all states, eradication costs would be the highest, at an estimated \$373 million, on average.
- If a strategy of targeted ring vaccination to curtail the rate of disease spread was adopted in Victoria with other states only stamping out, overall control costs are estimated to decline by 13 per cent to \$324 million, on average.
- If all states except Victoria adopted vaccination, the cost would be reduced on average to \$347 million, or by only 7 per cent.

These results indicate that under the large outbreak scenario, while the use of extensive vaccination reduces control costs in Victoria, it raises these costs in other states. With limited cases of disease in New South Wales, Queensland, South Australia and Tasmania, the results of disease spread modelling showed little variation in the number of animals culled under both stamping out alone and stamping out combined with vaccination strategies. This means that, while the cost of stamping out infected animals and dangerous contacts are similar for the two strategies, an added cost of vaccinating uninfected animals is incurred in the vaccination strategy.

Total control costs are shown to be significantly smaller for the small outbreaks compared with the large outbreak. Control costs in the large outbreak are as high as 84 per cent above costs in the small outbreak (Table 2).

Although not considered in this report, an outbreak of FMD involving feral animals in Australia could delay the detection of disease, increase the spread, delay disease eradication and proof of disease-free status. Resources for control programs to undertake the AUSVETPLAN Wild Animal Response Strategy may be required where feral animal populations are assessed as posing an unacceptable risk. This will increase the cost of controlling an outbreak.

Table 2 Total foot-and-mouth control costs by strategy and state a

Scenario/strategy	Vic. (\$m)	Qld (\$m)	NSW (\$m)	SA (\$m)	Tas. (\$m)	Total (\$m)
Large multi-state outbreak						
Stamping out	153	55	58	56	51	373
Stamping out with extensive vaccination	107	60	64	60	56	347
Stamping out with targeted vaccination b	104	55	58	56	51	324
Small outbreak in Victoria						
Stamping out	96	na	na	na	na	96
Stamping out with extensive vaccination	91	na	na	na	na	91
Small outbreak in North Queensland						
Stamping out	na	61	na	na	na	61
Stamping out with extensive vaccination	na	62	na	na	na	62

Note: **a** Values are averages estimated from 100 simulations. **b** Targeted vaccination in Victoria only and stamping out in all other states. **na** Not applicable.

Box 2 Estimating control costs

Abdalla et al. (2005) estimated decontamination costs for each industry based on labour requirements and the hire of necessary equipment for operations. These costs differ between industries depending on the construction of properties in each industry. Decontamination costs are estimated at \$50 000 per piggery, \$35 000 per dairy enterprise and \$20 000 per sheep and beef cattle enterprises. Furthermore, Garner, Roche and Wicks (2011) have assumed that the decontamination costs for mixed sheep and beef cattle farms are similar to estimates for beef and sheep provided above and are one-quarter of these costs for smallholder farms, where a smallholder farm has an average of 15 animals per property. Decontamination covers all properties where infected and dangerous contact herds are slaughtered.

In this analysis, it is assumed that vaccinated properties do not undergo decontamination. However, a small number of properties close to the vaccinated properties may be decontaminated. If this were to occur, actual costs of control for strategies involving the use of vaccination would be slightly higher than values estimated in this analysis.

The stamping out, slaughter and disposal of infected and dangerous contact animals is estimated at around \$15 000 for a herd of 4 000 sheep or pigs and a similar amount for 400 head of beef or dairy cattle (Abdalla et al. 2005). It is assumed that the slaughter and disposal of infected and dangerous contact animals is undertaken on farms.

Disease spread modelling in the ABARES analysis simulates emergency vaccination where a single dose is adequate, as vaccinated animals are assumed to be earmarked for slaughter. The costs for labour, cold storage, consumable items and delivery are estimated to be \$4.12 per dose, based on costs indexed from Garner, Roche and Wicks (2011).

The total labour costs for administration of the control strategies, such as the cost of administration, monitoring, surveillance activities and the running of local disease control centres, is based on estimates provided in Garner, Roche and Wicks (2011). It is assumed that all control centres will operate until the region or state is declared disease free.

In the ABARES analysis all costs are estimated in 2011–12 dollars.

Compensation costs

As specified in the government and livestock industry cost-sharing deed, the Emergency Animal Disease Response Agreement, farmers are to be compensated for slaughtered animals in accordance with prevailing livestock market prices. Arrangements for compensation payments where producers are forced to have their stock destroyed are based on the market value of stock. When affected properties are no longer quarantined, producers can apply for additional compensation equal to the difference between their initial compensation payment and the market value of the replacement stock. Compensation is based on the replacement market value (Abdalla et al. 2005).

Under the Emergency Animal Disease Response Agreement (EADRA 2001), compensation is to be paid to the owner of:

- any livestock or property that is destroyed for the purpose of eradication or prevention of the spread of an emergency animal disease
- any livestock that was certified by an accredited veterinarian to have died of the disease or livestock that would have been compulsorily slaughtered had they not died.

The deed also states that:

In determining the compensation to be paid no allowance shall be made for loss of profit, loss occasioned by breach of contract, loss of production or any other consequential loss whatsoever (in the context of the deed) (EADRA 2001).

For this analysis, livestock prices per head for each industry were obtained for 2011 from the ABARES Australian Agricultural and Grazing Industries Survey. Based on the current provisions in the deed it is assumed in this study that the slaughter of vaccinated animals would be undertaken through abattoirs, with no compensation provided for these animals. Changes to this policy would increase the estimated cost of compensation.

Compensation payments were estimated for each disease outbreak scenario and control strategy (Table 3). On average, costs vary between \$6.3 million and \$60.2 million, depending on the size and location of the outbreak and control strategy employed to eradicate the disease.

Table 3 Total compensation costs by strategy and state ^a

Category	Vic. (\$m)	Qld (\$m)	NSW (\$m)	SA (\$m)	Tas. (\$m)	Total (\$m)
Large multi-state outbreak						
Stamping out	56.3	1.3	1.4	1.0	0.3	60.2
Stamping out with extensive vaccination	17.9	1.3	1.3	0.8	0.3	21.6
Stamping out with targeted vaccination b	36.4	1.3	1.4	1.0	0.3	40.3
Small outbreak in Victoria						
Stamping out	16.4	na	na	na	na	16.4
Stamping out with extensive vaccination	12.0	na	na	na	na	12.0
Small outbreak in North Queensland						
Stamping out	na	6.3	na	na	na	6.3
Stamping out with extensive vaccination	na	6.3	na	na	na	6.3

a Values are averages estimated from 100 simulations. **b** Targeted vaccination in Victoria only and stamping out in all other states. **na** Not applicable.

4 Modelling economic impacts of a disease outbreak

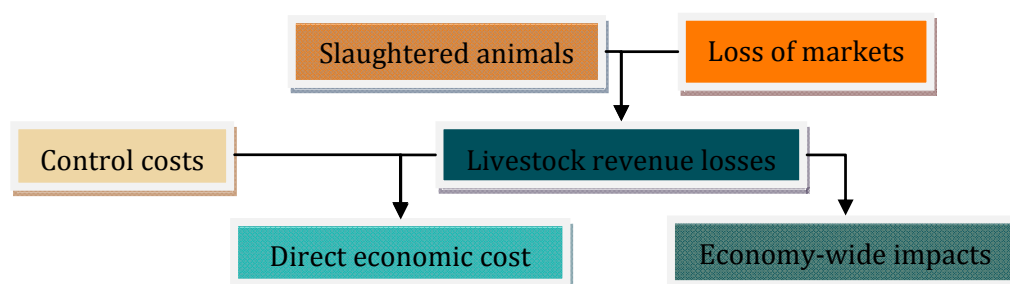
Once the presence of foot-and-mouth disease (FMD) is confirmed in a country, most other countries will immediately ban the importation of its FMD-susceptible livestock products. Trade bans on Australian exports following an FMD outbreak could cause substantial economic losses. For a large exporter of livestock and livestock products such as Australia—which exports 70 per cent of production value from FMD-susceptible livestock and livestock products (Box 3; Table 4)—economic losses from trade bans can far outweigh the cost of control (Horwitz 2012).

An FMD outbreak in Australia could result in direct economic costs to industry and flow-on effects to other related industries and the economy. Choosing an FMD management strategy will involve several trade-offs as the strategy employed will influence the operational control costs, duration of the outbreak, duration of export market access restrictions (Abdalla et al. 2005) and the flow-on effects of these to other industries. These trade-offs, as well as the social impacts, need to be considered in selecting a management strategy.

Economic impacts

An outbreak of FMD is expected to generate direct economic costs to FMD-susceptible livestock industries, and flow-on effects to related industries and other sectors of the economy (Figure 3).

Figure 3 Economic impacts from a foot-and-mouth outbreak



Source: ABARES

The direct cost is the total cost borne by livestock industries. This comprises two elements: revenue losses in the livestock industry as a result of losses both in domestic and export markets and the cost of control strategies (Chapter 3). The annual revenue loss will depend on the products excluded from trade and the time to regain access and recover trade (Box 4). Economy-wide effects are the combined revenue losses or gains throughout the economy as a result of outbreak-induced changes in supply of and demand for FMD-affected products. It represents the direct and flow-on effects on the economy.

Flow-on effects from an FMD outbreak can impose economic costs on other industries (Rich 2004) including upstream and downstream industries related to agriculture and rural tourism. The interdependence of business enterprises in rural areas can result in income and job losses in businesses related to agriculture, with large sections of the community negatively affected. For example, in 2001 FMD outbreaks in the United Kingdom resulted in the closure of markets, abattoirs and haulage companies and several agricultural advisors, shearers and other

rural contractors lost their jobs (Barclay 2005). In Australia, an outbreak could also affect tourism, transport and sport (DAFF 2005). There may also be some benefits to consumers in terms of lower prices.

Box 3 Australian production and trade of FMD-susceptible livestock, 2010–11

Table 4 summarises Australia's production and export statistics for FMD-susceptible commodities, including red meat, live exports and other livestock products such as wool and milk products.

These statistics illustrate that revenues generated from FMD-susceptible commodities are due to the large revenues generated from exports. Therefore, trade restrictions on these commodities may result in large revenue losses to Australian livestock producers. In 2010–11 the volume of beef and sheep meat exports was approximately 63 per cent of total production and the value of beef and sheep exports, including live exports, (at wholesale prices) was estimated at 65 per cent of the gross value of production. The quantity of wool exports in 2010–11 was approximately equal to annual domestic production and valued at \$3 048 million (fob). The value of dairy products exported (at wholesale prices) was estimated at 46 per cent of the gross value of production. However, the impact on the pork industry is expected to be less severe because in 2010–11 the value of pork exports (at wholesale prices) was estimated at 10 per cent of the total value of pork production.

Australia's meat exports are currently concentrated in a few major markets. In 2010–11 beef and veal meat exports (at wholesale prices) was estimated to represent 64 per cent of Australia's gross production value. Japan, the United States and Republic of Korea imported around 69 per cent of total exports in the same year (ABARES 2012). The majority of Australia's live cattle and sheep exports are destined for Asia and the Middle East. The United States is the largest destination for Australian lamb, accounting for around 20 per cent of the volume of exports. Other destinations for lamb include the China, European Union, Japan and Middle East. The Middle East is a major destination for Australian sheep meat, with mutton accounting for 46 per cent of the volume of Australian exports in 2010–11. The largest importers of Australian pig meat in 2010–11 were Singapore (53 per cent of export value), New Zealand (14 per cent) and Papua New Guinea (9 per cent) (ABS 2013). By contrast, milk products are exported to many countries, with the largest market in Japan, followed by Singapore and China.

Products not examined here may also be affected by trade bans, including other livestock products such as offal and hides and agricultural inputs such as used farm machinery (Appendix B).

Table 4 Australian production and exports of FMD-susceptible commodities, 2010-11

Commodity	Production				Exports		Domestic meat consumption
Sector	Herd numbers (m)	Slaughtered (m)	Quantity (kt)	Gross value (\$m)	Quantity (kt)	Value (\$m fob)	Quantity/person (kg)
Beef meat a	25.9	8.1	2 133	7 164	937	4 328	33.9
Live cattle exports	na	na	728 c	660	728 c	499	na
Dairy cattle (milk production)	2.6	na	9 101 b	3 932	488 d	2 345	na
Sheep meat	73.1	23.2	514	2 513	243	1 429	9.5
Live sheep exports	na	na	2 916 c	348	2 916 c	348	na
Wool	na	na	429	2 673	444	3048	na
Pig meat	0.3 e	4.6	342	919	31	106	24.6

a The quantity of beef produced from dairy cattle is included in the value for beef meat. b Milk production in megalitres (ML). c Number of animals million. d Butter, cheese, casein, skim and whole milk powder exported (kt). e Number of sows. na Not applicable.

Source: ABARES 2013

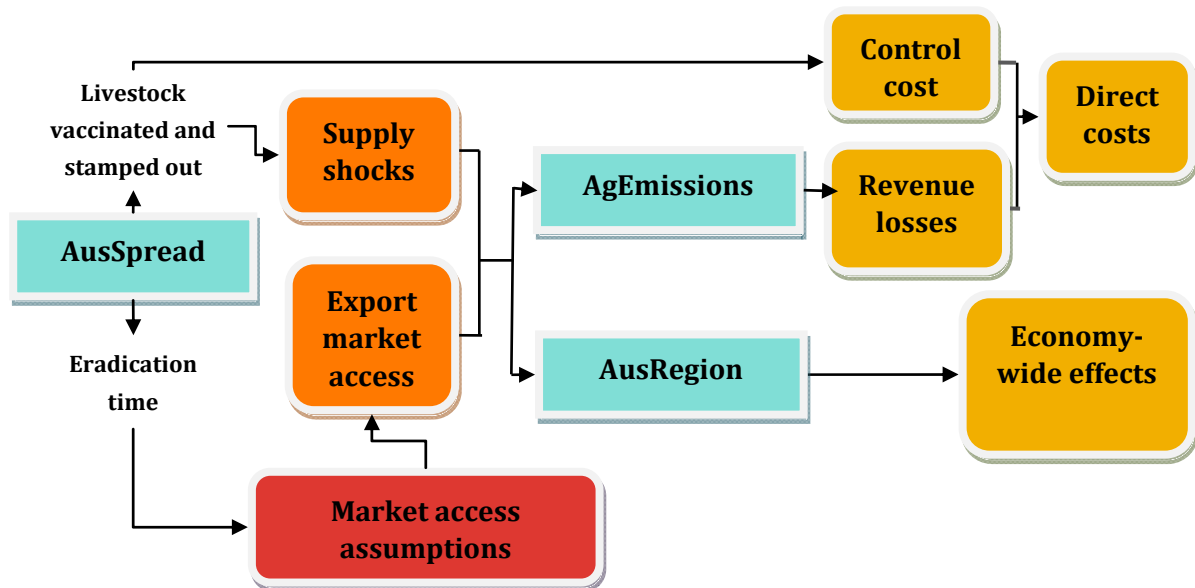
Modelling the economic impacts of a foot-and-mouth outbreak

Output from AusSpread hypothetical scenarios (Chapter 3)—number of animals culled and time to eradicate FMD—combined with the expected time to access and recover markets was input into two economic models (Figure 4):

- AgEmissions is used to estimate revenue losses to livestock producers due to export suspensions. The market effects combined with the estimates of cost of control (Chapter 3) constitute the direct costs of an outbreak.
- AusRegion is used to estimate the economy-wide effects from an outbreak—overall effects on the Australian economy, including on directly affected upstream and downstream industries.

For both models, a period of 10 years was used to quantify the economic effects of an FMD outbreak. This was to allow sufficient time for economic agents and variables to adjust to the effects of FMD outbreaks considered in this study. The present value of these effects was calculated using a 7 per cent discount rate based on the 2010 edition of the Australian Government's *Best practice regulation handbook*.

Figure 4 Framework to estimate economic impacts of a foot-and-mouth outbreak



Source: ABARES

Box 4 Estimating economic impacts

In the event of an outbreak, concerns about disease transmission are likely to result in immediate closure of export markets for FMD-susceptible commodities from Australia. These products will then be diverted to the domestic market, depressing prices. The domestic market response following an FMD outbreak is represented in Figure 5, where supply and demand of susceptible commodities in the domestic market before an FMD outbreak are represented by S_1 and D_1 , respectively. At the world equilibrium price (P_w) the quantity exported is ES_1 —the difference between the quantity of product supplied (Q_1) and the quantity of product demanded in the domestic market (Q_d).

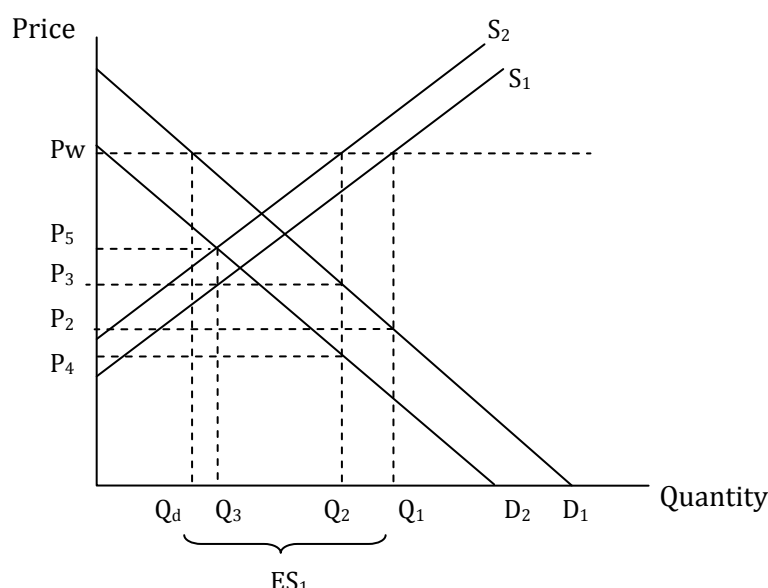
With closure of export markets following an outbreak, assuming that 100 per cent of FMD-susceptible products are diverted to the domestic market, domestic supply would increase from Q_d to Q_1 , with prices falling from P_w to P_2 .

Within Australia, management of an FMD outbreak would result in quarantine and slaughter of infected or at-risk livestock. Shifting the commodity supply curve from S_1 to S_2 , reducing the quantity supplied in the domestic market to Q_2 at price P_3 .

In addition, if domestic consumers have food safety concerns the domestic market's ability to absorb excess product will fall. A decline in domestic demand will result, shifting D_1 to D_2 and further depressing domestic prices to P_4 .

If export markets remain closed for an extended period, suppliers will adjust to a new equilibrium where the quantity supplied equals quantity demanded at Q_3 and price P_5 . Initially, consumers will benefit with meat supplied at depressed prices; however, producers will supply a smaller quantity at prices below pre-incursion world prices.

Figure 5 Domestic market response to a foot-and-mouth outbreak



Modelling direct impacts

The livestock industry revenue losses were modelled using AgEmissions—the ABARES dynamic multi-regional, multi-commodity, forward-looking partial equilibrium model (Thorpe & Klijn 2002) (Box 5).

The model is used to estimate revenues losses for livestock producers in each scenario and strategy, with and without an FMD outbreak. The impact of an FMD outbreak is estimated as deviations in revenue from the reference case. Compensation costs are not included in the calculation of direct costs because they are already accounted for in the estimate of revenue losses.

Two model adjustments were incorporated in AgEmissions to estimate the revenue losses. First, the quantity of FMD-affected products exported from Australia is restricted to the proportion of

annual exports recovered following an FMD outbreak (see 'Market access assumptions'). Second, state livestock herds were reduced to account for livestock culled during outbreaks. Data for these values were obtained from AusSpread and it is assumed that once removed from the herd, livestock animals do not generate any revenue for producers.

Box 5 AgEmissions model

AgEmissions is a forward-looking model that projects the annual volume of agricultural commodities produced and consumed domestically, by state, quantities traded with the rest of the world and the national price that balances regional supplies with domestic and export demand for each commodity.

The model contains supply and demand equations for 15 agricultural commodities—including meat from grass-fed and feedlot cattle, meat and dairy products from dairy animals, sheep meat, pig meat, wool, other animals and broadacre crops. AgEmissions also contains animal inventory constraints to determine the annual size of livestock herds and the number slaughtered annually in each state. Land resource constraints limit land used for cropping and grazing activities, while feed constraints divert coarse grains to animal feed.

Inverse demand functions for each commodity are specified as a function of real gross domestic product, an index of real prices and the quantity of commodity consumed by region and year. The marginal cost of a commodity is a function of the quantity of the commodity produced and the opportunity cost of land required in production.

The forward-looking feature in AgEmissions allows for adjustments in livestock herd numbers to meet long-run equilibrium conditions. The feature assumes that producers have perfect information regarding the future state of Australian agricultural production systems and the behaviour of their trading partners. This allows producers to make decisions each year that aim to generate maximum profits in the long term.

For example, following an FMD outbreak export restrictions are imposed that stop the trade of FMD-susceptible product. Producers observe severe restrictions on exports in the medium term that are not completely removed in the long term. In response to severe export restrictions in the medium term, producers are forced to sell large quantities of FMD-susceptible commodities into the domestic market at low prices. When producers foresee that exports will not return to pre-incursion levels, they will gradually reduce stock numbers to ensure profits are maximised.

ABARES incorporated an inventory equation in the model to ensure that sales of excess supply into the domestic market that occur following a large FMD incursion will occur over a two years, softening the decline in prices.

Modelling economy-wide impacts

The economy-wide effects of an FMD outbreak were estimated using [AusRegion](#), the ABARES bottom-up, multi-regional, multi-sectoral, recursive dynamic computable general equilibrium model of the Australian economy.

AusRegion explicitly specifies inter-sectoral and inter-regional dependencies that arise from decentralised economic decisions for production, consumption and trade. In its most disaggregated form, AusRegion has 43 sectors—including forestry, fisheries and 16 agricultural sectors—representing all eight Australian states and territories. For this study, the commodity aggregation includes six livestock sectors, six other agricultural sectors and three food processing sectors. The agricultural database for AusRegion is drawn largely from the ABARES farm survey data.

AusRegion simulates the effect of a change in one or several parts of an economy (such as the agriculture sector) on the rest of the economy. In an FMD outbreak losses in the affected livestock sectors are expected to flow through to the meat processing industries and to input providers of the affected livestock sectors (such as feed suppliers) and then through to the state and national economies. In this analysis AusRegion simulates this effect, estimating industry-specific and economy-wide impacts such as gross state product (GSP), gross regional product (GRP) and gross domestic product (GDP). The GRP values are produced for states where the outbreak starts and values are presented within and outside the control area. GSP values are estimates for the remaining affected states and GDP for the nationwide effect.

