ERADICATION OF FOOT AND MOUTH DISEASE
IN
COMPETITOR COUNTRIES

SUMMARY REPORT

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PROJECT M.075

AUSTRALIAN MEAT AND LIVE-STOCK RESEARCH
AND DEVELOPMENT CORPORATION

ANALYSIS OF MARKET THREATS

ERADICATION OF FOOT AND MOUTH DISEASE IN COMPETITOR COUNTRIES

SUMMARY REPORT

SEPTEMBER, 1990

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GLOSSARY

Adjuvant	Component of a vaccine which enhances the normal immune response.
Aetiology	Cause of disease.
Antibody	Immunoglobulins formed in response to introduction of foreign material into the body that is recognised by the body as foreign. Their characteristic property is to combine under physiological conditions with the inducing material (antigen).
Antigen	Material which, when introduced to the body, can provoke an immune response.
Asymptomatic	Not showing any signs of disease.
Attenuated Vaccine	Living vaccine made from a strain of the organism concerned which has been modified to reduce its virulence.
Capsid	Shell or protein coat of some viruses.
Carrier	Animal which carries an infectious agent without expressing clinical signs of the disease.
Endemic	Disease regularly occurring in a country/region.
Epidemic	Disease prevalent amongst a population at a particular time.
Epidemiology	Study of the factors involved in the frequency and distribution of a disease in a population.
Epitope	Antigenic determinant on a micro-organism.
Immunoglobulins	Proteins produced by plasma cells which are capable of specifically binding antigens.
Incidence	Frequency of new cases appearing in a population during a specified period.
Lesion	Site of structural or functional change in body tissues produced by disease or injury.
Pathogenisis	The sequence of events from the time of infection to the development of disease or a morbid or pathological state.
Prevalence	Proportion of animals in a population which are affected by disease at a given point in time.
Prophylaxis	Prevention or warding off disease.

Serotype	A group of organisms that can be identified by serological techniques which when they infect an animal will provoke a natural immunity against members of that serotype but not against a member of any other serotype.
Sporadic	Disease with scattered or intermittent occurrence.
Stamping Out	Control of FMD outbreaks by slaughtering livestock, imposing movement restrictions and disinfecting infected premises.
Viraemia	Virus spreading through the body via the bloodstream.
Zoosanitary	Pertaining to animal health, restoration of animal health or absence of agents injurious to animal health.

1. INTRODUCTION

The presence or absence of FMD is an important determinant of prices in the World meat trade. Australia's favoured trading position would be seriously threatened if:-

(i) major exporters which currently have FMD succeed in eradicating it through conventional means; or
(ii) a new control or eradication technique is developed such as a safe and more effective vaccine.

This study was commissioned by AMLRDC to:-

(i) analyse and quantify the probability of different rates of eradication in various regions over a range of time horizons;
(ii) assess the impact of different events and event combinations on the markets for Australian meat and livestock products;
(iii) identify actions to mitigate the threat or soften its impact;
(iv) formulate a long-term strategy which recognises the threat; and
(v) highlight any R&D projects or programs which will help respond to the threat.

2. CHARACTERISTICS OF FMD

2.1 GENERAL CHARACTERISTICS

FMD is a widely distributed and highly contagious viral disease of all cloven-footed animals in which it causes vesicles in the mouth, on the udder and on the feet. The virus occurs in seven serotypes which cause clinical signs which are indistinguishable. There is no cross-protection between serotypes, and within each serotype there is also considerable antigenic variation between the 64 sub-types. Antigenic variation is one of the most difficult problems in protecting animals by vaccination. It means that a wide range of vaccines must be available.

The virus usually infects animals via the mucosal and lymphoid tissues of the pharyngeal/tonsillar region. Less frequently, infection can occur through cuts in the mouth or on the feet. Following replication at the point of entry, the virus enters the blood stream in which it may circulate for three to five days. A secondary phase of replication is initiated by blood-borne virus in glands such as lymph nodes, thyroid or adrenals. During this secondary phase the sites of vesicle development on the skin are established, leading to visible lesions.

In cattle, vesicles followed by ulcers appear on the tongue, in the mouth and sometimes on the muzzle or in the nostrils. Vesicular lesions on the feet involve the coronary band, bulbs of the heel and the interdigital space. Mortality in adult cattle is rarely more than 5%, but often is greater in calves. In pigs, mouth lesions are less prominent but feet lesions and lameness are notable. There is also depression, anorexia and loss of condition. High mortality of piglets is common. In sheep and goats, adults are not generally severely affected and the disease may go unnoticed. Sheep and goats can therefore serve as a reservoir of the virus which spreads to other species. A number of wild mammals also carry or develop the disease, and can play a significant role in its transmission, especially in Africa.

2.2 TRANSMISSION OF FMD

FMD is one of the most highly contagious diseases due to the resistance of the virus, the great susceptibility of domestic animals, the short incubation period, and the very large amounts of virus produced by infected animals. The disease can be transmitted by:-

(i) Movement of infected livestock - this is the most common mechanism. The fact that animals excrete the virus during the incubation period is of considerable epidemiological importance. Also, some animals may remain carriers after the symptoms have disappeared.

(ii) Consumption of infected animal products such as meat, swill and milk. The virus will persist in quick-frozen meat, but is inactivated during the pH decline which accompanies rigor mortis. However, the virus will survive in offals and bone marrow where a pH drop does not occur. Semen can also carry the virus.

(iii) Contact with contaminated people.

(iv) Contact with birds and other mechanical vectors.

(v) Contact with contaminated equipment or vehicles.

(vi) Airborne transmission - this can be important under certain weather and topographic conditions. Pigs are important in airborne transmission as one pig may exhale as much virus as 3,000 infected cattle. Mathematical models have been developed to predict the patterns of airborne spread.

(vii) Vaccines which have not been correctly inactivated and laboratory escapes can also be responsible for outbreaks.