In AusRegion, the effect of FMD on the whole economy is modelled by exogenously shocking the livestock levels to reflect culling of infected animals and reducing export volumes to reflect estimated trade restrictions. To estimate the economic effects of each scenario, AusRegion is simulated twice. The first simulation is the reference case, which reflects a business as usual economic trajectory for 10 years; the second sets of simulations estimate the impact of each FMD scenario compared with the business as usual situation. The estimated impacts are deviations from the reference case.

Market access assumptions

Market access assumptions were developed for this analysis to address concerns raised by Matthews (2011) regarding values used in previous studies. Matthews concluded that past studies had assumed ‘that international market access would be speedily restored following eradication’. However, Matthews (2011) noted that key importing countries would set their own timetables to convince themselves that eradication was achieved. This time frame would extend beyond that established by the World Organisation of Animal Health (OIE). Further details on the estimate of market access assumptions is provided in Appendix B. This could be of greater relevance where the outbreak is widespread across many regions of the country.

Market access assumptions for large outbreak

For a large outbreak affecting multiple regions in Australia, assumptions on the time to regain markets and the proportion of trade recovered following eradication of the disease were obtained through a survey of experts. This was followed by a workshop to arrive at an agreed set of assumptions to be used in modelling the economic costs of restrictions on Australia’s exports of FMD-susceptible products.

To develop country-specific trade assumptions, ABARES and the DAFF FMD Taskforce sought feedback from industry bodies and assistance from areas of DAFF—including Animal Biosecurity – Food; Trade and Market Access; and Office of Chief Veterinary Officer. For each importing country, participants considered the factors that would affect the time to recommence trade:

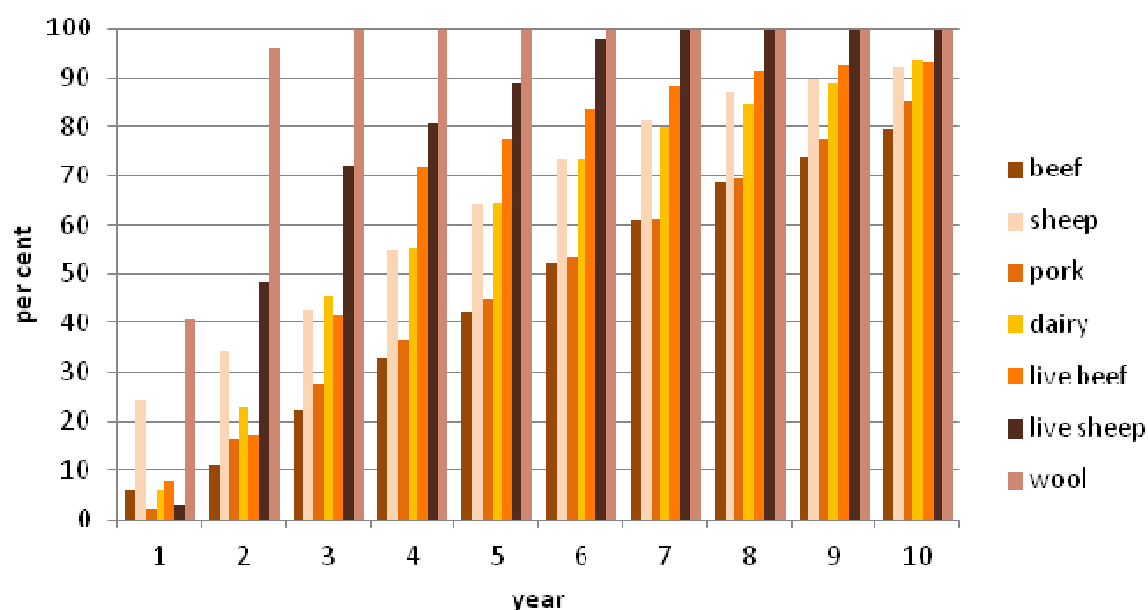
- OIE guidelines for recovery of a country’s FMD-free status
- country-specific requirements for proof of disease-free status that could involve research activities and negotiations
- operational requirements (such as health certificates) following agreement to resume trade.

Factors considered for market share recovery included product substitution by other international livestock suppliers and the type of product. For example, because Australia is a dominant supplier of wool, the wool export market is expected to recover relatively quickly once Australia can satisfy time, temperature or disinfection requirements. By contrast, export markets for beef may not fully recover since competitors in the world beef trade can supply market requirements.

Based on market access assumptions developed for each importing country, the proportion of total exports that could be exported was estimated for each year after eradication. Figure 6 shows estimates for the large outbreak scenario, which would take five months to eradicate using the stamping out strategy. It is assumed that once the disease has been eradicated and vaccinated animals removed, the additional time to regain market access will be equivalent for all response strategies. Thus the difference between market access recoveries for the response

strategies with a large multi-state outbreak scenario will be determined by the eradication time and time to remove vaccinates, as shown for beef for the large outbreak scenario (Figure 7).

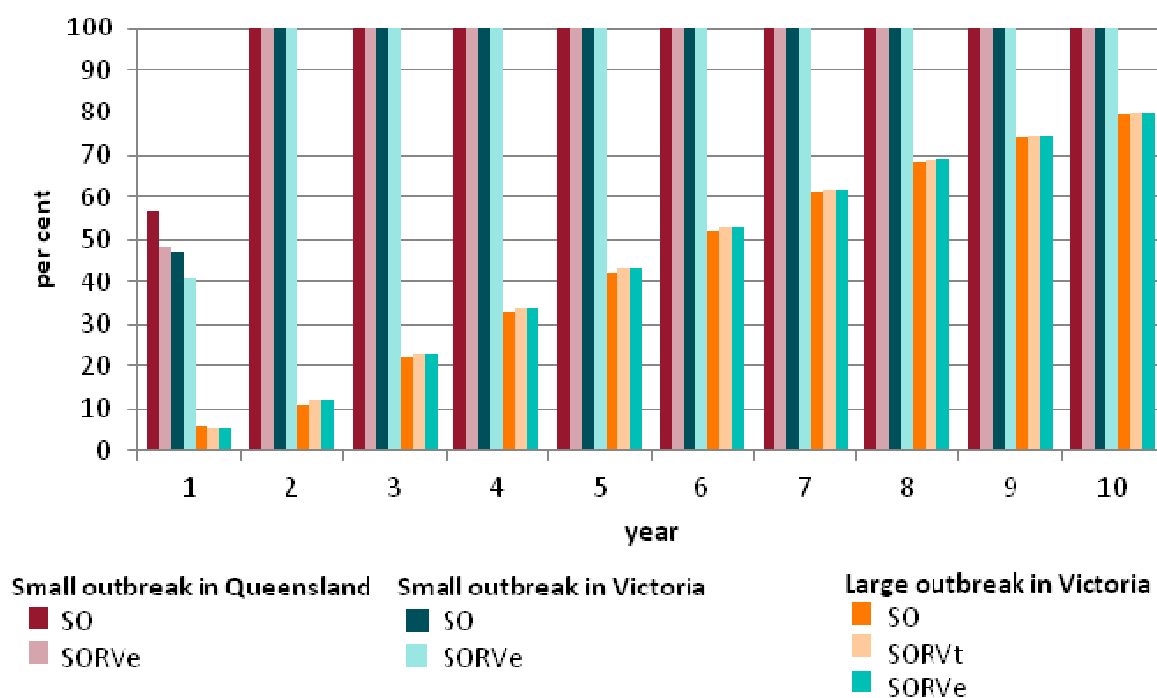
Figure 6 Annual commodities exports following a large outbreak—5 months for eradication using stamping out



Note: Expected annual proportion of commodity exported is estimated as the assumed percentage of market share regained for each country, weighted by the proportion of exports to a destination.

Source: ABARES

Figure 7 Annual beef exports for different outbreak scenarios and eradication strategies



SO = stamping out. SORVe = stamping out with extensive vaccination. SORVt = targeted vaccination.

Note: Expected annual proportion of commodity exported is estimated as the assumed percentage of market share regained for each country, weighted by the proportion of exports to a destination.

Source: ABARES

Key features of these assumptions are:

- Export of FMD-susceptible products to endemic and free markets is closed following an outbreak. In the first year following an outbreak there is virtually no export of livestock products except for wool and there may be some trade to endemic markets (Figure 6). In this analysis, big markets (not recognised as FMD-free by the OIE) such as the Republic of Korea or China remain closed to Australian exports even after meeting the OIE's requirements. This assumption is based on the situation in the United States where a bovine spongiform encephalopathy outbreak created difficulties for US exporters in accessing the Korean market.
- In this study, export closures for Australia's meat products last longer than assumed in previous FMD impact studies, such as the Productivity Commission (2002).
- Biosecurity requirements for an individual country were assumed to be the same across meat products. Entry requirements for live sheep and cattle for an individual country were assumed to be the same. After accounting for differences in requirements between importing countries, beef has the lowest market share recovery in year 10 (around 80 per cent), followed by pork (87 per cent) and sheep meat (92 per cent). With the exception of wool and live sheep, Australia does not recover trade to pre-incursion levels in 10 years. Productivity Commission (2002) estimates assumed full recovery for beef in year eight, lamb in year four and mutton in year five.

Market access assumptions for small outbreak

For the small outbreaks, assumptions for the return of market access were based on a best-case outcome. The duration of market closure as a result of a small FMD outbreak will also depend on the willingness of trading partners to accept Australian products once the OIE officially recognises FMD-free status. Outbreaks confined to one production region and quickly eradicated are expected to result in a faster return to trade; quick resumption of trade reflects greater confidence by trading partners in Australia's disease-free status and gives competitors less time for market substitution.

Duration of market closure with a small outbreak could vary for different trading partners, depending on their level of confidence in Australia's free status and efforts by Australia to reassure importers. In the absence of a clear indicator of the length of trade suspension in the event of a small FMD outbreak, it is assumed that all countries accept current OIE guidelines for regaining FMD-free status and allow trade accordingly. Market closure period constitutes the time taken for eradication and removal of vaccinates to be completed, plus a three-month waiting period, starting from when the last infected and/or vaccinated animals were killed. In strategies where vaccination is used, it is assumed that after destroying the last case of infection it would take another month to slaughter all vaccinates. Figure 7 provides an example of quick recovery of export markets for beef.

Estimates of market recovery are highly optimistic. Countries may adopt a level of protection higher than OIE guidelines (WTO 1998). This would increase the minimum time to regain market access even after successful eradication of a small FMD outbreak (Appendix B). The time required to prove FMD-free status to the OIE may be more than three months. For example, Japan's application to be officially recognised by the OIE as FMD-free in October 2010 was

delayed 120 days after submission, 214 days after decontamination of the last case (APHIS 2011; OIE 2011b). These factors should be considered when interpreting results from the small outbreak scenario simulations.

5 Economic impacts of a disease outbreak

The direct costs of a foot-and-mouth disease (FMD) outbreak in Australia are estimated as the sum of revenue losses to the livestock industry and control costs. Cost estimates are large, amounting to billions of dollars for both the small outbreak—where FMD is confined to a small production area—and a large outbreak involving all eastern states of Australia. However, the direct costs of a small outbreak are significantly smaller than those of a large outbreak.

The size of revenue losses to the livestock industry are mostly determined by export trade restrictions resulting from an FMD outbreak. Export restrictions account for delays in the time to regain access to export markets and limitations on the amounts of exports regained. As discussed in Chapter 4, delays in accessing export markets and limitations on the amount of export regained are more severe in the large outbreaks than they are for the small outbreaks.

Details for the direct costs estimated by size of outbreak, location and eradication strategy are provided in Table 5.

Table 5 Present value of direct costs of foot-and-mouth disease across 10 years

Scenario/strategy	Revenue losses (\$b)					Total revenue losses to livestock producers c (\$b)	Control costs (\$b)	Direct economic costs (\$b)
	Beef meat a	Sheep meat b	Pork	Wool	Dairy product			
Large multi-state outbreak								
Stamping out	32.26	10.22	1.11	2.19	6.05	51.84	0.37	52.21
Stamping out with extensive vaccination	30.88	9.74	1.05	2.19	5.69	49.54	0.35	49.89
Stamping out with targeted vaccination	30.84	9.66	1.05	2.19	5.55	49.29	0.32	49.62
Small outbreak in Victoria								
Stamping out	0.79	1.42	0.16	2.20	1.33	5.90	0.10	6.00
Stamping out with extensive vaccination	0.88	1.46	0.18	2.21	1.44	6.17	0.09	6.26
Small outbreak in North Queensland								
Stamping out	0.73	1.36	0.14	2.20	1.16	5.58	0.06	5.64
Stamping out with extensive vaccination	0.82	1.41	0.16	2.20	1.31	5.90	0.06	5.96

a Values are estimated as the sum of revenues losses from grain-fed beef, grass-fed beef, beef from dairy animals and the meat equivalent for live cattle exports. **b** Values are estimated as the sum of revenue losses for sheep meat and the meat equivalent of live sheep exports. **c** Revenue losses include the losses to producers and the cost of compensation to government.

Large outbreak scenarios

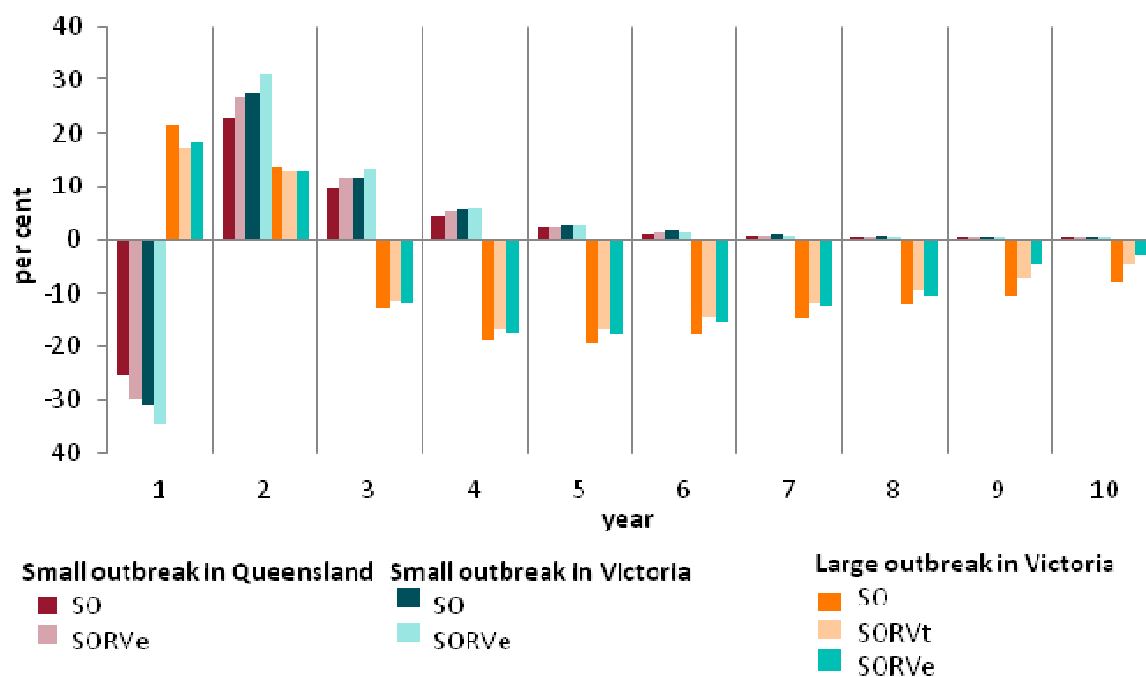
If an FMD outbreak were to occur in Victoria and spread to the other eastern states of Australia, direct costs are estimated at between \$49.6 billion and \$52.2 billion (in present value terms) over 10 years, depending on the strategy to eradicate the disease (Table 5). Regardless of the method used to manage the disease, revenue losses to the industry (which includes cost of compensation from the government) are around 99 per cent of the total direct cost, while the cost of eradicating the disease is less than 1 per cent, or about \$350 million.

In the large outbreak scenario, restrictions on exports could last for several years for some countries and products, with market share not fully recovering in 10 years. With loss of access to export markets, livestock prices in Australia would fall significantly as products destined for exports are diverted to the domestic market.

Following a large outbreak and in response to the extended loss of export markets, producers would reduce the animals held in the first two years. This increases production of meat and reduces production of livestock products such as dairy. With reduced livestock, production of meat, wool and dairy would be reduced in subsequent years. Since exports of meat and dairy are not expected to fully recover after 10 years following a large outbreak, production and livestock numbers would remain below the baseline (without FMD).

For example, beef exports in the large outbreaks are, on average, 94 per cent below the reference case in the first year, increasing to approximately 20 per cent below in the tenth year. The first year would see an on average 20 per cent increase in meat production and an estimated 13 per cent increase in the second year as producers reduce livestock held (Figure 8). With exports restricted at 20 per cent below the reference case in the long term, production is estimated to remain 5 per cent below the level in the reference case and optimal herd size levels at 8 per cent below the baseline in the tenth year.

Figure 8 Change in grass-fed beef production relative to the baseline



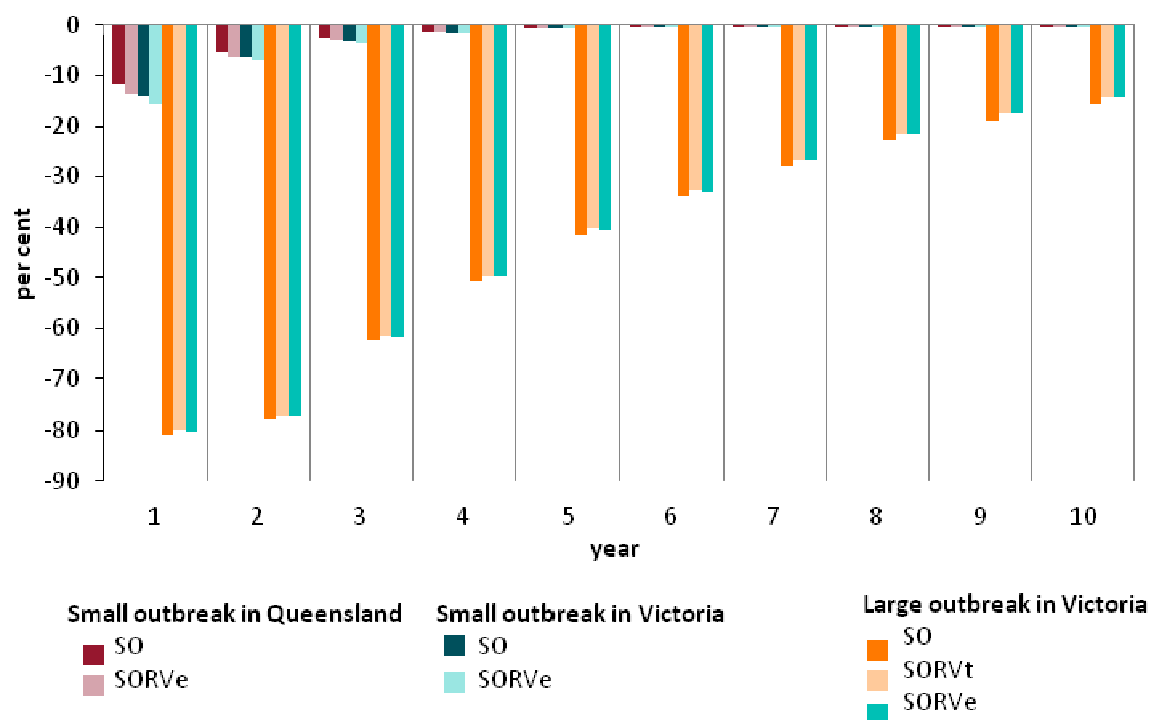
SO = stamping out. SORVe = extensive vaccination. SORVt = targeted vaccination.

Source: ABARES

With diversion of product to the domestic market (and increased meat production in the short term), domestic prices would be significantly depressed but are estimated to recover over 10 years to about 80 per cent of their original value. This is illustrated for beef in Figure 9, where beef prices are projected to fall by 80 per cent in the first year following an outbreak, with an estimated 66 per cent of production diverted to the domestic market. This decline is consistent with the 69 per cent fall in pork price in Taiwan when 40 per cent of pork production was diverted to the domestic market following an FMD outbreak in 1997 (Chang, Hsia & Griffith

2005). Beef exports are not expected to fully recover over the 10-year simulation period, and revenue losses accumulate as beef prices remain below those in the reference case (Figure 9).

Figure 9 Change in grass-fed beef prices relative to the baseline price



SO = stamping out. SORVe = extensive vaccination. SORVt = targeted vaccination.

Source: ABARES

Of the FMD-susceptible livestock examined, the beef industry bears the largest decline in revenue at on average around \$31 billion or 62 per cent of the revenue losses for all affected livestock industries (Table 5). The remaining industries affected by an FMD outbreak face smaller losses, with the effect on the pork industry the smallest. While losses from export restrictions on these industries are smaller, these industries also respond by diverting exports to the domestic market and are also faced with reduced prices. The pork industry is least affected because, in addition to being a relatively small industry, it exports only around 15 per cent of its production.

Dairy cow numbers are reduced in the first year on average by 21 per cent as a result of export restrictions in the large outbreak. These numbers return to baseline levels only with the removal of export restrictions. Given a reduction in herd numbers the production of Australian dairy products is also reduced. The more severe the export restrictions, the larger are surpluses diverted to the domestic market, which lowers dairy product prices.

Wool exports in the large outbreaks are restricted to about 44 per cent of the baseline level in the first year, 96 per cent in the second and 100 per cent in the remaining year on average. The comparatively rapid recovery of wool export markets relative to other products is a key driver of the comparatively low revenue losses.

Of the eradication strategies examined, vaccination (particularly targeted vaccination) is shown to be the least costly strategy for a large outbreak. The cost of this strategy is estimated at \$2.5 billion lower than the cost of a stamping out strategy. Compared with stamping out, targeted vaccination with stamping out reduces eradication time by 46 days on average,

allowing market access to be recovered earlier, even with an additional month waiting time to remove vaccinated animals.

Small outbreak scenarios

With the best case of early access to and full recovery of export markets, the direct cost of a small FMD outbreak to Australia is significantly smaller than the cost of a large outbreak. This cost is estimated at between \$5.6 billion and \$6.2 billion (in present value terms) over 10 years, depending on the outbreak location and the strategy to eradicate the disease. As with the large outbreak, approximately 99 per cent of direct costs in a small outbreak scenario are from revenue losses to the livestock industry, with eradication costs accounting for an average of 1.3 per cent of direct costs or around \$80 million. On average, the direct cost of a small FMD outbreak is estimated at \$45 billion (or 88 per cent) smaller than the average cost of a large outbreak. This is driven by highly optimistic assumptions for regaining market access for the small outbreak. Control costs decline on average by \$280 million or 78 per cent between scenarios. With such large falls in revenue losses and control costs, it makes economic sense to contain and eradicate an FMD outbreak quickly.

The direct cost of a small outbreak in a more extensive production area in North Queensland is slightly smaller than the cost of a small outbreak in an intensive production area in Victoria (Table 5). The more extensive production system in Queensland results in a smaller supply shock from control actions. More significantly, it allows faster eradication of the disease, resulting in quicker market access recovery and reduced direct costs.

In response to the expected short closure of export markets, production of meat products are reduced in the first year as farmers hold on to livestock. In the second year, meat production is estimated to increase in response to the recovery of export markets, reducing surplus stocks. This is illustrated for beef in Figure 8, where exports are restricted for the first year but fully recover in the second year. This results in, on average, a 30 per cent reduction in production in the small outbreaks in the first year and a 10 per cent increase in beef stocks. In the second year production for the small outbreak increases on average to 27 per cent over the baseline, offsetting the initial fall in production in the first year in response to the recovery of export markets. This would be achieved by reducing surplus stocks generated in the first year.

As in the large outbreak, the diversion of product to the domestic market reduces prices received. With producers holding some stock back, the fall in prices for the small outbreak is not as great as in the large outbreak. Beef prices in the small outbreak scenarios are only projected to fall by approximately 10 per cent in the first year of the outbreak. Prices have recovered close to baseline values by the fifth year, with restrictions on Australian exports fully removed from year two onward (Figure 9).

The pork and lamb industries, like the beef industry, incur market costs from the restriction of exports. For both pork and lamb, export restrictions for the small outbreaks are less than those for the large outbreaks; hence, the losses are smaller (Table 5). The direction of trends in sheep and pork prices, production and stock numbers are identical to those for beef. Losses to the beef industry are smaller than those for other FMD-affected industries (with the exemption of pork) in the small outbreak scenarios, despite market access being similar for all products.

In the small Victorian outbreak, stocks of dairy cows are projected to fall by 1.3 per cent in the first year, reducing dairy production. The faster recovery of markets results in relatively smaller market losses following small outbreaks, compared with large outbreaks.

The wool industry bears the largest cost of around \$2.2 billion or around 37 per cent of the total livestock industry losses in the smaller outbreak scenarios. The pork industry was the least affected sector. In the small outbreaks, exports are restricted to, on average, 48 per cent of the base line levels in the Victorian outbreak (using stamping out) and 100 per cent in subsequent years.

In both small and large outbreak scenarios, revenue losses for the wool industry are similar, with slightly higher loss in the smaller outbreaks. This reflects the influence of assumed inelastic demand for wool in the short run based on market power from Australia's large global production of wool. These results may change if the time out of the market for wool was extended beyond that assumed in the large outbreak scenario.

Stamping out is shown to be the least costly strategy if an outbreak is small. In Queensland, where the production areas is not intensive, spread is slow and can be quickly and effectively controlled with stamping out, the time required for eradication using stamping out and vaccination are similar. For the small Victorian outbreak, vaccination reduced eradication time by 6 days compared with stamping out (Table 1). In both small outbreaks, the return of export markets would be delayed with vaccination compared to using stamping out as a result of the additional one month to manage vaccinates. As a result, the direct costs of an outbreak with vaccination are greater than when using stamping out (Table 5).

Economy-wide impacts

ABARES used the AusRegion model to evaluate wider economic impacts of a large outbreak scenario and a small outbreak scenario in Victoria, each controlled using stamping out. Results shown illustrate possible impacts on regional, state and the national economies, as well as effects on industries that are linked to FMD-susceptible industries. The regional/state/economy-wide effects reported incorporate all economic changes and show that the magnitudes of impacts vary by area.

Also reported is a selection of other industries that may be affected by the outbreak but that are not classified as FMD susceptible. Findings show that while some industries lose, others could benefit from an FMD outbreak. The reported economy-wide effects (Table 6) are not directly comparable with the other industry effects (Table 7) due differences in the units of measurement. The economy-wide effects are estimated in value added terms (that is net of material input costs), while the other industry effects are estimated in gross revenue (inclusive of material input costs).

In principle, direct impacts on FMD-susceptible livestock (Table 5) and flow-on effects to other industries (Table 7) can be added. However, it is not possible in this case due to differences in the characteristics of the two models.

Large outbreak

The large FMD outbreak scenario is estimated to reduce gross domestic product by 0.16 per cent (\$23.6 billion in present value terms) over 10 years. The large outbreak scenario affects the regions selected for the small outbreak scenarios of Victoria and North Queensland and the remaining states and territories to a varying degree. The control areas of Victoria and Queensland are highly affected with their gross regional product estimated to fall by 0.92 per cent and 0.61 per cent, respectively, over 10 years. A region's economic reliance on the affected industries influences the level of impact.

By contrast, economies such as that in Western Australia are estimated to benefit from an expansion in mining and related sectors as resources are reallocated to these industries. The industries become more competitive internationally due to lower domestic costs of production, such as labour cost and cost of borrowing money, due to overall lower prices as the outbreak slows economic activity.

Table 6 Estimated regional, state and national impacts—large foot-and-mouth outbreak controlled using stamping out

Jurisdiction	Gross product	
	(%)	(\$m)
New South Wales	-0.12	-5 794
Victoria control area	-0.92	-2 695
Rest of Victoria	-0.30	-9 336
North Queensland control area	-0.61	-293
Rest of Queensland	-0.31	-8 755
South Australia	0.01	116
Western Australia	0.14	3 395
Tasmania	-0.18	-464
Northern Territory	0.15	267
Australian Capital Territory	-0.01	-41
Australia	-0.16 a	-23 600 b

a weighted total change in gross product **b** Gross domestic product.

Source: ABARES

Industries that are input providers to the FMD-affected industries are expected to be adversely affected by the outbreak; these include service providers such as transport, trade and feedstock suppliers. By contrast, industries that are competitors in production are expected to benefit from the outbreak. The present value of the gross value of production or revenue of input-providing industries is estimated to decline by \$11.5 billion, 0.32 per cent lower than in the absence of the outbreak. Agricultural and food processing industries other than livestock are estimated to expand; these include grain production, horticulture production and their downstream processors. Collectively, they are estimated to increase their production by 2.2 per cent (\$15 billion in present value terms) over 10 years.

The impact on service provider and directly competing industries is provided to show there are gainers and losers apart from the directly FMD-affected livestock industries. Industries other than those reported here are also impacted indirectly by the outbreak; these include mining, most of manufacturing and services.

Table 7 Change in revenue of other selected industries—large foot-and-mouth outbreak controlled using stamping out

Jurisdiction	Production of service providing industries a		Production of competing industries b	
	(%)	(\$m)	(%)	(\$m)
New South Wales	-0.27	-3 244	2.00	3 904
Victoria control area	-0.43	-388	2.27	753
Rest of Victoria	-0.61	-5 077	1.78	2 237
North Queensland control area	-0.05	-2	12.16	146
Rest of Queensland	-0.35	-2 650	3.60	4 943
South Australia	-0.09	-218	1.16	1 053
Western Australia	0.11	409	2.18	1 808
Tasmania	-0.46	-311	0.63	107
Northern Territory	0.04	10	4.69	84
Australian Capital Territory	-0.10	-46	0.30	4
Australia	-0.32 c	-11 516	2.19 c	15 038

a Examples of service providing industries include transport, trade and feedstock providers. **b** Examples of competing industries include grain production, horticulture and other livestock production. **c** Weighted total percentage change.
Source: ABARES

Small outbreak

Return of market access was assumed to occur within three months for the small Victorian outbreak. A uniform 53 per cent reduction in exports across all livestock and livestock products was applied for the first year. By contrast, for the large outbreak scenario, larger and varying levels of export reductions were applied to different livestock products over longer periods. As a result, the small outbreak scenario has a smaller economy-wide impact because of its more moderate and short-lived impact, allowing economies a longer time to adjust to the initial impact. The North Queensland control region is most affected, with its gross regional product being lower by 0.66 per cent (\$315 million in present value terms) over 10 years. The relatively large impact on this region's economy is partly explained by the small number of industries and the limited capacity of the economy to restructure following an external shock such as closure of a major export market. This is in contrast to the diverse industries found in the other economies including the Victorian control region.

The small Victorian outbreak is estimated to result in a 0.03 per cent (\$4.6 billion) reduction in the gross domestic product, discounted over 10 years.

Table 8 Estimated regional, state and national impacts, small foot-and-mouth outbreak controlled using stamping out

Jurisdiction	Gross product	
	(%)	(\$m)
New South Wales	-0.01	-605
Victoria control area	-0.28	-809
Rest of Victoria	-0.04	-1 207
North Queensland control area	-0.66	-315
Rest of Queensland	-0.18	-5 112
South Australia	0.01	100
Western Australia	0.14	3 345
Tasmania	-0.06	-163
Northern Territory	0.06	112
Australian Capital Territory	0.03	100
Australia	-0.03	-4 554 a

a Gross domestic product.

Source: ABARES

Uncertainty in the cost estimates

Estimated results of the likely impacts of an FMD outbreak on the Australian economy are indicative of possible outcomes in the event of an actual outbreak situation. The absence of disease experience relevant to the present means some of the data and variables and consequently costs cannot be predicted with certainty. The main sources of uncertainty are:

- Disease management—the efficiency of operational activities, logistics, communications and the ability to readily provide financial, human and technical requirements are untested in actual FMD situations. Although a number of exercises to test Australia's preparedness for a disease outbreak were successfully completed, a level of uncertainty remains.
- Likely reactions of main importers of Australian livestock products—this will determine the duration of trade suspension and the speed of full market recovery once Australia regains FMD-free status. These are likely to be influenced by a complex set of factors, including internal issues and Australia's trading partners.

- Possible effects of disease on domestic demand for livestock products—consumer demand is assumed to remain relatively unaffected by the disease because FMD is not considered to significantly affect human health. However, consumer perceptions of negative health effects could reduce consumption and increase the economic cost of the outbreak.

Sensitivity analysis

AgEmissions and AusRegion estimates of direct and flow-on economic costs have identified input parameters likely to impact on the estimated economic effects of an FMD outbreak. These include market access assumptions, the discount rate and the number of livestock slaughtered to eradicate the disease. Analysis of the sensitivity of results to changes in these parameters is undertaken to assess if the findings are robust.

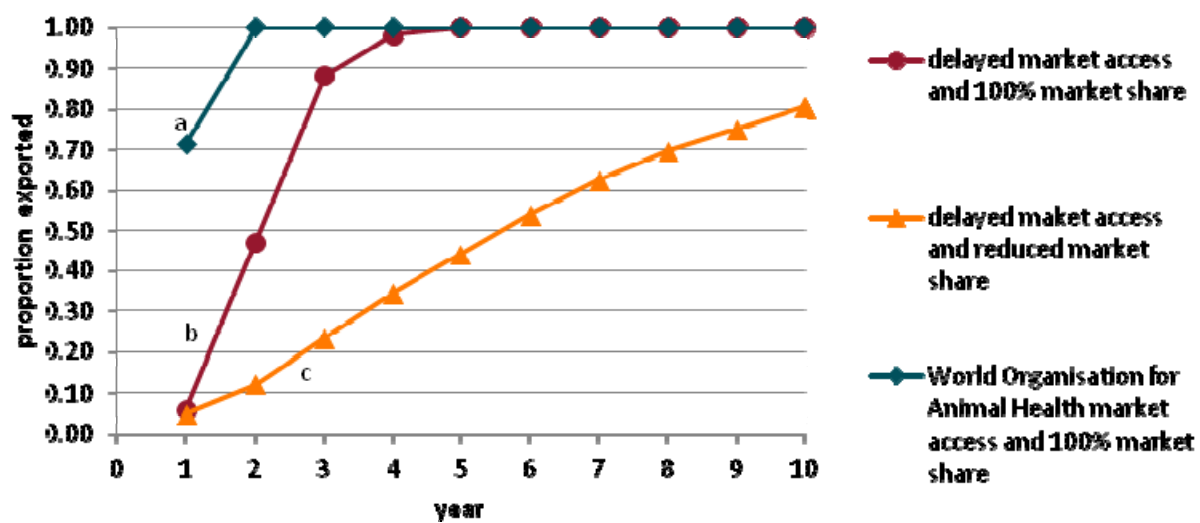
Market access

Assumptions for the return of market access and recovery of market share for the small outbreak represent an optimistic return of trade. In reality, return of market access may vary as recognition from the OIE may take longer and importing countries are likely to set their own requirements to recognise eradication (Appendix B). Competition from other exporting countries will reduce the return of market share. The potential effect of altering these two underlying factors on the market assumptions is explored using the small outbreak in Victoria with stamping out as the treatment strategy.

If importing countries impose additional market access requirements, the recovery of trade will be delayed (line b of Figure 10). With very few countries allowing trade in the first few years, trade is fully recovered in five years. This is three years longer than when all countries are assumed to comply with OIE guidelines (Figure 10). The economic loss from delayed market access is expected to be greater than the estimated \$6 million for the trade restriction (Figure 10).

A reduction in market share is more likely when market access is delayed and importers find alternative sources of product. If, in addition to the delay in market access, the return of market share is also reduced by the country-specific expectations, the assumed return of trade will be further reduced and will not be expected to recover to 100 per cent in 10 years (line c of Figure 10). Under these illustrative assumptions, expected losses from the small Victorian outbreak would be significantly greater than those presented in Table 5, approaching losses estimated for the large multi-state outbreak.

Figure 10 Changes to market access time and market share for beef exports—small outbreak in Victoria controlled using stamping out



Source: ABARES

Increasing or decreasing the time to regain market access and proportion of market share is not expected to affect the least costly strategy for a given outbreak scenario. If either of these two factors is increased for all control strategies, the magnitude of losses from an outbreak will increase and the strategy that reduces the time out of the market will remain the most effective.

Discount rate

Changes in the discount rate will not affect the relative economic costs of FMD outbreaks and the relative cost-effectiveness of eradication strategies. An increase in the discount rate will reduce total present value of economic costs for each scenario and strategy. Conversely, a decrease in the discount rate will increase the present value of costs.

Animals slaughtered

Supply shocks to the economic models are included as the number of livestock (cattle, sheep and pigs) slaughtered in each outbreak scenario and for each eradication strategy. An increase in these numbers will increase the total economic costs of an FMD outbreak. However, the impact of supply shocks on the estimate of economic costs is expected to be negligible since the proportion of animals slaughtered is very small.

For example, the number of cattle slaughtered averaged 0.2 per cent of the national herd for both vaccination and stamping out strategies of a large FMD outbreak. The primary impact on economic costs is expected to come from the closure of export markets. The volume of products diverted to the domestic market will average 66 per cent of production for beef. The number of animals slaughtered is also a reflection of the scale of outbreak, which is expected to increase the time to regain the markets. Therefore, the increase in the number of animals slaughtered is not expected to change the relative costs of an FMD outbreak.

6 Social impacts of a disease outbreak

In considering the impact of FMD control strategies, the wider social effects on households and communities must be considered alongside the economic effects. ABARES has assessed the potential social impacts of an FMD outbreak in Australia through a literature review and discussions with focus groups in Victoria's Goulburn Valley and in North Queensland.

The literature review (Kruger et al. forthcoming) investigated developed countries' experiences with FMD outbreaks. It also examined Australia's experience with other emergency animal disease outbreaks, such as equine influenza, Newcastle disease and Ovine Johne's disease. The focus groups used semi-structured questions to examine the social impacts that participants would expect to occur following an FMD outbreak. Focus group questions were developed from FMD scenarios in AUSVETPLAN, information from the literature review and consultation with DAFF experts. A detailed description of social research methods used in this study is in Appendix C.

Fifty-one people participated in the social impact study. Participants were chosen in consultation with state jurisdictions to capture a representative range of views of those likely to be directly affected by particular outbreak scenarios. The study does not cover the social impacts at a national level.

The research shows that in the event of an FMD outbreak, social impacts will occur at the personal, household and community levels. The severity of these impacts will be influenced not only by the size of the outbreak, but also the existing context, which influences the vulnerability of a community and its ability to recover. Figure 11 provides a conceptual framework for explaining the social impacts of an FMD outbreak and shows the linkages between components of the social system.

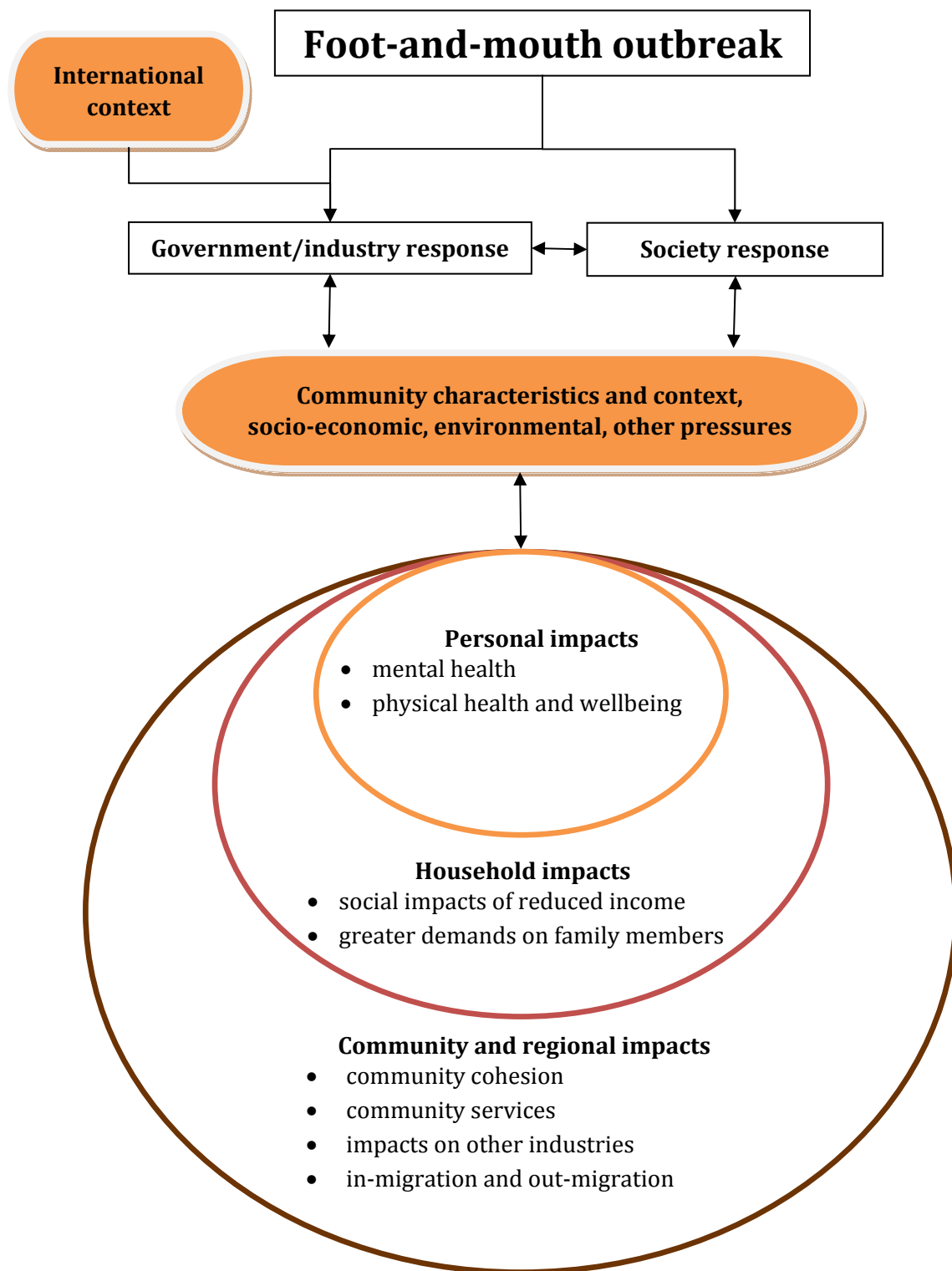
Many social impacts are generated by the loss of income—particularly at the household level. Others result from the control measures used to manage and eradicate FMD. Due to the complex nature of social impacts it is difficult to separate causes. For example, psychological distress can be caused by both loss of income and exposure to control measures such as stamping out.

It is not only producers who experience social impacts during an outbreak; those involved in the agricultural supply chain and response staff can also be affected. Stakeholders in this study reported that the impacts on local councils, emergency response staff and veterinarians largely flow from implementation of the control strategy. The effects on abattoirs, stock transporters, stock agents, saleyards, milk processors and associated agricultural industries stem from potential loss of income and uncertainty in business continuity (Figure 11).

Factors affecting the scale of social impacts

Several factors determine the number of people affected by an FMD outbreak and the magnitude of these impacts. These factors are discussed in the context of the small outbreak scenarios in North Queensland and Victoria and the large multi-state outbreak scenario.

Figure 11 Framework for analysis of social impacts of a foot-and-mouth outbreak



Source: ABARES

Differences in social impacts between small and large outbreaks

Several case study participants believed that the impact of an FMD outbreak will directly relate to the size and length of the event. The longer the event, the more difficult it is for those affected as they cannot employ coping mechanisms for, for example, repression of traumatic memories after a trauma passes (Westen, Burton & Kowalski 2006).

The length of the outbreak and time out of export markets is likely to influence the recovery of producers and businesses. Several producers doubted whether they would be able to overcome the impacts of even a short outbreak. Business participants said their businesses could continue with reduced income for a short time, but this would be unsustainable for a prolonged period. Milk processing companies and feed mills indicated they might be able to meet the demand for products in the short term by collaborating with similar businesses. For example, in order to meet contracts, milk processors who sourced from within the outbreak control area would top up the reduced milk volumes from that area with milk sourced from other areas or processors. However, this was not considered sustainable. This suggests that a large outbreak involving a longer time frame is likely to have more adverse flow-on effects to livestock related businesses than a small outbreak.

Some participants suggested the availability of response staff would lessen the longer response efforts continued. For example, response staff from locations at a distance from the outbreak would need to return to their families and other obligations and veterinarians cannot leave their practices indefinitely.

Characteristics of the community

Rural communities are not homogeneous and their ability to cope with an FMD outbreak will vary. The way a community responds to a crisis will depend on a range of factors.

Socio-demographics

Communities with good economic performance and low levels of social disadvantage are likely to deal better and recover more quickly from crises than communities with less favourable profiles (Productivity Commission 2002). Factors that can affect a community's ability to cope include employment rates, income, education, remoteness and frequency and scale of shocks (Productivity Commission 2002). An overview of the North Queensland and Victorian case study areas is in Appendix D.

Experience with animal disease outbreaks

Previous experience with an actual animal disease outbreak or a simulation exercise is likely to enhance a community's ability to cope with an FMD outbreak. For example, dairy farming communities in Victoria were involved in Exercise Diva, a simulation conducted in 2009 by the Victorian Department of Primary Industries (DPI). As a result, Shepparton Council residents' preparedness for an emergency animal disease outbreak has increased. Precautions include identifying disposal sites for carcasses and putting agreements in place for vaccine storage and carcass transport. Council employees interviewed by ABARES said that before this exercise they would have relied on instructions from DPI in the event of an FMD outbreak.

Dependence on agriculture

The level of economic dependence on agriculture in the local community will greatly affect its ability to deal with, and recover from, the economic impacts of an FMD outbreak. For both case study areas (except Shepparton), agriculture is the main industry of employment (ABS 2011) (Appendix D). This potentially places these communities at a disadvantage in recovery from an

FMD outbreak. For example, following the 2001 FMD outbreak in the UK, the hardest hit areas were those that relied primarily on agriculture and tourism (Convery et al. 2005).

Location relative to an outbreak

The Productivity Commission (2002) identified that FMD control measures will divide the country into three main areas, with the source of social impacts and number of people affected differing in each area:

- In the restricted area around the outbreak, quarantine restrictions will be in place until FMD-susceptible animals and animal products have been destroyed and the property decontaminated. Control measures are likely to have a significant impact on people in this area and those carrying out the control. The number of people in the area is likely to be relatively small. However, the trauma caused by management techniques to prevent the disease from spreading are often more distressing than the disease itself (Mort et al. 2004).
- In the control area around the restricted area, people will be affected by the movement restrictions on livestock imposed by AUSVETPLAN. The social impact of control measures would be small relative to the quarantine measures. With a national standstill in place, this area would be very large until restricted areas were accurately delimited.
- Outside the control area, most people would be largely unaffected by FMD control measures. However, loss of export market revenues would generate significant financial stress for livestock and related industries.

Similar results were found in a survey analysis of the 2007 outbreak of equine influenza in Australia, where respondents reported elevated levels of psychological distress during the outbreak (Taylor, Agho & Griffin 2008; Taylor et al. 2008). Higher levels of stress were reported for people who lived in the high-risk and buffer zones. Reported stress levels were significantly higher for respondents whose main income was dependent on horses (Taylor et al. 2008).

Behaviours that affect efforts to control foot-and-mouth disease

The actions of producers can either facilitate or delay implementation of AUSVETPLAN control measures in response to an outbreak.

According to case study participants some producers might engage in inappropriate behaviour in order to protect their stock and livelihoods. For example, it was suggested producers might hide or move stock to prevent them from being culled or vaccinated. Stock might also be moved away from the outbreak area to avoid the stigma attached to that region. This behaviour is not only risky; other producers may lose trust in the government's ability to control the disease if no action is taken against such behaviour. Swift action against irresponsible producers is an important part of maintaining producers' trust in the response effort, as is following up on reports of illegal behaviour.

Producers who participated in focus groups indicated that if producers do not trust that the authorities have the ability to deal with FMD adequately, they will be more likely to take action on their own, including:

- shooting feral animals in the hope of preventing disease spread
- burying culled stock if there is a delay between culling and burial
- attempting to undertake their own decontamination process; in a previous emergency animal disease outbreak, one producer felt authorities took too long to start the decontamination process for his sheds, so he set the shed on fire in his own attempt to decontaminate.

Social impacts of foot-and-mouth disease

Personal impacts

Personal impacts are defined here as the way a person experiences an event. Personal impacts are centred on the mental and physical health effect that an animal disease outbreak can cause.

Mental health

Distress is one of the main mental health issues experienced as result of an emergency animal disease outbreak. Distress is any form of mental suffering, including fear, anxiety, stress and depression (Dohrenwend et al. 1980). Psychological distress is emotionally and cognitively draining and compromises an individual's ability to deal with everyday life. Distress from traumatic experiences can result in health-related issues, such as sleep disruptions, flashbacks, uncontrollable emotions and loss of concentration (Bailey et al. 2004; Mort et al. 2005). For example, during the 2007 equine influenza outbreak in Australia, many emergency response workers experienced difficulties settling back into routine work after the outbreak was contained (ENRC 2000; Mort et al. 2005).

Causes of mental health issues

Case study participants referred to a range of mental health issues that could result from an FMD outbreak, including:

- loss of control and identity
- animal welfare concerns
- uncertainty
- social isolation.

According to many participants, financial strain resulting from an FMD outbreak would be one of the biggest causes of mental health issues. As this issue affects households, it is discussed in 'Household impacts'.

Participant comments made during interviews and focus groups also confirmed the findings of Mort and colleagues (2004) that mental health issues can result from long working hours, uncertainty about income and livelihoods, social isolation and a feeling that life is out of control. A producer describing the effect of this situation said, 'This would be a pain that changes you'.

Loss of control and identity

Some producers interviewed chose farming as an occupation because they value being in control of their own operation. Giving up control of their farming operation during an FMD outbreak would therefore be likely to have a significant psychological impact. For example, Berk (2006) notes that a person draws part of their identity from their profession. When an event prevents people from being able to work in their profession, or compromises the quality of their work, they can take this as a reflection on their abilities. One interviewee said that, for producers, their livelihood is a matter of 'what they do is who they are'.

During the outbreak of Ovine Johne's disease in Australia in 1999, farmers felt their life's work had been undone and they had failed the enterprise they had invested their lives in (ENRC 2000). The overall feeling was one of lost control and lost meaning in their lives (Bickerstaff et al. 2006). This was mirrored in the 2001 FMD outbreak in the UK where culling reportedly invoked a sense of failure among producers, a loss of a feeling of professionalism and a sense of not having 'done the job right' (Convery et al. 2005).

ABARES asked producer focus groups how they would deal with the culling process. This included witnessing a culling team carrying out the operation and what they thought about their own involvement in the culling of their animals. In one group, participants said they would prefer to come together as a group of local producers and undertake the culling themselves to ensure it was done humanely. Being excluded from the culling process was described as ‘the final kick in the gut’. In another focus group, one producer said he would prefer not to witness the destruction of his herd. Participant responses to this question suggest farmers want to have influence over the way that culling occurs. This reflects findings from the 2001 FMD outbreak in the United Kingdom. Authorities entered properties and carried out activities with little consultation with landowners. This contributed to a sense of loss of control and injustice, and led to anger and frustration among producers (Productivity Commission 2002).

Producers in the focus groups also had concerns about how they would be perceived by others. In Victoria, for example, producers thought they might be seen as poor neighbours or labelled as lepers if their herd became infected with FMD. This echoes feelings of farmers involved in the Australian outbreak of *Ovine Johne's* (ENRC 2000).

Animal welfare

Witnessing the destruction of animals is distressing for producers, even though the livestock would normally be slaughtered. For UK producers involved in the 2001 FMD-related slaughter there was a sense of death in the wrong time and wrong place (Convery et al. 2005). In addition, sending animals to the abattoir means farmers normally do not witness firsthand the killing of their animals (Convery et al. 2005). Almost half of farmers whose livestock were culled during the 2001 FMD outbreak in the Netherlands experienced symptoms similar to post traumatic stress disorder, such as nightmares, flashbacks and feelings of complete loss of autonomy (Olf et al. 2005). During the 1999 outbreak of *Ovine Johne's* in Australia, the culling program was stopped because of the severe emotional distress of farmers, government officials doing the culling and non-farming rural families (Hall et al. 2004).

A key theme that emerged from all producer focus groups is the affection producers have for their animals. A producer describing his traumatic experience of culling a large number of sheep commented, ‘Shooting is a very traumatic thing for your family and everyone else. It was the worst thing I ever did, but you just have to deal with it’. He described how months later, he still smelt the bodies of the sheep, although he added that ‘It could have been in my head’.

Animal welfare can also be put at risk by restrictions on the movement of animals (Rubira 2009). For example, during the 2001 FMD outbreak in the United Kingdom, stock feed could not be supplied to farms in quarantined areas (Mort et al. 2004). Movement restrictions meant that farmers were unable to sell stock and had to hold the stock for longer. In some cases, holding areas quickly became overstocked and turned muddy and unsanitary. This caused farmers to become stressed about the welfare of their animals.

Uncertainty

Producers in Queensland said it would be stressful not knowing how long an outbreak might last and that it would ‘feel like walking a tightrope’. The producers in the Victorian case study emphasised it would be very important for their mental health to be able to see the light at the end of the tunnel. They said that they would prefer to know from the start what they could expect and the steps involved in the disease eradication process. Feelings of uncertainty about income, livelihoods and future prospects caused by an outbreak can increase stress and reduce the ability to cope with traumatic events (Productivity Commission 2002).

Social isolation

Several case study participants mentioned that producers and people from local towns would be likely to limit their movements during an FMD outbreak in order to avoid contributing to disease spread. This is despite AUSVETPLAN not restricting people's movement, other than requiring decontamination procedures on declared premises and moving through roadblocks during an FMD outbreak. Other self-imposed movement restrictions can contribute to the overall inability of producers and the broader community to participate in recreational activities to 'blow off steam' (Bailey et al. 2004; Mort et al. 2005).

A survey of horse owners found that during the 2007 equine influenza outbreak in New South Wales, movement restrictions left them feeling isolated, leading to psychological distress and frustration (Taylor, Agho & Griffin 2008). Horse owners who did not have infected animals also became socially isolated because they refrained from interacting with other people in an attempt to prevent the disease from spreading (Myers 2011). A significant proportion of horse owners also reported feeling socially or professionally unwelcome in less infected or uninfected areas. Half the respondents indicated that they would not trust people from an infected area to decontaminate properly and they would not be welcoming or willing to socialise with them.

A range of people may experience mental health issues

Distress may be experienced not only by producers but also by others involved. Frontline workers such as government response workers and vets may also experience high levels of distress during an animal disease outbreak. In both case study areas, participants who had been part of an emergency response team, and those from local councils who had experienced an emergency animal disease outbreak, reflected how increased workloads, new roles and working with new colleagues brought in by an outbreak created high levels of stress. For many response workers this was in addition to having to sell government response policies, which they might not personally support, to distressed producers.

During interviews, veterinarians believed that if they were involved in the response to an FMD outbreak they might experience blame; for example, for spreading FMD between properties or finding the first FMD case. For veterinary practices located away from FMD-affected areas, focus group participants expected increased workload for remaining veterinarians in practices that send some of their veterinarians to assist with response efforts. Participating veterinarians indicated that veterinary practice that were unable to meet demand from regular clients might lose clients to rival practices. It was also suggested that veterinary practices close to or in FMD-affected areas might have decreased income because of lower demand from producers and the broader community due to reduced spending power.

Physical health and wellbeing

According to producers in the case studies, the main physical health and wellbeing impacts were sleepless nights that interfered with decision-making, concern about working with chemicals during the decontamination process, and working in overalls in North Queensland where the temperature can reach 40 °C.

Household impacts

Impacts on individuals can also affect their families because the pressure can cause changes in how people relate to each other (Figure 11). The economic impacts of an FMD outbreak discussed in this report can also have a profound effect on entire households.

Social impacts of reduced income

Several case study participants suggested significant social impacts would result from financial strain placed on producers by an FMD outbreak. As many of Australia's meat and livestock export markets would be lost, livestock producers would expect to face substantially reduced incomes. The ABARES economic modelling showed the livestock industry and other related industries would be greatly affected. Each household's financial status will influence the capacity of individuals and families to withstand these adverse changes; persistent financial pressure facing individuals and families often leads to emotional distress (Westen, Burton & Kowalski 2006). UK residents with lower incomes as a consequence of FMD reported lower quality of life and health (Mort et al. 2004).

In the restricted areas, eradicating FMD by culling animals creates a substantial reduction in short-term cashflow for affected farming families. Rapid provision of compensation for culled animals is therefore important. The value of properties with infected stock may be reduced by their disease history (Productivity Commission 2002). Many producers use the value of their land or their herd as equity to borrow funds; the persistent financial pressure could generate emotional distress (Westen, Burton & Kowalski 2006). During the Ovine Johne's outbreak, Australian families in affected regions were unable to sell their farms due to quarantine restrictions, but the asset value of their farms prevented them from accessing a pension (Senate Rural and Regional Affairs and Transport References Committee 1998). These impacts worsen the direct economic hardship caused by outbreaks.

Many participants raised concerns about the effects of culling on irreplaceable stock bloodlines that have taken generations to develop. Barclay (2005) noted that affected families may have no option but to restock their farms with animals that attract lower market prices than the original pedigree stock. Some producers with stud animals gain significant income from their prize animals through semen sales or renting out stud animals. The family would then need to adapt to the long-term reduced income generated by on-farm activities. Culling for eradication would have a negative, long-term impact on all these business activities and associated income.

In the control zones, movement restrictions would prevent FMD-free farmers trading healthy stock. This would reduce income and increase expenditure on feeding this stock (Mort et al. 2005). In the 2001 FMD outbreak in the United Kingdom, this had a greater negative effect on lower income households, which are less financially resilient to shocks, and caused a higher level of stress (Oparinde & Birol 2008). Despite these increased costs and loss of potential income, FMD-free farmers were not eligible for compensation (Mort et al. 2005).

Outside the restricted area, loss of export market revenues can generate significant cashflow problems. Causes include reduced livestock prices and potential difficulties in selling livestock when there is an oversupply on the domestic market. Participants also expressed concerns about a long-term change in the value of properties. Sustained reductions in livestock prices could reduce demand for farmland and farm machinery and lower potential sale prices. Difficulties in selling farm assets can increase the effect of short-term cashflow reductions, increasing the need for assistance. Producers identified negotiation with banks about debt repayments and reduced interest rates as forms of assistance that would be helpful during an FMD outbreak.

Evidence of the financial pressure caused by FMD was observed in the United Kingdom, where debt-related enquiries at local citizen advice bureaus in FMD-affected regions increased by 30 per cent (Cumbria Foot and Mouth Disease Inquiry Panel 2002). Reports spoke of families who 'tightened their belts' to sustain their farm business and who survived on elderly parents'

pensions (Barclay 2005). The uncertainty about the length of the outbreak and market closures compounded the difficulty of managing household finances.

Case study participants pointed out that many farm families had limited options for generating alternative income. Many producers do not have alternative employment skill sets and, if the economy is affected by an FMD outbreak, job opportunities in the region are likely to be limited. Some producers mentioned that their partner's ability to engage in off-farm employment might also be affected. This could be due to self-imposed movement restrictions or the partner's employment in the livestock industry being directly affected by the FMD outbreak.

This reflects findings from the United Kingdom in the 2001 FMD outbreak, where movement restrictions prevented some households from operating off-farm businesses (Cumbria Foot and Mouth Disease Inquiry Panel 2002). In some cases, women who normally stayed home took up off-farm work, which led to further isolation of men who remained on-farm. The change of gender roles also sometimes affected relationships. In some cases, women urged their partners to find another way of life than farming (Barclay 2005).

Businesses in the agriculture supply chain, such as transporters, abattoirs, saleyards and milk processors, may also be affected. They may have to alter their operations in response to an outbreak. For example, transporters of livestock products that usually move through an area might be forced to make detours or deliver at a different location if there is an outbreak in the area. These routes could be less safe or longer, adding to the workload. Interview participants were also concerned that current and future business opportunities might be affected by the stigma of being located in an FMD-affected region.

In the UK 2001 FMD outbreak, many non-farming businesses had to draw on family and household financial resources to stay afloat. Family and household members had to act as a buffer by increasing working hours and taking pay cuts. This placed pressure on the household and contributed to mental and physical health impacts, such as exhaustion, increased tension between family members and general stress (Phillipson et al. 2002).

Strained and greater demands on family relationships

Case study participants mentioned that an FMD outbreak in Australia may cause strain on family relationships. For example, while some marriages might grow stronger, the situation was likely to put great strain on these relationships. Stress from financial pressure in particular can combine with the personal emotional challenges of an FMD outbreak and this can negatively affect family relationships.

Several focus group participants suggested the stress and pressure of the situation will reduce intimacy within couples. Studies show that preoccupation with financial pressures and perceived lack of control over financial situations can create feelings of depression, anger and frustration (Conger et al. 1994; David & Mentler 2004). These factors tend to lower marital satisfaction as partners withdraw rather than support each other emotionally (Conger, Reuter & Conger 2000). During the 2001 FMD outbreak in the United Kingdom, family arguments often resulted from financial difficulties and extra workloads (Deaville et al. 2003; Productivity Commission 2002).

Producers from the Queensland focus group indicated they were unlikely to seek emotional support outside the house. This may mean spouses (usually wives) will play a key role in their partners' emotional support. According to one producer's wife, some women are already equipping themselves to support their partners during stressful events. Given the likely strain

on relationships, relying on partners for support could add extra pressure or result in lack of support if partnerships break down.

Stress can also negatively affect parenting. Parents experiencing financial pressure may be less responsive to children's needs and more hostile toward their children; this can contribute to adolescent behavioural problems (Conger et al. 1994). Some producers, recalling past periods of stress, observed that children are affected by the atmosphere in the home.

Queensland producers were concerned that farming households affected by FMD might no longer be able to afford to send their children to boarding school. This could lead to a need for home schooling which would place additional strain on the family. Children may also experience less social contact with their friends, while extracurricular and other recreational activities are likely to be minimal.

Some farming families who participated in this study reflected on their experiences of emergency animal disease outbreaks. One family member left the area for to escape the situation, which included facing the culling of livestock and experiencing rejection and blame by local community members. The departure of family members can further disrupt the home environment, especially where children are involved.

People who lose their jobs, such as transporters who normally spend long periods away from home, are likely to spend more time at home with their families during an outbreak. This could cause a shift from the usual routine and, together with the reduced cashflow, may cause tension within households. Other families may experience extended periods of absence; for example, families of support workers recruited to assist with eradication, such as veterinarians.

Community impacts

The impact on communities is largely the result of cumulative effects on individual producers, their households and agencies and businesses affected by a disease outbreak (Figure 11).

Social cohesion

Community cohesion refers to social ties, shared loyalties, community commitments and a sense of belonging within communities. It is crucial to community sustainability and wellbeing (Holdsworth & Hartman 2009).

Communities with strong social cohesion are characterised by a high level of reciprocal caring, sharing of knowledge and ideas, and the provision of services through community groups and charities. Individuals involved in communities with strong social cohesion are likely to trust one another, share values and support one another in various ways. Reciprocal relationships may also encourage people to act cooperatively as there is an expectation that the support given will be returned (ABS 2010). Social cohesion can help communities pull through in times of crisis. However, crises can damage social cohesion in communities.

Producers gave mixed responses to how an FMD outbreak in the Victorian Goulburn Valley case study could affect social cohesion. Some mentioned communities coming together during local flooding to assist with sandbagging and other volunteer activities. A community representative commented that local shires put aside resentment stemming from different funding levels and banded together to respond to the 2012 floods.

However, producers and DPI staff described being accused of introducing and spreading anthrax and were concerned that the general community would similarly blame them during an FMD outbreak. One goat producer felt he could be targeted because goats are perceived as dirty

animals. Furthermore, verbal reports indicated that some producers' family members were confronted and bullied during previous disease outbreaks.

Some thought that migrant families in Shepparton might be blamed for introducing FMD into the region. Several interviewees suggested migrants smuggle animal products into Australia and are therefore a biosecurity risk. The uneasy feelings some Shepparton residents have toward other cultures, and the fact that many migrants are employed on farms or abattoirs, was given as a possible reason for migrants being blamed for introducing or spreading FMD.

Several Victorian participants cited examples of similar events during actual outbreaks, describing the strain between producers abiding by biosecurity protocols and those perceived to be breaking the rules. Residents were suspicious of strangers during this time; according to one interviewee locals became anxious because they associated unfamiliar faces with illegal animal transport. Tension may also arise from perceptions that some producers are illegally moving or hiding stock during an emergency animal disease outbreak (Taylor, Agho & Griffin 2008).

In the North Queensland case study, most participants believed that the community will pull together during an FMD outbreak and that the town community would support producers. Producers and townspeople will be likely to experience the economic impacts together because towns are highly reliant on graziers and a feeling of 'us and them' is rare. Few participants believed FMD-affected producers would be stigmatised.

Community activities

Particular activities, such as the numerous agricultural shows in both case study regions, would probably be cancelled during an FMD outbreak because of movement restrictions placed on livestock. A Victorian community representative advised that these shows are well attended and their postponement may lower community morale and income. Further, producers who have spent time preparing their animals for agricultural shows may seek to blame someone for their wasted effort. During an equine influenza outbreak some producers blamed DPI staff for preventing them from attending a local pony show.

Smaller, everyday activities between individuals may also be affected by an FMD outbreak. Producers described how, during an anthrax outbreak, people gave them a 'wide berth' on the streets and refused to participate in their regular lawn bowling or tennis matches. Producers' children were told not to attend birthday parties. These changes may come about through a combination of fear of spreading the disease and tense relationships between people. Producers in the United Kingdom had similar experiences (Barclay 2005; Cumbria Foot and Mouth Disease Inquiry Panel 2002).

Community services

During small, localised FMD outbreaks, essential local council services can be maintained by drawing on staff from neighbouring shires. An interviewee confirmed that this occurred during the Victorian floods, where less immediate concerns such as approving planning permits were postponed. A Queensland council representative believed that an FMD outbreak would affect a multi-million dollar road construction project in the region. The council's usual service delivery might also be affected if staff were involved in managing the outbreak.

Impacts on other industries

An FMD outbreak may have consequences for those businesses and staff not eligible for compensation. The reduced spending power of agricultural families is likely to affect most businesses in rural towns.

Several participants suggested tourism would be hard hit by an FMD outbreak because tourists would avoid the region. Towns north-east of the Victorian case study area, such as Echuca and Yarrawonga, are part of a large tourism industry. A tourism officer at a local council described how negative media portrayal of fires and drought had reduced tourism numbers and a community representative confirmed that floods had reduced tourist visits to Echuca. This person was also concerned that incorrect perceptions of the health risks FMD poses could ‘scare tourists off’, as was the case during a blue-green algae bloom that damaged houseboat tourism.

Fruit-producing farms in the Victorian case study area typically do not have livestock but many are surrounded by livestock farms, so an FMD outbreak could affect horticulture. As with floods and fruit fly outbreaks, road blocks may delay fruit deliveries from the farm to cold storage, which diminishes fruit quality. One interviewee felt that FMD would not significantly affect the horticulture industry. Other interviewees were confident that processors and the horticulture industry would find a way around the problem.

In-migration and out-migration

During an FMD response period, rural towns are likely to experience an influx of people, including veterinarians, field officers and slaughter teams. Some participants from the North Queensland case study believed that efficiency with which the response team works with locals to implement control strategies determines how readily the community accepts the influx of response personnel. The community is more likely to accept response measures where communication is forthcoming and transparent.

Participants observed that few job opportunities exist outside the agricultural industry, especially in the smaller towns in the case study areas, such as Hughenden. A lack of alternative job opportunities for displaced workers from agricultural and associated industries could lead to a loss of people and skills from the community, as workers leave to search for work (Barclay 2005). This could have long-term consequences for small towns that are trying to increase their population (Senate Rural and Regional Affairs and Transport References Committee 1998).

Choice of eradication strategy

Some interviewees saw the three options for eradication as sequential: ‘if stamping out fails, vaccinate and remove the animals from the population. If too many animals need to be vaccinated due to uncontrolled disease spread, move to vaccinating and leaving the animals in the population’ (Appendix F). Responses to eradication strategies can be summarised as:

- Stamping out—most farmers and supply chain members favour this method as the quickest way to end an outbreak and reduce financial and social impacts
- Vaccinate and remove the animals from the population—many producers and industry stakeholders consider this method could prolong an FMD outbreak and social impacts; animal welfare concerns might arise because the public would not understand why healthy vaccinated animals had to be culled
- Vaccinate and leave the animals in the population—producers and industry stakeholders feel this method would affect them financially for longer because export markets could be lost permanently. Sustaining operations with prolonged low meat prices would not be possible. However, the method may be more attractive to livestock owners with alternative income sources who do not want to lose specialised breeds or valuable livestock genetics to culling.

Producers need more information about response strategies and implications of using each. Most producers, stock agents and livestock transporters are unaware of FMD implications, plans

for response activities and compensation. Online information about FMD rarely reaches its target audience. Producers are more concerned about common diseases and have difficulty justifying the time required to research a disease that may never occur.

Broader community response

With every new outbreak, public outcry grows; large-scale culling of animals to protect a country's disease status may no longer be acceptable to the general public (Aerts, Evers & Lips 2006). Policymakers need to be aware that increased public concern can escalate debate about the best response action and affect government decisions (COMEST 2005; Lewis & Tyshenko 2009). After the 2001 FMD outbreak in the United Kingdom, the government was criticised for not using vaccination (Anderson 2002; Campbell & Lee n.d.). This led the United Kingdom Department of Environment, Food and Rural Affairs to revise the response management plan to FMD (Anderson 2002). In 2011 media coverage of Australian cattle being slaughtered in Indonesia and the resulting public outcry led to the Australian Government temporarily suspending Australia's export of live cattle to Indonesia. While animal activists and members of the general public praised the suspension, the agricultural industry, particularly beef producers, were angered and worried (Hastreiter 2013).

Public response to a livestock disease outbreak can be influenced by community perceptions of risk and other issues occurring in society at the time (Kasperson et al. 1998; Lewis & Tyshenko 2009). The mass media shapes community perception of and attention to a disease outbreak (Lewis & Tyshenko 2009). For example, sensationalised news can lead people to believe they or others (including animals) are at risk (Kasperson et al. 1988). In its extensive coverage, the UK media often referred to the 2001 FMD outbreak as a war and a crisis (Nerlich et al. 2002).

'Crisis management is as much about dealing with human perceptions about the crisis and the management of a crisis as it is about physically resolving the crisis situation' (Miller & Ritchie 2003). In the Republic of Korea in 2010–11, public outcry against the slaughter of apparently healthy animals and the reportedly inhuman methods used extended globally (CFIA 2011). Culling and images of burning pyres and mass burials of livestock in the United Kingdom and the Netherlands in 2001 caused public indignation (European Parliament 2002a, b). In the Netherlands, media coverage of the destruction of vaccinated animals provoked calls to allow the animals to live (European Parliament 2002b).

Australia's response strategy for FMD should consider the opinions of those whose taxes pay for the response (AHA 2011). Welfare of livestock under movement controls should also be monitored. In the United Kingdom in 2001, the public calls to allow movement of some animals for welfare reasons (Spickler & Roth 2008). The importance of ensuring the welfare of animals under movement controls needs to be noted and provided for in response plans (European Parliament 2002a).

7 Managing social impacts of a disease outbreak

This chapter identifies ways to minimise social impacts caused by the response strategy and its financial impacts.

The United Kingdom has experienced two major outbreaks of foot-and-mouth disease (FMD) in the last 15 years—in 2001 and 2007. The UK Government’s handling of the first outbreak was widely criticised and contributed to the devastating impact of FMD on the UK economy and society (Anderson 2002). An inquiry held in 2001 after the first outbreak identified nine lessons to be learned. Implemented in the 2007 outbreak, the lessons helped improve procedures and minimised social and economic impacts (Anderson 2008).

Build an effective response team

A skilled response team stands at the centre of an effective response effort. Frontline response staff are the face of the government’s response strategy. Community and stakeholder interactions with frontline staff can influence perceptions of how effectively the government is implementing the response plan. When building a response team:

- **Look beyond technical skills in response staff**—ABARES focus group participants recommended each response team appoint someone with interpersonal skills to liaise with producers affected by the FMD outbreak. Skills would include negotiating and dealing sensitively with distressed producers. Either a trusted local person from the farming community or an industry liaison officer could act as a focus for consultation and advice to local industry under the AUSVETPLAN.
- **Communicate roles and responsibilities clearly and early**—a DPI employee recalled a frustrating lack of clarity about her role and responsibilities during an actual emergency animal disease response. Clearly defined roles and responsibilities as part of response procedures will enable response teams to begin work quickly and effectively. They will also need regular and prompt updates when circumstances or approaches change.
- **Involve regional DPI staff in simulation exercises**—to ensure efficiency and effectiveness of local emergency animal disease disaster management plans. This would also build DPI staff confidence in their and the Australian Government’s ability to manage an FMD outbreak. In 2009 Victoria’s Exercise Diva simulation tested the state’s capability to deal with a hypothetical outbreak of FMD. During the exercise, regional DPI staff used their local knowledge and networks to refine the response plan and put agreements in place for carcass disposal sites, vaccine storage facilities, sealed transport for carcasses and decontamination of premises.
- **Establish protocols for involving veterinarians**—according to veterinarians in the ABARES focus group, not all veterinarians would participate in an FMD response. Before agreeing to make themselves available for future response teams, veterinarians need to know the conditions for involvement, such as remuneration and logistical support, are well defined in advance.

Communicate effectively

Access to timely and accurate information can contribute to community resilience in an FMD outbreak because it is fundamental to good decision-making (Longstaff & Yang 2008). Poor communication from agencies can make a crisis worse as people will seek answers elsewhere

(Miller & Ritchie 2003), potentially resulting in misinformed decisions. Slow information provision can contribute to confusion, frustration and noncompliance with regulations.

Principles to guide the development of any communication strategy include:

- **Provide information in an accessible, regular and consistent way**—explain policies, plans, practices and requirements concisely and in plain English, with key messages clearly summarised (Barclay 2005). Producers and others do not always understand bureaucratic (Mort et al. 2004) or legal language (ENRC 2000). One interviewee reflected that during previous animal disease outbreaks, she had to ask DPI staff to clarify and translate information for producers. Providing regular information updates ensures people are informed and reduces frustration. Ensuring information is consistent reduces confusion and builds confidence that the response is being implemented effectively.
- **Use multiple communication methods**—using a wider range of communication methods (including online) meant community and stakeholder engagement in the 2007 FMD outbreak in the United Kingdom was better than during the 2001 outbreak (Anderson 2008). Interviewees in the ABARES study concurred, recommending use of multiple communication methods during an Australian outbreak (Appendix E).
- **Involve people who producers and rural communities know and trust to assist in communicating key messages**—messages are better received by communities when they come from someone they know and trust, such as local veterinarians and stock agents. During the 2007 equine influenza response in Australia, horse owners' attitudes changed when they heard information from well-known, respected members of the horse-owning community who were appointed as industry liaison officers (Webster 2011).
- **Include good news stories**—several ABARES interviewees mentioned that hearing positive stories about communities banding together, or containment success, would boost people's morale during an FMD outbreak.
- **Communicate reasons behind decision-making**—local communities' trust in government information sources could be lost if government decisions appear irrational, if requirements are impractical or if government does not deliver on promises.

The media can help disseminate information during an FMD outbreak. However, Victorian producers and veterinarians with animal disease experience spoke of being hounded by reporters during the response phase and the outbreak situation being misrepresented in the media. Veterinarians described being followed by reporters as they travelled to clients' properties. Producers talked of the frustration of not being able to answer media questions because of a lack of information.

Several interviewees were concerned about the negative media portrayal of FMD outbreak responses. For example, there was concern that if producers need to cull animals for welfare reasons during an outbreak, this would be misrepresented by the media. Participants stressed the need for a spokesperson to handle the press on producers' behalf. This would ease the emotional toll on producers. Other suggestions included police-enforced restriction on media access to FMD-infected areas.

Information needs of different stakeholders

Communication strategies should provide information targeted to address the needs of different stakeholder groups in an outbreak. This section details major stakeholder groups, the information they will need during an outbreak and methods to communicate with each group.

Producers and industry stakeholders

Uncertainty can cause psychological distress during an emergency disease outbreak (see ‘Mental health’). Effective communication is central to overcoming uncertainty and reducing distress. Uncertainty would be at its highest level early in the outbreak and is likely to relate to several factors (Hagar & Haythornthwaite 2005; Productivity Commission 2002):

- **market access**—how long markets will be closed and the impact on current and next season’s prices
- **income**—short-term cashflow and how long the cashflow will be affected by the closure of markets; stakeholders also need clear information about compensation, including who is eligible and for what
- **information about what to do**—to deal with the outbreak effectively, producers need information on
 - how to diagnose the disease
 - how to prevent infection
 - what to do if infection is suspected
 - how to comply with disease control policies
 - who will come to their farms to carry out livestock culls and dispose of animal carcasses
 - how to apply for movement permits
 - available financial and mental health support services
 - the nature of the outbreak in their area, such as which farms are infected and what animals are involved
- **government involvement**—including timing and extent of government financial support, policy interventions and the effectiveness and consistency of disease containment efforts
- **face-to-face communication**—one of the most effective ways to engage producers and industry stakeholders about sensitive issues, this provides people with the opportunity to ask questions (Kruger et al. 2012).

Local communities and the wider public

Information for local communities and the wider public should focus on explaining:

- what FMD is and what it means for human health
- that FMD poses no food safety risk and that meat from FMD-vaccinated animals is safe for human consumption (AHA 2012)
- what the government’s response plan is and reasons for animal culling and/or vaccination
- where carcass burial sites are located and procedures in place to prevent risks to human health.

Addressing community information needs and misconceptions will reduce community tension that may arise from fear or uncertainty and could reduce the demand for information from on-ground response staff. Anticipating community questions and misconceptions can reduce misinformation and generate greater cooperation. For example, DPI staff participating in the case studies felt the public would be less confrontational with response staff if they understood the need for roadblocks and other response actions that cause inconvenience.

Engage local residents and producers

The 2001 FMD experience in the United Kingdom shows that communities can become frustrated and disenfranchised when response teams do not consult them about response actions (Anderson 2002). Engaging with residents during the response builds trust and social acceptability for the process. The UK Government's inclusion of local residents in the response in the 2007 FMD outbreak is thought to have led to fewer social impacts than the earlier outbreak (Anderson 2008). Points to note are:

- Locals may hold valuable information about their local area that can help response teams tailor response strategies (Anderson 2008; Barclay 2005). This includes knowledge of geography, road networks, local contractors and suppliers, or trade routes. For example, Queensland focus group participants pointed out that Google maps includes roads that do not exist.
- Policies need to provide producers with the option of participating in the response process on their property. This may include culling and/or vaccination of their animals (see 'Causes of mental health issues') and the use of lay vaccinators, such as producers or stock handlers. This would also reduce resourcing pressures.

Establish support services

Producers and other business representatives interviewed indicated that financial support during an outbreak would be vital to keep their businesses afloat and would greatly contribute to reducing stress.

Financial support

Focus groups and the literature identified financial support needs as:

- **Relief from debt pressure for affected producers**— according to those interviewed financial compensation should be provided quickly to prevent cashflow problems and keep the bank and other creditors 'at bay' during an FMD outbreak. Producers would like support from government to approach banks and financial organisations to ask for leniency for their loan repayments.
- **Provide access to financial advice**—producers from the Victorian focus groups suggested rural financial counsellors provided as part of drought assistance could be helpful. This type of service was heavily used during the 2001 FMD outbreak in the United Kingdom and helped producers develop financial strategies and feel more in control (Cumbria Foot and Mouth Diseases Inquiry Panel 2002).
- **Equitable support policies**—interviewees were concerned for producers and businesses that would not be eligible for compensation but whose income might be reduced during an FMD outbreak. This includes livestock transporters, stock agents and abattoir employees. During the 2001 FMD outbreak in the United Kingdom, this inequality of access to support drew wide criticism (Scott, Christie & Midmore 2004). Producers whose animals were not infected were caught in restricted areas and were therefore unable to sell the livestock. However, they still had to feed and care for the animals. Unequal treatment of different affected groups can increase tension within communities and undermine social cohesion (Barclay 2005; Taylor et al. 2008).

ABARES is not advocating a particular approach to support measures in this paper; it is reporting comments from others.

Mental health support

International experiences highlight the need for mental health support services during an FMD outbreak. The Australian Psychological Society could provide advice on the availability and appropriateness of mental health support services and providers. Principles for providing emotional support to affected communities include:

- **Make preventive treatment available**—interviewees mentioned the importance of having appropriate mental health delivery systems in place before an outbreak. A Queensland psychologist pointed out that preventive mental health care is just as important as treatment for mental health issues after they arise. Response staff suggested inviting a qualified person to talk about mental health issues; for example, a frontline worker in a previous disease outbreak might encourage people to be more open toward and aware of opportunities to seek emotional support during an outbreak. A producer's wife said she and others are educating themselves about how to support their husbands during stressful times and would welcome professional help with this if it were offered.
- **Build upon existing support networks**—the community and mental health workers in both case study areas reported that people in rural areas take time to develop trust in using mental health services provided by non-community members and that most seek support from existing support services and networks in their local community, such as voluntary organisations, church groups and other civic groups. These can become important providers of emotional and practical support during an outbreak (Hall et al. 2004; Peck 2005; Peck et al. 2002).
- **Provide group counselling in social settings**—interviewees preferred talking to others with similar experiences. This technique was been used in the Queensland case study area to help people cope with the impacts of natural disasters. Group counselling for producers and response workers could be delivered in small, informal social settings. Some participants suggested these sessions could involve or be facilitated by a trained counsellor. This would ensure appropriate support is offered and that anyone showing symptoms of a diagnosable mental health condition is treated or referred appropriately. Some producers suggested meetings during an FMD outbreak where people can share their experiences. This could be a barbecue, or an FMD update meeting with refreshments provided afterward to encourage producers to talk to each other. Advertising these sessions as counselling sessions will be likely to deter people from attending.
- **Make services available to the wider community and be innovative**—mental health services should be provided for all those affected by an FMD outbreak, not solely for producers with infected livestock (ENRC 2000; Peck 2005). For example, veterinarians and other response personnel who are overwhelmed with work may require mental health support. These services could be delivered in innovative ways so that they reach target audiences. For example, veterinarians participating in this study suggested that counsellors should ring them every few days during an outbreak to see how they are coping, rather than the veterinarian having to call the counsellor. In Victoria, interviewees spoke highly of a mental health service available during the drought, where family or friends could call in if they suspected someone was experiencing mental health problems. An expert would then follow up with this person.
- **Ensure long-term support is available beyond the recovery phase**—normal experiences of psychological distress can become a diagnosable mental illness if a person is still experiencing severe symptoms some time after the event (DSM-IV-TR 2004). A psychologist in the Queensland case study region reported still seeing people suffering psychological distress from Cyclone Yasi, which had affected the area more than a year earlier in 2011.

8 Conclusion

An outbreak of foot-and-mouth disease (FMD) is expected to have substantial economic and social impacts on Australian livestock industries, related industries and the Australian community. Investment in prevention, eradication and restoring market access is expected to reduce these effects. The different effects of an outbreak across regions will require customised support and communication to promote recovery and reduce hardship.

Prevention and early detection

An FMD outbreak in Australia, whether limited or widespread, is likely to impose economic and social costs. A large multi-state outbreak is expected to result in extreme economic and social losses. Costs could be reduced through biosecurity efforts aimed at preventing an FMD outbreak, such as offshore and onshore measures. This is crucial given increases in the number of people and goods entering Australia and the associated risk of disease introduction.

The Australian Government Department of Agriculture helps keep Australia FMD-free by managing biosecurity controls onshore to minimise the risk of the disease entering the country. The Australian Government is also responding to the 2008 Beale review of Australia's quarantine and biosecurity arrangements and to the Matthews (2011) review of Australia's preparedness for the threat of FMD. The Matthews review stated that it is now time to attend relatively more to the prevention and preparedness issues of the FMD emergency management continuum. Australia's biosecurity system has worked well in the past but the system is far from perfect and Australia's biosecurity agencies are significantly under-resourced (Beale et al. 2008).

Early detection and eradication of FMD is to Australia's advantage. First, the economic and social costs of shorter outbreaks are significantly smaller than longer ones, primarily due to ongoing delays in regaining market access. Second, the disease may not be eradicated if it escapes early detection and becomes widespread. Areas of investment to consider include resourcing of surveillance, response and livestock tracing.

Surveillance

Resourcing of surveillance to assist in swift detection of an outbreak is fundamental. Producers, stock agents and livestock transporters could help identify symptoms of an outbreak early. However, few are aware of FMD implications and plans for associated response activities. Results from the case study interviews indicated that producers do not actively seek FMD-related information; they are more concerned about common diseases and have difficulty justifying the time required to research a disease that may never occur. Online information about FMD is not reaching its target audience. Surveillance measures that identify the role of government, businesses and community are important in detecting the disease early and reducing the potential costs of an outbreak.

Emergency response

Resourcing of the emergency response will help ensure rapid eradication of an FMD outbreak and reduce economic and social impacts. Ongoing preparation for an outbreak could include simulations exercises, identifying available resources, developing arrangements for producer participation in eradication activities and improving livestock tracing.

Involving regional department of primary industry staff in simulation exercises, as has occurred for such exercises in the past, will improve their preparedness for an FMD outbreak. Protocols

should be established for involving veterinarians in an FMD outbreak response team. Simulation exercises can also serve as an indicator of the number of veterinarians willing to participate in the response team.

Biosecurity engagement with private veterinarians, industry and other sources (for example, emergency response volunteers) and resource sharing at national level could make better use of available resources. Allowing producers and stock handlers to participate in eradication activities, such as vaccinating their own livestock, can free up veterinary and other expertise for technical tasks such as stamping out and enhanced surveillance. This could also reduce social impacts of eradication activities such as feelings of loss of control.

Livestock tracing

A standardised system of national livestock traceability could improve the technical response to an FMD outbreak and the capacity for Australian industries to regain market access. When FMD is detected, tracing at-risk livestock and livestock products is essential to understanding the nature and spread of the outbreak. Successful implementation of the livestock standstill and accurate livestock tracing will provide accurate and timely information on the extent of the spread, helping decision-makers choose optimal response measures.

Effective livestock traceability is also important during vaccination and subsequent management of vaccinated animals. It can help demonstrate that all vaccinated animals have been destroyed or tested for FMD antibodies to prove that they are not infected. Accurate livestock traceability would be important to satisfy World Organisation for Animal Health and trading partner requirements. It could enhance the confidence of Australia's trading partners that the outbreak is being controlled and in future claims of disease-free status.

Accurate livestock traceability systems for sheep and goats are particularly important for tracing FMD risk. Sheep and goats show either no or few clinical symptoms, increasing the risk of undetected FMD spread. Further, if Australia pursued a geographical zoning approach or an enterprise-level compartmentalisation approach to more rapidly facilitate trade, all traded livestock and their products would need to be certified as only coming from a free zone or free compartment.

Market access

Closure of export markets is expected to generate most of the cost from an FMD outbreak. Any efforts that speed up re-establishing market access and recovery in market prices will reduce the overall cost of on outbreak.

The Department of Agriculture and industry market access programs, such as those run by the Red Meat Market Access Committee, could play an important role in restoring markets. This was demonstrated by the UK Export Certification Partnership following the 2007 FMD outbreak. Such partnerships help prioritise negotiations with key markets, address biosecurity risk mitigation requirements for each partner and reach agreement on restoring market access more quickly.

Maintaining biosecurity reputation and improving existing technical cooperation with trading partners and animal health organisations can reduce the time to satisfy verification and administrative requirements of trading partners. This work could include establishment of pre-agreed trading arrangements with trading partners to reduce the time for negotiating market access. For example, work on the trans-Tasman FMD Action Plan, a bilateral initiative between

Australia and New Zealand, aims to reduce the time taken to resume trade in livestock products across the Tasman in the event of an FMD outbreak.

Impacts of an outbreak on industry could also be reduced by establishing agreements with trading partners on commodity-specific strategies to meet certification requirements, such as FMD treatments for wool and dairy products. Understanding the potential for zoning and compartmentalisation as mechanisms to facilitate resumption of trade is also important to managing an outbreak. DAFF is working with the Animal Health Quadrilateral Group (United States, Australia, New Zealand and Canada) to build Australian capacity to implement zoning arrangements acceptable to other key commodity markets.

Export-oriented industries are expected to benefit from efforts to restore export market access. Industries with mainly a domestic market focus would benefit to a lesser extent, as opening of export markets will help domestic price recovery by absorbing some of the excess supplies of both the product and its substitute products on the domestic market.

Maintaining domestic consumer confidence and support will also be important in minimising the effects of an outbreak. Industry and government are collaborating to develop a communications strategy, including dissemination of authoritative statements from Food Standards Australia New Zealand about the safety of livestock products during an FMD outbreak.

Australia has developed plans and procedures to manage the technical aspects of FMD control. However, findings from this report suggest investment in developing plans and procedures to deal with trade and market access issues could generate significant benefits.

Selection of eradication strategy

In selecting the eradication strategy to implement in the event of an outbreak, the epidemiology, economic effect and the social impacts of an outbreak and control measures should be considered.

Economic and epidemiology considerations

The least costly strategy to eradicate the disease will depend on the initial conditions of the outbreak and the type of production system in the outbreak areas. Eradication plans and capacity should therefore be flexible. Under all the scenarios examined, total direct economic costs were minimised by the eradication strategy that restored market access fastest.

Stamping out

Stamping out is shown to be more cost effective for a small outbreak in extensive livestock production systems (such as the hypothetical outbreak in Queensland). In extensive production areas, rates of disease spread are expected to be low, requiring fewer resources for culling and disposal and enabling these measures to keep pace with new cases of infected and at-risk animals. Conditions under which the spread of the disease was expected to be slower favour implementation of the stamping out management strategy. Using vaccination under these conditions could add to the total cost of the outbreak, as shown in the Queensland outbreak scenario.

For a small outbreak in a more intensive production area (such as the hypothetical outbreak in Victoria), vaccination with stamping out was shown to reduce eradication time, compared with stamping out only. Vaccination also reduced the variability in time to eradicate the disease, and reduced the chance of an extended outbreak occurring. However, on average, the reduction in

eradication time was not sufficient to offset the delay in market access associated with the removal of vaccinated animals.

Vaccination

For potentially wider and fast-spreading outbreaks, resources may not be adequate to keep up with stamping out requirements, with the risk that the outbreak will not be adequately controlled. In the large multi-state outbreak scenario, vaccination allowed earlier return to trade, even when taking into account the need to remove vaccinated animals from the population to regain World Organisation for Animal Health disease-free status. For the large outbreak, the reduction in eradication time with vaccination more than offsets the additional time needed to deal with vaccinated animals, allowing a quicker resumption of trade. Under these circumstances vaccination is likely to be an effective disease management tool, offering a greater certainty in reducing the time taken to contain and eradicate the disease, and therefore reduce the duration of the outbreak.

Vaccination would be preferable with successively longer delays in detecting the disease or lower availability of resources to fight an outbreak. Either of these factors would place greater demands on available resources, increasing the chances of the disease spread overwhelming containment efforts. This effect is demonstrated in the simulated outbreak scenarios for Victoria, where results suggest early vaccination could be beneficial. The merits of vaccination are yet to be proven for less intensive livestock production areas in other states.

Importantly, targeted vaccination was shown to be as effective as widespread vaccination while reducing the total numbers vaccinated. The use of targeted vaccination could reduce the constraints on resources while allowing eradication to be undertaken quickly.

In addition to monetary cost savings, using vaccination could also reduce the need for rapid large-scale pre-emptive culling and disposal of animals. This could, as seen in the 2001 UK outbreak, reduce social and environmental costs associated with stamping out.

Developing clearer and more detailed guidelines on the use of FMD vaccination as part of an effective response will therefore be important in outbreak preparedness. Ongoing research directed at developing diagnostic tests to distinguish between vaccinated and infected animals supports the need for continual updating of FMD control policies. Developments, made in conjunction with efforts to review the provisions of the World Organisation for Animal Health guidelines, could see vaccination-to-live given the same terms for regaining disease-free status as vaccination with culling. If research efforts came to fruition and trading partners acknowledged the findings, then a shift toward using vaccination as a major component of FMD control could be considered.

Social considerations

Most farmers and supply chain members in the social impact analysis nominated stamping out as their first preference, followed by vaccinating and removing the animals from the population (Appendix F). Vaccinating and leaving the animals in the population was the least preferred method. Several people saw these three options as sequential; that is, 'if stamping out is failing, then vaccinate and remove the animals from the population. If too many animals need to be vaccinated due to uncontrolled disease spread, move to vaccinating and leaving the animals in the population'.

Many producers and industry stakeholders saw stamping out without vaccination as a more viable option than vaccination alone, which they felt could prolong the FMD outbreak and

associated social impacts. Vaccination-to-live is likely to be viewed favourably by livestock owners with specialised breeds or valuable livestock genetics. However, interviewees were concerned that this method would have a greater and more protracted financial effect because export markets could be lost permanently. Also raised was concern that the public would not understand why healthy vaccinated animals had to be culled and that this may create animal welfare concerns. Respondents felt that members of the public who do not have a financial connection to the agriculture industry may support vaccinate-to-live measures due to the perceived animal welfare benefits.

Nationally and internationally, public objections to government policies with perceived negative animal welfare implications are increasing. Use of stamping out to eradicate disease, especially where large numbers of animals are culled, has resulted in a large negative public response.

Regions will be affected differently

Both economically and socially, the impacts are not confined to regions directly affected by the eradication strategy. Outside the control areas of each outbreak scenario, the loss of export markets is expected to cause significant economic and financial stress. Industries related to the affected industries, including service providers such as transport, trade and feedstock suppliers, are expected to be affected by the outbreak. As a result, psychological and financial support within and outside the control areas will be important as households and communities face losses in income and uncertainty surrounding business continuity.

Changes in economic activity will differ across states and regions, and in accordance with the dependence of each region on livestock production and livestock export markets. For example, Queensland and Victoria's regional areas have a greater economic reliance on the affected industries than do other area and state economies. Economies such as Western Australia are estimated to grow due to expansion in mining and related sectors as they become more competitive in the international market.

A range of business types can be financially affected by an FMD outbreak. These businesses may require financial support during the outbreak and during recovery. Assistance could include compensation or indirect support from banks holding loans. Engagement with agencies and institutions to provide support (for example, Centrelink, charity organisations) would be vital.

Measures to manage social impacts

An FMD response plan and the way it is implemented presents opportunities to manage social impacts. Communications, social support, counselling and recovery arrangements will need to target not just those individuals and communities directly affected by control measures, but affected communities Australia-wide.

When implementing the response plan, local residents and producers should be involved as they may hold valuable knowledge about their local areas that can assist in tailoring response strategies to the local area. Giving producers the option to participate in the culling process may reduce the social impact of loss of control and the psychological distress it creates.

Providing financial and mental health support services may reduce the overall social impacts of an FMD outbreak. A socially focused plan of action that includes appropriate counselling services for a range of stakeholders (for example, producers and response staff) during and after the outbreak will help individuals, households and communities recover after an outbreak.

Building an effective response team by including staff with strong people and technical skills will create confidence in the government's ability to respond to an FMD outbreak. Clearly communicating roles and responsibilities to the response team will reduce confusion.

Communication

A communication strategy that is well understood by the livestock industry and government agencies and support staff involved in a response strategy is vital. Livestock producers and potential support staff seem largely unaware of current communication strategies, such as the 'Model Arrangements for Leadership during Emergencies of National Consequence' that the Council of Australian Governments endorsed in 2008. This suggests a need for engagement with stakeholders to ensure effective roll-out of an integrated FMD response and a communication strategy needs to be implemented and reinforced among stakeholders.

During an FMD outbreak, a clear communication strategy presented in plain English will build stakeholder and public confidence that the government is responding appropriately to the outbreak. This could include clear information about compensation policies to alleviate stakeholder concerns about eligibility and build confidence in government's ability to respond to an FMD outbreak. A checklist for an effective communication strategy is contained in Chapter 7.

Response centres need to provide producers with more information about the response strategies and implications of using different strategies. Confusion about the strategies could lead to frustration and delayed or inappropriate responses by producers.

Appendix A: Disease spread results from AusSpread

The three hypothetical outbreak scenarios developed by Garner (2012) for single point outbreaks in Victoria and North Queensland and a multi-state outbreak starting in Victoria are discussed briefly.

Small hypothetical outbreak in North Queensland

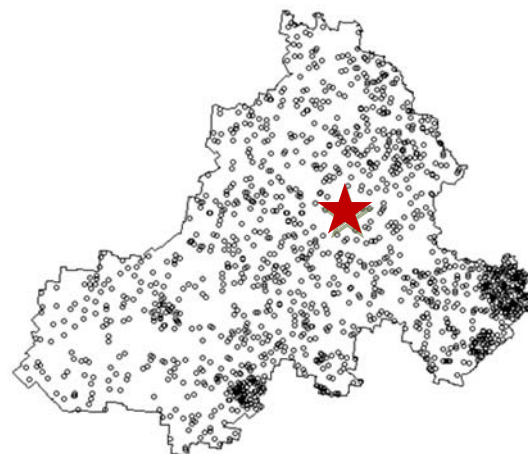
Foot-and-mouth disease (FMD) is introduced in May in a smallholder pig farm in Dalrymple (Map A1a) through illegal swill feeding. It spreads for 28 days before it is detected (silent phase) on the pig farm and in local sheep and beef farms—a total of five infected premises and one immune farm. Given the intensity of livestock production in nearby areas, the region—Aramac, Belyando, Dalrymple, Flinders, Longreach and Winton—is declared a control area. The AusSpread model has 1429 mostly beef farms in this control area (Map A1b) (Garner 2012).

Map A1 Small outbreak, North Queensland

a. Point of introduction of FMD



b. Farms within control area



Source: Garner 2012

Two control strategies are used: stamping out and stamping out with extensive vaccination. Control measures are implemented in the restricted area within the AusSpread model, including:

- a 10 kilometre restricted area around infected premises
- a 3 kilometre surveillance zone around infected and direct contact premises
- if vaccination is used, a 10 kilometre suppressive ring vaccination for all species around all infected and direct contact premises (begins 12 days into the control program).

As well, four teams are assigned for surveillance and operations in infected premises during the first three days of control measures, increasing to 35 teams after eight days. Ten teams attend vaccinations at the start, increasing to 30 teams after three weeks.

Small hypothetical outbreak in Victoria

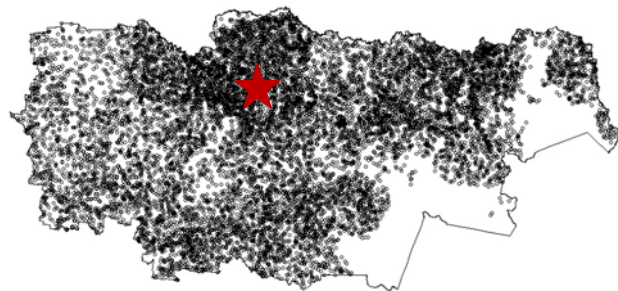
Introduction of FMD occurs in May when pigs in a Goulburn Valley farm are fed swill (Map A2a). When the disease is detected 21 days after incursion 18 premises are reported as infected. The Statistical Divisions of Loddon, Goulburn and Ovens–Murray (MapA2a) are declared a control area. The area comprises 13 249 agricultural businesses, including beef, dairy, sheep, beef–sheep, feedlot, pig and smallholder farms (Garner 2012). Unlike the North Queensland outbreak area, where production is predominantly cattle on rangelands, the Victorian outbreak area is a high density livestock production area (Map A2b).

Map A2 Small outbreak, Victoria

a. Point of introduction of FMD



b. Farms within control area



Source: Garner 2012

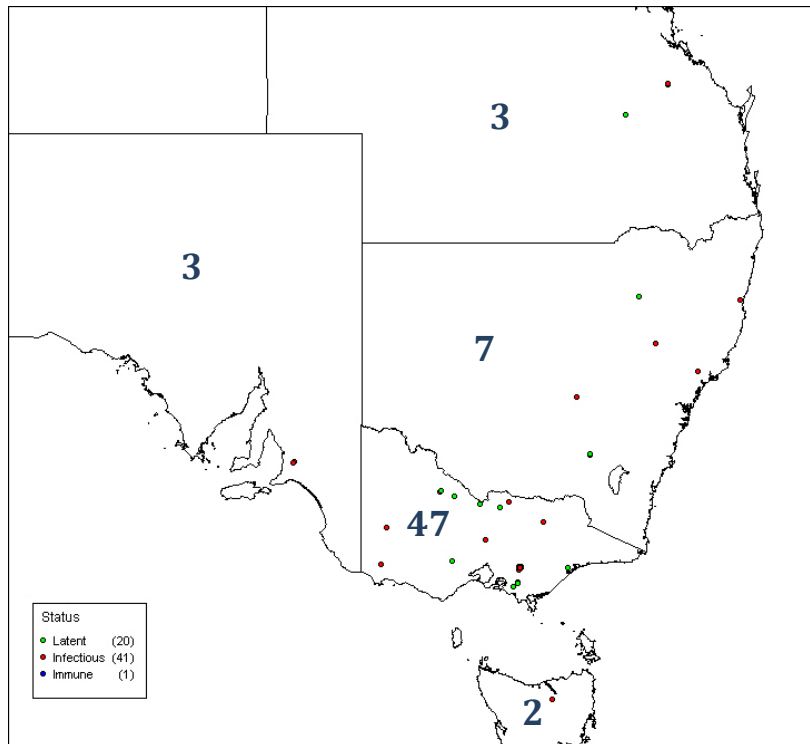
Control strategies and measures are the same as for the small outbreak in North Queensland. However, when vaccination is used, a small radius vaccination zone (5 kilometres instead of 10 kilometres) was used, reflecting the smaller sizes and the close proximity of farms in this region. The smaller farm sizes mean vaccination can be done more quickly. However, due to the intensity of livestock production in the area, resources for eradication are greater than the outbreak in North Queensland (see 'Control costs').

Large hypothetical multi-state outbreak

This outbreak uses the large FMD outbreak scenario developed by the Animal Health Committee's FMD Resources Working Group as part of a work plan to help the working group estimate resources required to achieve eradication (Garner 2012).

In this scenario, FMD is introduced through contaminated waste food that is brought into Australia by a traveller returning from overseas and illegally fed to pigs in a small pig farm in Victoria. The disease is not detected for three to four weeks after its introduction in May. Out-of-region traces of FMD are used to initiate infection in other areas. By the time the disease is detected, infection has spread to New South Wales, Queensland, South Australia and Tasmania (Garner 2012) (Map A3).

At the time the disease is detected 62 premises are identified as infected across the five states (Garner 2012).

Map A3 Number and distribution of infected premises, multi-state outbreak

Source: Garner 2012

As with the small outbreak scenarios, the two control strategies are used: stamping out and combining stamping out with ring vaccination. It is assumed that when vaccination is used, sufficient vaccine is available. Two strategies for vaccination are explored (Garner 2012): targeted vaccination and ring vaccination. The targeted risk-based approach to ring vaccination involves vaccination of cattle only (and sheep on cattle–sheep mixed farms) in Victoria, given the extent of the outbreak in this state. Broad brush suppressive ring vaccination is used in all infected jurisdictions for all FMD-susceptible species.

It is assumed here that all jurisdictions have adequate capacity to implement vaccination with vaccination teams available during the entire vaccination program. Control program for the multi-state outbreak includes a 72-hour national standstill after first diagnosis of FMD and declaration of a state-wide control area for jurisdictions with infected animals.

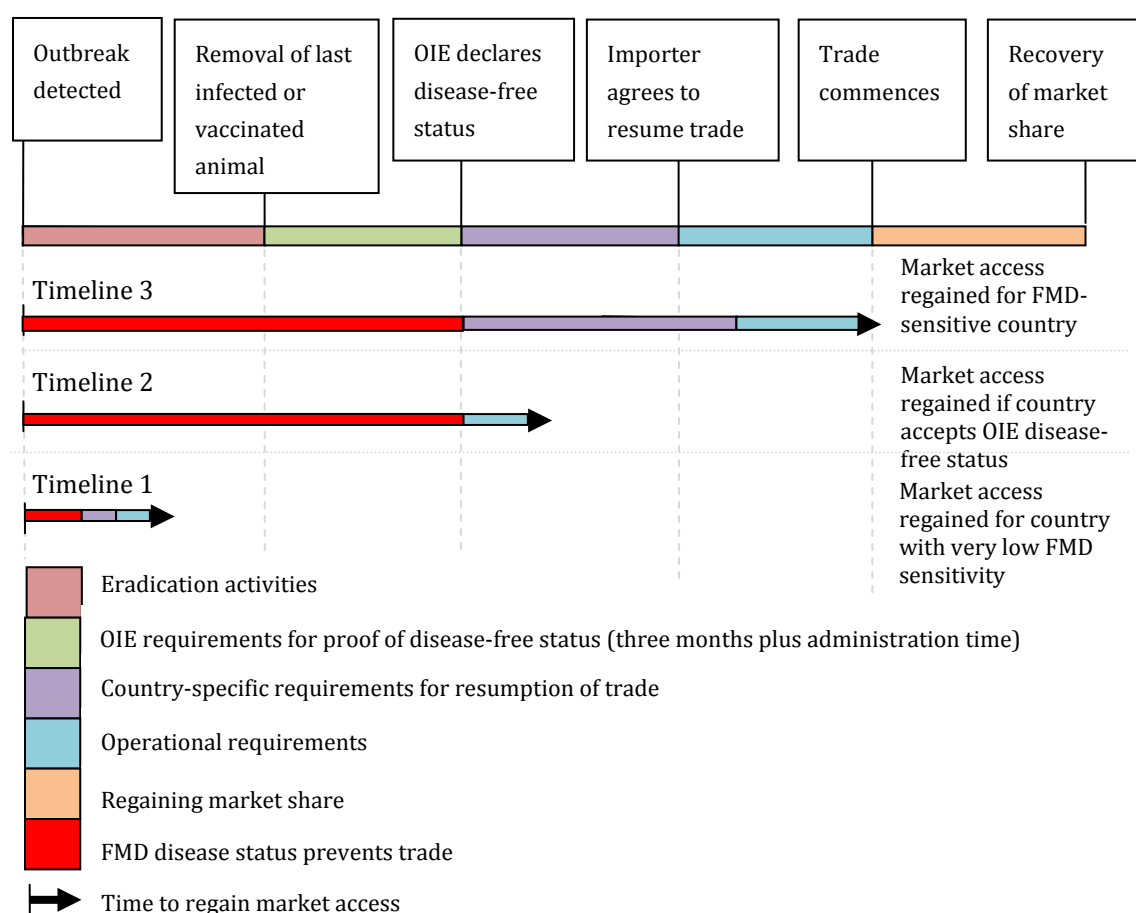
Appendix B: Market access assumptions

Time for trade to recover

'The point in time following eradication of FMD when export trade resumes will be determined by Australia's individual trading partners', once they have 'satisfy[ied] themselves that eradication has indeed been achieved. This may take months after Australian authorities had declared Australia disease free' (Matthews 2011).

The time required for trade to recover depends on the elapse between eradication and recognition by trading partners of disease-free status and the resumption of (Figure B1). Once access to a market has been granted, exports can recommence; however, the return of exports to pre-outbreak levels may be delayed and in some cases may not recover.

Figure B1 Time to regain market access following an outbreak



OIE = World Organisation for Animal Health

Source: ABARES

Resumption of trade

To regain FMD-free status under World Organisation for Animal Health (OIE) guidelines a country must wait a designated period after the last case and submit documented evidence supporting its case (Figure B1). OIE guidelines require a waiting period of three months after the

last case of infected and vaccinated animals are slaughtered or six months after the last vaccination-to-live. Despite these standard waiting times, following stamping out, on average it took 4.5 months (1.5 months longer) for countries to be recognised by the OIE as FMD-free (Junker et al. 2009). For some countries this time can be much longer. It took some 18 months for the Republic of Korea to regain FMD-free status after the last infected animal was destroyed in 2000 (Junker et al. 2009). Uruguay waited 22 months after the last outbreak in 2001 (Junker et al. 2009).

The World Trade Organization's (WTO) sanitary and phytosanitary arrangements recognise that it is not always appropriate to impose the same international standards because of differences in climate, existing pests or diseases or food safety conditions (WTO 1998). WTO members may choose to adopt a higher level of protection (Welte 2000). Trading countries therefore have bilateral agreements that do not necessarily comply with all the OIE requirements (AusVet & CSIRO 2005). For example, the agreed health certificate between Australia and the Republic of Korea for export of beef requires Australia to have been free, for the past two years, from foot-and-mouth disease (DAFF 2004).

For Australia's main export destinations, two periods may increase the time required to regain market access beyond OIE requirements:

- First, country specific requirements for proof of freedom—a period beyond OIE declaring freedom before trading partners recognise that Australia is free of FMD. The country-specific proof of freedom may require time to complete paperwork and research, the time for negotiation or for visits from country representatives to agree to resume trade (Figure B1).
- Second, operational period—a period following agreement to resume trade to ensure applicable health certificates are in place so trade can commence. This operational administration may require, for example, negotiation of new certificates or waiting until the time specified in existing health certificates is met (Figure B1).

Factors that can influence the time for a country to regain access to international livestock markets include disease management expertise, outbreak size and duration and political factors (Johnson & Stone 2011). For example, although the United Kingdom regained FMD-free status nearly four months after the large outbreak in 2001, it took six months to re-export pig genetics to non-EU markets and 50 months to reinstate live pig certificates to China (UKECP 2009). Following the small 2007 outbreak, the use of face-to-face meetings with veterinary authorities in priority countries helped re-establish certification faster. Recommencement of trade in pig genetics to non-EU markets was reduced to six weeks and live pig certificates to China to five months. This example highlights the significance of the outbreak size and demonstrates the importance of negotiation in regaining market access (UKECP 2009).

Recovery of market share

Following a disease outbreak, the return of exports to pre-outbreak values may be relatively quick, significantly delayed or in some cases may not recover (Figure B1). Following the 2003 bovine spongiform encephalopathy outbreaks in Canada and the United States, the time taken for export revenue recovery was 31 and 50 months respectively. However, following a small outbreak of FMD in Argentina in 2006, exports recovered within a few months with most countries continuing to accept beef from FMD-free zones within Argentina (Johnson & Stone 2011).

Importers may find alternative sources of products, depending on availability from competing countries. As one exporter loses market share others will gain market share. For example, following the 1997 FMD outbreak in Taiwan, pork exports valued in 1996 at US\$1.6 billion fell to

US\$234 million in 1997 with loss of the Japanese market (Chang, Hsia & Griffith 2005). The loss of exports from Taiwan to the Japanese market resulted in expanding pork shipments from the United States (23 per cent), Denmark (18 per cent) and Canada (5 per cent), to the exclusion of Taiwan (Johnson & Stone 2011; Yang 2012).

Factors that may influence the length of market recovery include previously exported product type and value and disease management timeline. Other factors include domestic price changes for inputs and products, weather changes that impact productivity, consumer response and prices for competing protein products (Johnson & Stone 2011).

Domestic market response

With loss of export destinations, product originally destined for export markets will be diverted to the domestic market. The action of diverting previously exported products on domestic markets creates an oversupply of produce and the subsequent fall in prices lowers returns to producers.

During the 1997 FMD outbreak in Taiwan, loss of exports to Japan, which accounted for 90 per cent of Taiwan's total pork export, saw 27 million tonnes of pig meat diverted to the domestic market (Chang, Hsia & Griffith 2005). This oversupply, combined with domestic consumers shying away from pork consumption, resulted in a dramatic fall in prices. Pork prices fell immediately from NT\$55 to NT\$17 after the announcement of the FMD outbreak—well below the NT\$40 cost of production—with the loss in export revenues estimated at approximately NT\$600 million per annum (Chang, Hsia & Griffith 2005).

For other exporters, outbreaks of FMD have seen similarly large diversion of product to domestic markets. In 2000 the Republic of Korea diverted 80 265 tonnes of pork destined for Japan to the domestic market following an FMD outbreak (Park, Jin & Bessler 2008). After an outbreak in July 2000 Argentina's exports of beef fell 52 per cent from 276 094 tonnes to 132 966 tonnes (Rich 2004). The fall in beef exports, principally due to the loss of high value markets including the United States, Canada, Japan and Republic of Korea, resulted in a 62 per cent drop in value, worth \$440 million (Rich 2004). In Uruguay, beef export volumes declined by 38 per cent (\$152 million) after an outbreak in 2000 (Rich 2004). In Brazil, loss of the Russian export market (which accounted for 65 per cent of pork exports) resulted in price declines of 30 per cent below the cost of production, causing serious damage to the pork industry (FAO 2006).

The ability of the domestic market to absorb excess supply will influence the magnitude of any price changes. Some products can experience greater price reductions where there is little demand on the domestic market. The ban on exports following the 2001 FMD outbreak in the United Kingdom led to light lambs and sow meat originally destined for Europe being diverted to local relatively small markets (DEFRA & DCMS 2002). Negative consumer perceptions and willingness to consume infected meat can reduce demand further (Box B1).

Government and industry are collaborating on a communications strategy that could help maintain domestic consumer confidence in the event of an outbreak. Initiatives include an authoritative statement from the Food Standards Authority of Australia and New Zealand about the safety of livestock products; this is ready for distribution.

Box B1 Consumer preference

How FMD will affect domestic demand for livestock products will be shaped by social and economic factors that influence consumer food-purchasing behaviour, including risk perception, price and preference for a product.

Price and attachment

Reduced meat prices may induce some consumers to increase their consumption of animal products. The price at which this occurs may be influenced by household income and expenditure and the individuals' perception of risk. In the United States, 'demand response to food safety is small compared to price and expenditure, suggesting that although some consumers will reduce demand for food safety, they will be more likely to be swayed by price' (Piggott & Marsh 2004). In Australia, price seems to be a significant driver of the quantity of meat consumed. Historically in Australia, a reduction in the price of meat has resulted in a similar increase in consumption (Productivity Commission 2002). Price is therefore expected to be a significant determinant in people's consumption of meat following an outbreak of FMD.

Risk perception

While FMD is not a human health problem, 'there could be significant domestic consumer resistance to consuming meat and animal products following an FMD outbreak' (Matthews 2011). This reaction could be influenced by social factors such as food safety perception and downplaying or exaggerating the risk.

Food safety—concern about food contamination by bacteria or germs, and the link between food and disease can reduce animal product purchases (Horwitz 2012; McCarty 2007). This may be magnified by limited knowledge of a disease and lead to confusion with unrelated diseases that have human health effects, such as bovine spongiform encephalopathy (BSE). Following the FMD outbreak in Taiwan, domestic demand for pork fell with consumer concern about food safety; this was despite assurances from the government (Chang, Hsia & Griffith 2005). Consumers tend to have short attention spans for food safety issues and, in the absence of frequent message reception, are unlikely to adjust their preferences (Dahlgren & Fairchild 2002). Reduction in pork demand in Taiwan is variously reported to have lasted from six to 12 months (Yang et al. 1999).

Downplaying of risk—other events during an outbreak can impact consumers' risk perception of animal products. For example, during the outbreak of BSE in Canada, consumers increased their consumption of beef despite the risk of contracting the BSE variant Creutzfeldt-Jakob disease. This was in contrast to the reaction of consumers in other affected countries, including the United Kingdom, Germany and Japan. Research has attributed this counter-intuitive behaviour to distractions from other social issues—namely the war in Iraq, severe acute respiratory syndrome and West Nile virus (Lewis & Tyschenko 2009).

Exaggeration of risk—negative media coverage of FMD can influence consumers' perception of contamination risk, and hence their purchasing behaviour. Research suggests that media coverage contributed to reduced domestic demand for fresh and frozen animal products during animal disease outbreaks in several countries (Beach et al. 2008; Yang & Goddard 2011). Negative media can be compounded by the reactions of scientists, government, activists, supermarket chains, celebrities and peers, who reaffirm or heighten consumer perceptions of product safety. In the 2001 FMD outbreak in the United Kingdom, supermarkets indicated they would not stock product made from vaccinated animals for fear of consumer backlash (Matthews 2011).

Potential cost of FMD in Australia

Various studies have estimated the impact an FMD outbreak could have on Australia. Tozer and colleagues (2010) used a bioeconomic optimisation model to estimate the economic impact on the beef industry. Using several scenarios that differed by depopulation rates and trade ban settings, livestock producers were estimated to experience significant losses under scenarios with uniform trade bans. Under scenarios where one-year trade bans applied across Australia, expected losses were between \$465 million and \$765 million for livestock producers. Over the longer term, beef trade would return to pre-outbreak levels. In the interim, beef exports to the United States, Korea and Indonesia would fall in some years by 80 per cent before export recovery began.

A study by Dent and colleagues (2002) used the Monash Multi-Regional Forecasting model to estimate the potential impact of FMD on Queensland's livestock and meat-processing industries. Under a long-term market closure condition, where export markets to FMD-free countries were closed for six years, it would take 15 years for Queensland to return to pre-outbreak levels of economic output. Losses in gross domestic product over the 15 years would be an estimated \$7.1 billion, with the heaviest losses in year seven. Results of the short-term scenario—where

trade bans are enforced for two years—show the Queensland economy taking 10 years to recover, with estimated losses of \$900 million over three years.

In its estimates of losses for the Australian livestock industry from FMD, the Centre for International Economics (2010) modelled two scenarios: a six-month contained outbreak and a one-year extensive outbreak. Under the contained scenario where 50 per cent of markets were closed in the first year, losses were approximately \$9 billion. This compared with \$18 billion under the extensive scenario in which 100 per cent of export markets were closed in the first year. Market access losses represented 90 per cent of total losses with export markets taking between two to four years to fully recover, depending on the size of the outbreak.

The Productivity Commission estimated (2002) income losses to the Australian livestock and meat processing sector of a large FMD outbreak (without zoning and taking 12 months to eradicate) at \$12.8 billion to \$14.8 billion over 10 years (or \$17.3 billion to \$20 billion in 2012–13 dollars), with around 75 per cent of this cost accounted for by export revenue losses (Table B1).

Table B1 Direct income losses for the livestock and meat processing sectors

Outbreak	Export revenue losses (\$m)	Domestic revenue losses (\$m)	Total revenue losses (\$m)
Small	3 333	2 373	5 706
Medium	4 611	2 994	7 605
Large	9 480	3 332	12 812
Large (with zoning)	–	–	4 200
Large (two-year trade ban)	10 398	4 396	14 794

Note: Estimates given in 2002 dollars.

Source: Productivity Commission 2002

Other livestock products

Australia exports an additional \$2.3 billion of other livestock products including offal, skins, hair and furs, prepared and preserved livestock products, other live animals (such as dairy cattle, horses and birds), animal feed (such as pet food), meat of other animals (including kangaroo, emu, reptiles) and other products (including semen and animal-based fertilisers) (ABS 2012).

Products derived from FMD-susceptible animals (such as offal and bovine skin) are likely to be shut out of the market for the same periods as meat products that are exported without extensive treatment. This will increase the loss in value of animals significantly.

Despite not being susceptible to the disease, other livestock industries—such as horses, kangaroo and emu—may also be affected. Some countries have import health certificates that require FMD-free status on these products; these requirements could prevent market access (DAFF 2013).

Other commodities

Trade of grain and used farm machinery was temporarily suspended by Australia following the outbreak of FMD in the United Kingdom; other countries could implement similar restrictions for an outbreak in Australia. Export disruption of these products is expected to be minimal, especially for wheat—given pressure on world supply and with FMD-afflicted countries such as Argentina continuing to be major wheat exporters (Productivity Commission 2002).

Appendix C: Social impact analysis methods

In May and June 2012 ABARES reviewed the literature on the social impacts of foot-and-mouth disease (FMD) outbreaks (Kruger et al. forthcoming). The review investigated FMD outbreaks in developed countries and experiences in Australia of other emergency animal disease outbreaks such as equine influenza, Newcastle disease and Ovine Johne's disease. This work was commissioned by DAFF Animal Biosecurity.

This work was extended during September to December 2012 to include two case studies in Victoria and Queensland. The social component of the Victorian case study was undertaken on 22 and 26 October 2012 in Shepparton, Tatura and Tongala. The social component of the Queensland case study area was undertaken between 19 and 23 November 2012 in Charters Towers and Hughenden.

During phone conferences in August 2012 the ABARES project team and representatives from the Victorian Department for Primary Industries and the Queensland Department of Agriculture, Fisheries and Forestry chose the case study locations and interview and focus group participants (Table C1).

Table C1 Interviews and focus group participants

Stakeholder	Victoria	Queensland
Interviews (one or two participants)		
Abattoir	1	1
Agriculture association staff member (organises agriculture related events)	1	1
Agriculture input business	2	0
Department of primary industry staff ^a	0	2
Chamber of commerce	0	1
Ethnic council	1	0
Livestock transporter	1	1
Local council staff (incl. emergency response staff, mayor, CEO)	3	4
Mental health staff	1	1
Milk processor	1	0
Livestock producer	1	1
Saleyard manager	1	1
Stock agent	1	1
Vets	2	0
Focus groups (three or more participants)		
Department of primary industry staff ^a	1 (4 participants)	0
Producers	2 (4 & 6 participants)	1 (6 participants)
Vets	0	1

^a DPI staff participated in their capacity as potential FMD response staff.

FMD outbreak scenarios were developed for different stakeholder groups based on the Australian Veterinary Emergency Plan (AUSVETPLAN), information drawn from the literature review and in consultation with FMD experts in the Department of Agriculture. These scenarios were sent to participants before the interview and focus group sessions to give them an understanding of what to expect during an FMD outbreak.

The semi-structured questions focused on the social impacts that participants expected would occur following an FMD outbreak, including what could be done to prepare them for an outbreak and who would make the preparations, what support would be needed during an outbreak and the characteristics of the community likely to influence how an individual might respond to an

outbreak. Questions designed to address the circumstances of different stakeholder groups were also asked. Finally, participants were asked to provide their thoughts about three outbreak response options, including:

- stamping out—where no vaccine used
- vaccinate-to-kill—where vaccine is used to prevent the disease from spreading and all vaccinated animals are culled once the disease has been eradicated in order to regain Australia’s FMD-free status as soon as possible
- vaccinate-to-live—where vaccine is used to prevent the disease from spreading and the vaccinated animals are left in the national herd to live out their lives.

A qualitative data analysis was carried out on the interview and focus group data to identify themes. These were integrated with the findings from the literature review in order to develop the social impact component of this report.

Interview questions

About the organisation

- What is your role in the organisation?
- What experience has the organisation had with crises, such as other emergency animal diseases or otherwise bushfires or floods?
- What lessons have you learned from these experiences that might be applicable to an FMD outbreak?
- What do you think an FMD outbreak in this area would mean for the organisation? [could prompt with how many staff will be caught up in the outbreak, effect on other services and resources, etc.]
- What would your organisation need to be prepared for an FMD outbreak? [ensure communication needs are explored]
- To what extent do these resources/services exist?
- What would your organisation need during an outbreak? [ensure communication needs are explored]
- To what extent do these resources/services exist?

About the community

- Who in the community do you think would be impacted by an FMD outbreak and how do you think they would be impacted?
- How do you think community members would respond to an FMD outbreak? [could prompt with where would they seek help?]
- What characteristics of the community might help it cope with an FMD outbreak?
- What characteristics of the community might make it more difficult for them to cope with an FMD outbreak?
- What do you think community members would need during an FMD outbreak?
- To what extent do you think these needs can be met by resources/services available in your area?
- What would the community need to be more prepared for an FMD outbreak? [could prompt with ‘For example, what would be their communication needs?’]

- As a member of the community, how do you think this area's community would respond to the issues around FMD vaccination? [provide explanation, using FMD pros/cons table].

Focus group questions

Vaccination (25 minutes)

Provide overview of the three response options. Then ask:

- What option do you prefer and why?
- Which one do you like least and why?
- How will you be impacted under each of these options?

Social impacts (45 minutes)

- Let's talk about the scenarios we've sent to you. [give background to scenarios, including that they can criticise it and say 'that doesn't apply to us, this area or this community'] We'll go through them stage by stage and I'll give you a quick overview of each stage as well as across the zones. Then I'd like us to discuss what each stage would mean for you. [go through 'FMD response stages' sheet]
- What, of all the things we have discussed, concerns you most?
- Let's talk about what this scenario would mean for members of your household and the relationships between them?
- What would it mean for your relationship with people outside your household; that is, neighbours, friends and family and others in the community?
- Now let's talk about the differences between a large and a small outbreak. [provide overview, including handout sheet with numbers about number of animals culled and percentage price drop; also mention impacts on export markets, ability to source feed]

Recovery (20 minutes)

- Now let's imagine we are some years, (say five) down the track since the outbreak and you are as good as back to normal.
- How did you get there?
- What kind of things did you do?
- Who helped you?
- What kind of things were most helpful? [prompt with 'What kind of things did you do?' 'Who provided assistance?' What kind of assistance was most helpful?]

Communication needs (15 minutes)

- What kind of communication would you need to prepare you for an FMD outbreak?
- What kind of communication would you need during an FMD outbreak? [can prompt with 'Remember, your communication needs may change during the outbreak period']

Context (15 minutes)

- Let's talk about the current context. How are the livestock industries currently going? [could prompt with 'What is good and not so good at the moment?']
- How do these issues influence how you will respond to an emergency animal disease outbreak such as FMD?

Appendix D: Socio-demographic profile of the case study regions

This section provides an overview of the social demographic profile of the two case study areas. It draws on ABARES fieldwork and data from the Australian Bureau of Statistics.

Victorian case study area profile

DAFF foot-and-mouth disease (FMD) experts chose the Victorian case study location to represent an intensive livestock production area. ABARES social scientists visited Shepparton, Tatura and Tongala as part of the fieldwork for this case study. The livestock industries in this region are dominated by dairying, but also involve beef, sheep, pig and goat production.

An overview of each town's population, median age and weekly income and main employment industries is provided in Table D1. Shepparton (within the Greater Shepparton Local Government Area) is one of the largest towns in the region (ABS 2011). It is a hub for surrounding farmlands and has greater economic diversity than neighbouring smaller townships. All these towns had weekly median household incomes below the Victorian average of \$1216 (ABS 2011).

Table D1 Overview of the towns visited in Victoria

Town	Population	Median age	Median weekly household income	Top industries of employment
Tongala	1 869	40 years	\$834	Dairy cattle farming; meat and meat processing; residential care services
Tatura	4 448	41 years	\$953	Dairy product manufacturing; water supply, sewage and drainage services; dairy cattle farming
Greater Shepparton	29 553	36 years	\$925	School education; hospitals; cafes, restaurants and takeaway food services

Source: ABS 2011

Increasing mechanisation of the dairy industry, recent downsizing of the SPC Ardmona food processing factory and closure of the Heinz factory in 2012 have reduced job opportunities in the Greater Shepparton area in recent years. Jobs at Murray Water have also declined.

The area has experienced several animal disease outbreaks (including anthrax and Ovine Johne's disease), bushfires and floods. Many producers, already in a precarious financial situation due to prolonged drought during the 2000s, have been hit by recent low milk prices. Several small producers have left the region and have been replaced by large corporations.

Greater Shepparton is a thoroughfare for freight between Queensland, New South Wales and Victoria. The case study area has a large agri-tourism industry in the upper north and along the Murray River.

The demographics of Greater Shepparton are changing: year-round employment in horticulture, enabled by the irrigation system, attracts migrant families. Around 14 per cent of Shepparton residents were born overseas and 14 per cent of local residents speak a language other than English at home (ABS 2011).

Queensland case study profile

The case study region was chosen for its geographically extensive livestock industry and because it is crossed by the Flinders Highway, a transport route between Queensland and the Northern Territory. Social scientists visited Charters Towers and Hughenden to do fieldwork for this case study. An overview of population, median age, weekly income and main employment industries in these towns is provided in Table D2.

Table D2 Overview of the towns visited in Queensland

Suburb	Population	Median age	Median weekly household income	Top industries of employment
Charters Towers	3 934	39 years	\$974	Sheep, beef cattle and grain farming; metal ore mining; school education.
Hughenden	1 792	40 years	\$935	Sheep, beef cattle and grain farming; local government administration; rail freight transport.

Source: ABS 2011

Hughenden is located in the statistical local area of Flinders and is the main business district of the region. Charters Towers is in the statistical local area of Dalrymple, an area heavily dependent on agriculture. Even the school education industry involves boarding schools servicing children from agricultural families. Agriculture is a major contributor to retail and services sector income. Weekly livestock sales at the Charters Towers saleyard draw many producers and their families to town, where they purchase goods at local stores. A strong relationship exists between the Charters Towers Queensland Department of Agriculture Fisheries and Forestry office, graziers and the Charters Towers Regional Council. Strong communication networks exist within the community.

Recent Queensland Government budget cuts have reduced service provision in both areas, particularly in mental health, disability employment and drug and alcohol treatment services. According to community members from both regions, the communities are very cohesive and people rally together to help each other in times of need. Both regions had limited experience of emergency animal disease outbreaks; however, they have regularly experienced natural disasters such as fires and floods.

Seventy per cent of the products from livestock industries in the Charters Towers and Hughenden regions are destined for export markets. Due to the geographically extensive nature of their business and large property sizes, producers do not have regular contact with their livestock. The Flinders Highway runs through some properties.

Appendix E: Communication tools

Participants provided feedback on communication tools that could be used in preparation for and during an outbreak of foot-and-mouth disease (FMD). A range of communication tools are needed in order to reach the intended audience. Participants also pointed out that people might change their habits during an outbreak; for example, the need for regular updates during an outbreak may motivate people who rarely use the internet to use it as an information source.

Table E1 Overview of participant feedback about communication tools

Tool	Preparing Industry	During outbreak		Considerations and comments
		Producers	Local community	
Television	Yes	Yes	Yes	Check which timeslots would be most effective for target groups. TV programs such as Border Security can be used to emphasise preparedness.
Websites	Yes	Yes	Yes	Can be updated quickly. Access requires a reasonable internet connection. Large documents can be difficult to open. Coloured documents printed in black and white sometimes do not make sense. Some local websites, such as Charters Towers E-village, are popular.
Agricultural newspapers, including <i>Stock and Land</i> , <i>The Weekly Times</i>	Yes	na	na	Many producers have a subscription to an agricultural newspaper. Can assist in creating awareness about FMD and what response might involve. Use coloured pictures to get readers' attention. Focus on economic impacts as this is what is important to producers. Too slow for updates during outbreaks.
Established networks, including word-of-mouth	Yes	Yes	Yes	Stock agents and veterinarians are trusted sources of information for producers. Communication from key, credible people within community carries more weight.
Mail-outs and information sheets delivered to households	Yes	na	na	Appeals to older producers. Can be attached to monthly milk reports supplied by milk processors. Many time-poor producers only glance at mail.
Information kit and reporting contact details	Yes	na	na	Can provide basic information and photos about what disease symptoms look like and who to report them to. Can be stored for easy reference.
Emails	Yes	Yes	Yes	Already used by some supply chain members to communicate with producers. Appeals more to young producers. Some rural residents do not use emails.
Social media	na	na	Yes	Can be updated quickly. Appeals to younger people. Not used by many older producers. Is affected by internet availability. An important space to refute rumours and misconceptions.
Local radio stations	na	Yes	Yes	Most producers have the radio on while they are in the dairy shed, on the tractor or in the car. Most community members listen to the radio commuting to/from work. Preferred stations vary—need to have messages on various radio stations.
Department of primary industries hotline with pre-recorded messages	na	Yes	na	Has been successful during other emergency animal disease outbreak responses. Good for generic messages.
Department of primary industries hotline answered by staff	na	na	na	Can provide information and advice about specific situations. Staff operating the lines need to have a good understanding of the area and how the rules apply to different industries.

Tool	Preparing Industry	During outbreak		Considerations and comments
		Producers	Local community	
Department of primary industries personal communication with staff. Farm visits by response officer or district veterinary officer to inform producers of procedures	na	Yes	na	Producers appreciated this interaction during actual emergency animal disease outbreaks. Very effective, but costly.
Meetings, including community and industry meetings	Yes	Yes	Yes	Played a key role in previous emergencies. Some producers thought FMD would be a suitable topic for regular industry group meetings, while others thought it would only attract producers if FMD sessions were piggy-backed onto other events. Some producers are not inclined to attend meetings unless an outbreak is occurring. Some producers might not attend for fear of spreading FMD to their farm. Meetings may be targeted by the media. Need people who can facilitate emotive audiences and are well informed about the outbreak situation and how the rules apply in different circumstances.
Mobile phone text messaging	na	na	na	Widely used for communication during bush fires. Quick way to reach many people with short sharp message and reference to where to find more information. Mobile reception is an issue in some areas. Not all producers are mobile phone users.

na = not applicable.

Source: ABARES

Appendix F: Participant comments on response strategy

At interviews and focus group sessions, most farmers and supply chain members nominated stamping out as their first preference, followed by vaccinate-to-kill and then vaccinate-to-live. Several people saw these options as sequential; if stamping out is failing, employ vaccinate-to-kill. If too many animals need to be vaccinated due to uncontrolled disease spread, move to vaccinate-to-live. Table F1 provides an overview of the comments that participants gave to the three response strategies.

Table F1 Participant comments about three disease control response strategies

Response strategy	Positive comments	Negative comments	Other comments
Stamping out	Provides fastest return to FMD-free status and is the quickest way to regain export markets	Likelihood that the disease is not controlled and gets out of hand	Before outbreaks, need to establish tipping point when stamping out is no longer effective and vaccination is required to control disease
Vaccinate-to-kill	Provides balance between ensuring disease is controlled within reasonable time frame and safeguarding from uncontrolled spread Ensures 'good business' for abattoirs shortly after outbreak period	Almost impossible to get 100 per cent muster on extensive Queensland properties—difficult to vaccinate all animals and find all vaccinated animals to cull Could prolong trauma in comparison with stamping out Farmers might hide animals from being vaccinated or hide vaccinated animals, for example, for breeding purposes Healthy vaccinated animals of all ages need to be slaughtered Abattoirs might be unable to cope with increased demand for slaughter	Limited number of abattoirs servicing Queensland case study area are struggling to keep up with demand. Might have to send vaccinated animals to abattoirs Rockhampton or beyond, which might cause animal welfare issues and the cost of transport will be high
Vaccinate-to-live	Healthy vaccinated animals will not be slaughtered unnecessarily. Precious genetic lines will not be lost unless they are FMD-infected	Takes longest to regain FMD-free status. Could lose export markets permanently Many farmers reported they will not be able to operate with prolonged low meat prices Some concern that vaccine might hide FMD infections and that it would come back Several believed they would struggle to find markets for vaccinated animals	Likely to be viewed favourably by livestock owners, such as small breeders, who have alternative income sources and specialised breeds or valuable genetics Not necessarily more humane as livestock will eventually be slaughtered for consumption
Overall comments	–	Decisions about which animals are vaccinated first could cause tension between and within livestock industries	–

References

- ABARES 2013, *Agricultural commodities: September quarter 2013*, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra.
- 2012, *Agricultural commodity statistics 2012*, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra, December.
- 2011, 'ABARES models: AusRegion', Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra, available at daff.gov.au/abares/models.
- Abdalla, A, Beare, S, Cao, L, Garner, G & Heaney, A 2005, *Foot-and-mouth disease: evaluating alternatives for controlling a possible outbreak in Australia*, ABARE eReport 05.6, Australian Bureau of Agricultural and Resource Economics, Canberra, April.
- ABS 2013, *International trade*, Australia, cat no. 5465.0, Australian Bureau of Statistics, Canberra.
- 2011, *2011 Census QuickStats*, Australian Bureau of Statistics, Canberra, available at censusdata.abs.gov.au/census_services/getproduct/census/2011/quickstat/0.
- 2010, *Family, community & social cohesion*, cat no. 1370.0, Australian Bureau of Statistics, Canberra.
- Aerts, S, Evers, J & Lips, D 2006, 'Development of an animal disease intervention matrix (ADIM)', in *Ethics and the politics of food*, preprints of the 6th Congress of the European Society for Agricultural and Food Ethics: EurSAFE 2006, Oslo, Norway, 22–24 June.
- AGD 2009, *Australian emergency management arrangements*, Attorney-General's Department, Australian Government, Canberra.
- Anderson, I 2008, *Foot and mouth disease 2007: a review and lessons learned*, The Stationery Office, London.
- 2002, *Foot and mouth disease 2001: lessons to be learned inquiry report*, The Stationery Office, London.
- AHA 2012, *Australian Veterinary Emergency Plan (AUSVETPLAN): disease strategy for foot-and-mouth disease*, version 3.3, Animal Health Australia, Canberra.
- 2011, *Meeting report: foot-and-mouth disease response policy review—joint government-industry peak body round table consultation*, Animal Health Australia, Canberra, available at animalhealthaustralia.com.au/wp-content/uploads/2011/05/FMD-round-table-report.pdf (pdf 747.10kb).
- APHIS 2011, *APHIS evaluation of the foot and mouth disease status of Japan*, Animal and Plant Health Inspection Service, Veterinary Services, United States Department of Agriculture, Washington, DC, available at r-calfusa.com/Animal_Health/110401APHISJapanFMDEvaluation.pdf (pdf 1.10mb).
- AusVet & CSIRO 2005, *Review of the potential impacts of new technologies on Australia's foot and mouth disease (FMD) planning and policies*, report to Department of Agriculture Fisheries and Forestry, AusVet Animal Health Services Pty Ltd and CSIRO Livestock Industries, Australian

Animal Health Laboratory, Canberra, available at [daff.gov.au/ data/assets/pdf file/0004/146875/ausvet_fmd_technology_fullreport_jul06.pdf](http://daff.gov.au/data/assets/pdf_file/0004/146875/ausvet_fmd_technology_fullreport_jul06.pdf) (pdf 1.11mb).

Bailey, C, Convery, I, Baxter, J & Mort, M 2004, 'Narratives of trauma and on-going recovery: the 2001 foot and mouth disease epidemic', *AutoBiography*, vol. 11, pp. 37–45.

Barclay, E 2005, *Local community preparedness for an emergency animal disease outbreak*, report for the Rural Industries Research and Development Corporation, Canberra.

Beale, R, Fairbrother, J, Inglis, A & Trebeck, D 2008, *One biosecurity: a working partnership—the independent review of Australia's quarantine and biosecurity arrangements report to the Australian Government*, Commonwealth of Australia, Canberra, September.

Beach, R, Kuchler, F, Leibtag, E & Zhan, C 2008, *The effects of avian influenza news on consumer purchasing behaviour*, United States Department of Agriculture, Washington.

Beckett, S & Garner, MG 2007, 'Simulating disease spread within a geographic information system environment', *Veterinaria Italiana*, vol. 43, pp. 595–604.

Berk, LE 2006, *Development through the lifespan*, Pearson, Boston, Mass.

Bickerstaff, K, Simmons, P & Pidgeon, N 2006, 'Situating local experience of risk: peripherality, marginality and place identity in the UK foot and mouth disease crisis', *Geoforum*, vol. 37, no. 5, pp. 844–58.

Bouma, A, Elbers, ARW, Dekker, A, de Koeijer, A, Bartels, C, Vellema, P, van der Wal, P, van Rooji, EMA, Pluimers, FH & de Jong, MCM 2003, 'The foot-and-mouth disease epidemic in the Netherlands in 2001', *Preventative Veterinary Medicine*, vol. 57, pp. 155–66.

Campbell, D & Lee, B n.d, *The foot and mouth outbreak 2001: lessons not yet learned*, The Centre for Business Relationships, Accountability, Sustainability and Society, Cardiff.

Centre for International Economics 2010, *NLIS (sheep and goats) business plan: the costs of full compliance with NLTPS*, research report, Centre for International Economics, Canberra.

CFIA 2011, *Foot and Mouth Disease Hazard Specific Plan*, Canadian Food Inspection Agency, Ottawa, available at inspection.gc.ca/animals/terrestrial-animals/diseases/reportable/foot-and-mouth-disease/plan/eng/1332174353793/1332174430101?chap=0.

Chang, HS, Hsia, CC & Griffith, G 2005, *The FMD outbreak in the Taiwanese pig industry and the demand for beef imports into Taiwan*, working paper, University of New England, Armidale.

COMEST 2005, *The precautionary principle*, World Commission on the Ethics of Scientific Knowledge and Technology, France.

Conger, KJ, Rueter, MA & Conger, RD 2000, *The role of economic pressure in the lives of parents and their adolescents: the Family Stress Model*, in LJ Crockett & RK Silberiesen (eds), *Negotiating adolescence in times of social change*, Cambridge University Press, Cambridge.

Conger, RD, Ge, X, Elder Jr, GE, Lorenz, FO & Simons, RL 1994, 'Economic stress, coercive family process, and developmental problems of adolescents', *Child Development*, vol. 65, no. 2, pp. 541–61.

Convery, I, Bailey, C, Mort, M & Baxter, J 2005, 'Death in the wrong place? Emotional geographies of the UK 2001 foot and mouth disease epidemic', *Journal of Rural Studies*, vol. 21, no. 1, pp. 99–109.

Cumbria Foot and Mouth Disease Inquiry Panel 2002, *Cumbria Foot and Mouth Disease Inquiry report*, Cumbria Foot and Mouth Disease Inquiry Panel, Cumbria, United Kingdom.

DAFF 2013, 'MICoR: Manual of Importing Country Requirements', Department of Agriculture, Fisheries and Forestry, Canberra, available at www.daff.gov.au/micor, accessed 19 September 2013.

—— 2012, *Australian Government Agricultural Incident Plan*, Department of Agriculture, Fisheries and Forestry, Canberra, December.

—— 2011, *Foot-and-mouth disease*, Department of Agriculture, Fisheries and Forestry, Canberra, available at daff.gov.au/animal-plant-health/pests-diseases-weeds/animal/fmd.

—— 2005, *National foot and mouth disease simulation: Exercise Minotaur evaluation report*, Department of Agriculture, Fisheries and Forestry, Canberra.

—— 2004, *Official health certificate with respect to meat, meat products and edible offal for export to Republic of Korea*, agreed 5 January 2004, Department of Agriculture Fisheries and Forestry, Canberra.

Dahlgren, R & Fairchild, D 2002, 'The demand impacts of chicken contamination publicity: a case study', *Agribusiness*, vol. 18, no. 4, pp. 459–74.

Davis, C & Mentler, J 2004, *The consequences of financial stress for individuals, families and society*, Carleton University, Ottawa, Canada.

Deaville, J, Kenkre, J, Ameen, J, Davies, P, Hughes, H, Bennett, G, Mansell, I & Jones, L 2003, *The impact on mental health and well-being of the foot and mouth outbreak in Wales*, Institute of Rural Health, Newtown, Powys & University of Glamorgan, Pontypridd.

DEFRA & DCMS 2002, *Economic cost of foot-and-mouth disease in the UK: joint working paper*, Department for Environment, Food and Rural Affairs and Department for Culture Media and Sport, London.

Dent, SK, Switala, JP, Adams, PD & O'Sullivan, MH 2002, 'Foot-and-mouth disease outbreak: modelling economic implications for Queensland and Australia', *Australasian Journal of Regional Studies*, vol. 8, no. 3, pp. 303–325.

Dohrenwend, BP, Shrout, PE, Egri, G & Mendelsohn, FS 1980, 'Nonspecific psychological distress and other dimensions of psychopathology measures for use in the general population', *Archives of General Psychiatry*, vol. 37, no. 11, pp. 1229–36.

DSM-IV-TR 2004, *Diagnostic and statistical manual of mental disorders*, 4th edn, American Psychiatric Association, Arlington, VA.

EADRA 2001, *Government and Livestock Industry Cost Sharing Deed*, Emergency Animal Disease Response Agreement, variation no. 12/01-25/05/12, Canberra, available at www.animalhealthaustralia.com.au/wp-content/uploads/2011/04/EADRA-Version-12-01-25-05-2012.pdf (pdf 1.1mb)

ENRC 2000, 'Control of Ovine Johne's disease in Victoria—discussion paper', Environment and Natural Resources Committee, Parliament of Victoria, Melbourne.

European Parliament 2002a, *Report on measures to control foot and mouth disease in the European Union in 2001 and future measures to prevent and control animal diseases in the European Union (2002/2153 (INI))*, November, European Parliament, Brussels, available at europarl.europa.eu/sides/getDoc.do?objRefId=9904&language=EN.

—— 2002b, 'European Parliament resolution on measures to control foot-and-mouth disease in the European Union in 2001 and future measures to prevent and control animal diseases in the European Union (2002/2153(INI))', 17 December, European Parliament, Brussels, available at europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+TA+P5-TA-2002-0614+0+DOC+XML+V0//EN.

FAO 2006, 'Impacts of animal disease outbreaks on livestock markets', paper presented at the 21st Session of the Inter-Governmental Group on Meat and Dairy Products, Rome, Italy, 14 November, Food and Agriculture Organization, Rome, fao.org/docs/eims/upload//234375/ah670e00.pdf (pdf 148kb).

Garner, MG 2012, *Foot and mouth disease outbreak scenarios in Australia—a modelling study*, internal report for the Department of Agriculture, Fisheries and Forestry, Canberra.

Garner, MG, Roche, S & Wicks, R 2011, *Assessing management options for pig farms that develop welfare problems in an emergency disease response*, Department of Agriculture, Fisheries and Forestry, Canberra, February.

Garner, MG & Beckett, S 2005, 'Modelling the spread of foot-and-mouth disease in Australia', *Australian Veterinary Journal*, vol. 83, pp. 758–66.

Hagar, C & Haythornthwaite, C 2005, 'Crisis, farming & community', *The Journal of Community Informatics*, vol. 1, no. 3, pp. 41–52.

Hagerman, AD, McCarl, BA, Carpenter, TE, Ward, MP & O'Brien, J 2011, 'Emergency vaccination to control foot-and-mouth disease: implications of its inclusion as a US policy option', *Applied Economic Perspectives and Policy*, vol. 34, pp. 119–146.

Hall, MJ, Ng, A, Ursano, RJ, Holloway, H, Fullerton, C & Casper, J 2004, 'Psychological impact of the animal-human bond in disaster preparedness and response', *Journal of Psychiatric Practice*, vol. 10, no. 6, pp. 368–74.

Hastreiter, MT 2013, 'Animal welfare standards and Australia's live exports industry to Indonesia: creating an opportunity out of crisis', *Washington University Global Studies Law Review*, vol. 12, issue 1, pp. 181–203, available at law.wustl.edu/WUGSLR/Issues/Volume12_1/wugslrv12_2013_issue1_181_203.pdf (pdf 247kb).

Holdsworth, L & Hartman, Y 2009, 'Indicators of community cohesion in an Australian country town', *Commonwealth Journal of Local Governance*, issue 2, January 2009, pp. 76–97, available at epress.lib.uts.edu.au/ojs/index.php/cjlg/article/download/1009/1013 (pdf 157kb)

Horwitz, R 2012, *Communicating with dairy consumers about FMD*, University of Iowa, Iowa.

Johnson, K, & Stone, K 2011, 'Export market recovery post livestock disease outbreak—cattle', fact sheet, Livestock Marketing Information Center, Denver, Colorado, November, available at lmic.info/memberspublic/LMICFactSheets/FS3-1111.pdf (pdf 155kb).

- Junker, F, Komorowska, J & van Tongeren, F 2009, *Impact of animal disease outbreaks and alternative control practices on agricultural markets and trade: the case of FMD*, OECD food, agriculture and fisheries working papers, no. 19, Organisation for Economic Co-operation and Development, Paris.
- Kasperson, RE, Renn, O, Slovic, P, Brown, HS, Emel, J, Goble, R, Kasperson, JX & Ratick, S 1988, 'The social amplification of risk: a conceptual framework', *Risk Analysis*, vol. 8, no. 2, pp. 177–87.
- Kruger, H, Duncan, A, Trestrail, C & Thompson, LJ forthcoming, *Reducing the social impacts of a foot and mouth disease outbreak in Australia: a literature review*, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra.
- Kruger, H, Stenekes, N, Clarke, R & Carr, A 2012, *Biosecurity engagement guidelines: principles and practical advice for involving communities*, ABARES report to client prepared for the Office of the Chief Plant Protection Officer, Department of Agriculture, Fisheries and Forestry, Canberra.
- Lewis, RE & Tyshenko, MG 2009, 'The impact of social amplification and attenuation of risk and the public reaction to mad cow disease in Canada', *Risk Analysis*, vol. 29, no. 5, pp. 714–28.
- Longstaff, PH & Yang, SU 2008, 'Communication and trust: keys for building resilience to "surprises" such as natural disasters, pandemic flu and terrorism', *Ecology and Society*, vol. 13, no. 1, article 3, available at <http://www.ecologyandsociety.org/vol13/iss1/art3/>.
- McCarty, R 2007, 'Research briefs: consumers want a human health reassurance message in the event of an FMD outbreak', *Issues Update 2007*, pp. 47–8, available at beefusa.org/uDocs/consumers_want_human_health_message_fmd.pdf (pdf 285kb).
- Matthews, K 2011, *A review of Australia's preparedness for the threat of foot-and-mouth disease*, Department of Agriculture, Fisheries and Forestry, Canberra.
- Miller, GA & Ritchie, BW 2003, 'A farming crisis or a tourism disaster? An analysis of the foot and mouth disease in the UK', *Current Issues in Tourism*, vol. 6, no. 2, pp. 150–71.
- Mort, M, Convery, I, Bailey, C & Baxter, J 2004, *The health and social consequences of the 2001 foot and mouth disease epidemic in North Cumbria*, Institute for Health Research, Lancaster University, available at esds.ac.uk/doc/5407/mrdoc/pdf/5407finalreport.pdf (pdf 2.67mb).
- Mort, M, Convery, I, Baxter, J & Bailey, C 2005, 'Psychosocial effects of the 2001 UK foot and mouth disease epidemic in a rural population: qualitative diary based study', *BMJ*, vol. 331, no. 7527, pp. 1234.
- Myers, J 2011, 'Impact of the Australian equine influenza outbreak on a small business that was not infected', *Australian Veterinary Journal*, vol. 89, pp. 161–2.
- Nerlich, B, Hamilton, CA & Rowe, V 2002, *Conceptualising foot and mouth disease: the socio-cultural role of metaphors, frames and narratives*, University of Nottingham, United Kingdom.
- OIE 2011a, *Terrestrial Animal Health Code, chapter 8.5, foot and mouth disease*, World Organisation for Animal Health, Paris, available at oie.int/eng/A_FMD2012/docs/en_chapitre_1.8.5.pdf (pdf 246kb).
- 2011b, *17th meeting of the OIE Sub-Commission for Foot and Mouth Disease Control in South-East Asia and China*, Bali, Indonesia, 7–11 March, World Organisation for Animal Health, Paris, available at oie.int/doc/ged/D10957.PDF (pdf 979kb).

- Olf, M, Koeter, MWJ, Van Haaften, EH, Kersten, PH & Gersons, BPR 2005, 'Impact of a foot and mouth disease crisis on post-traumatic stress symptoms in farmers', *The British Journal of Psychiatry*, vol. 186, no. 2, pp. 165–6.
- Oparinde, AO and Birol, E 2008, 'Impacts of HPAI on rural livelihoods: conceptual and analytical frameworks', Africa/Indonesia team working paper no. 10, available at influenzatraining.org/documents/s17585en/s17585en.pdf (pdf 1mb).
- Park, M-S, Jin, YH & Bessler, DA 2008, 'The impacts of animal disease crises on the Korean meat market', paper presented to American Agricultural Economics Association annual meeting, Florida, 27–29 July, available at ideas.repec.org/p/ags/aaea08/6365.html.
- Peck, DF 2005, 'Foot and mouth outbreak: lessons for mental health services', *Advances in Psychiatric Treatment*, vol. 11, no. 4, pp. 270–6.
- Peck, DF, Grant, S, McArthur, W & Godden, D 2002, 'Psychological impact of foot-and-mouth disease on farmers', *Journal of Mental Health*, vol. 11, no. 5, pp. 523–31.
- Phillipson, J, Lowe, P & Carroll, T 2002, *Confronting the rural shutdown: foot and mouth disease and the north east rural economy*, Centre for Rural Economy, Newcastle.
- Piggott, NE & Marsh, TL 2004, 'Does food safety information impact US meat demand?', *American Journal of Agricultural Economics*, vol. 86, pp. 154–74.
- Productivity Commission 2002, *Impact of foot and mouth disease outbreak on Australia*, research report, AusInfo, Canberra.
- Queensland Government 2004, *Regulatory impact statement: implementation of the National Livestock Identification System—proposed amendments to the Stock Identification Regulation (1985)*, Department of Primary Industries and Fisheries, Brisbane.
- Rich, KM 2004, *Animal diseases and the cost of compliance with international standards and export markets: the experience of foot-and-mouth disease in the Southern Cone*, agricultural and rural development discussion paper, The World Bank Group, Washington, DC, available at bnpp-kd.org/en/publications/animal-diseases-and-cost-compliance-international-standards-and-export-markets.
- Rubira, R 2009, 'Animal welfare considerations in response to an emergency animal disease', in *Animals and human health*, RSPCA Australia Scientific Seminar 2009, 24 February, available at www.cabdirect.org/abstracts/20123352965.html;jsessionid=28D76F5415684627F8BB7A51C121B503.
- SCoPI 2012, *SCoPI 1 communique: foot-and-mouth disease*, Council of Australian Governments' Standing Council on Primary Industries, Canberra, available at mincos.gov.au/communiques/scopi-1.
- Scott, A, Christie, M & Midmore, P 2004, 'Impact of the 2001 foot-and-mouth disease outbreak in Britain: implications for rural studies', *Journal of Rural Studies*, vol. 20, no. 1, pp. 1–14.
- Senate Rural and Regional Affairs and Transport References Committee 1998, *The incidence of Ovine Johne's disease in the Australian sheep flock*, Canberra.
- Spickler, AR & Roth, JA, 2008, *Emerging and exotic diseases of animals*, 3rd edn, Center for Food Security and Public Health, Iowa State University, Iowa.

- Taylor, M, Agho, K & Griffin, E 2008, *Human impacts of equine influenza*, University of Western Sydney.
- Taylor, M, Agho, K, Stevens, G & Raphael, B 2008, 'Factors influencing psychological distress during a disease epidemic: Data from Australia's first outbreak of equine influenza', *BMC Public Health*, vol. 8 no. 1, p. 347.
- Thorpe, S & Klijn, N 2002, *Projections of agricultural activity and associated greenhouse gas emissions 2001–20*, ABARE report to the Australian Greenhouse Office, Canberra, July.
- Tozer, PR, Marsh, TL & Perevodchikov, EV 2010, 'Domestic and trade impacts of foot and mouth disease and BSE on the Australian beef industry', in *Proceedings of the Australian Agricultural and Resource Economics Society 2010 Conference*, Adelaide, 10–12 February.
- UKECP 2009, *UK Export Certification Partnership—background*, Export Certification Limited, Cheshire, available at ukecp.com/about-ukecp/.
- Webster, WR 2011, 'Overview of the 2007 Australian outbreak of equine influenza', *Australian Veterinary Journal*, vol. 89, pp. 3–4.
- Welte, V 2000, 'Risk analysis and OIE, in multilateral trade negotiations on agriculture: a resource manual', module 12, in *III. Agreement on the Application of Sanitary and Phytosanitary Measures (SPS) and Agreement on Technical Barriers to Trade (TBT)*, Food and Agriculture Organization of the United Nations, Rome, available at fao.org/docrep/003/x7354e/x7354e12.htm.
- Westen, D, Burton, L & Kowalski, R 2006, *Psychology: Australian and New Zealand edition*, John Wiley & Sons, Milton, Qld.
- WTO 1998, *Understanding the WTO Agreement on Sanitary and Phytosanitary Measures*, World Trade Organization, Geneva, available at wto.org/english/tratop_e/sps_e/spsund_e.htm.
- Yang, J & Goddard, E 2011, 'Canadian consumer responses to BSE with heterogeneous risk perception and risk attitudes', *Canadian Journal of Agricultural Economics*, vol. 59, no. 4, pp. 493–518.
- Yang, PJ, Ju, RP, Jong, WB & Song, HT 1999, 'The 1997 FMD outbreak in Taiwan and its economic impacts', *Animal Husbandry Fortnightly*, vol. 61, pp. 25–29.
- Yang, SH 2012, 'The impacts of foot and mouth disease on international pork trade: an extension of the gravity model', PhD thesis, University of Kentucky, USA, available at uknowledge.uky.edu/agecon_etds/4.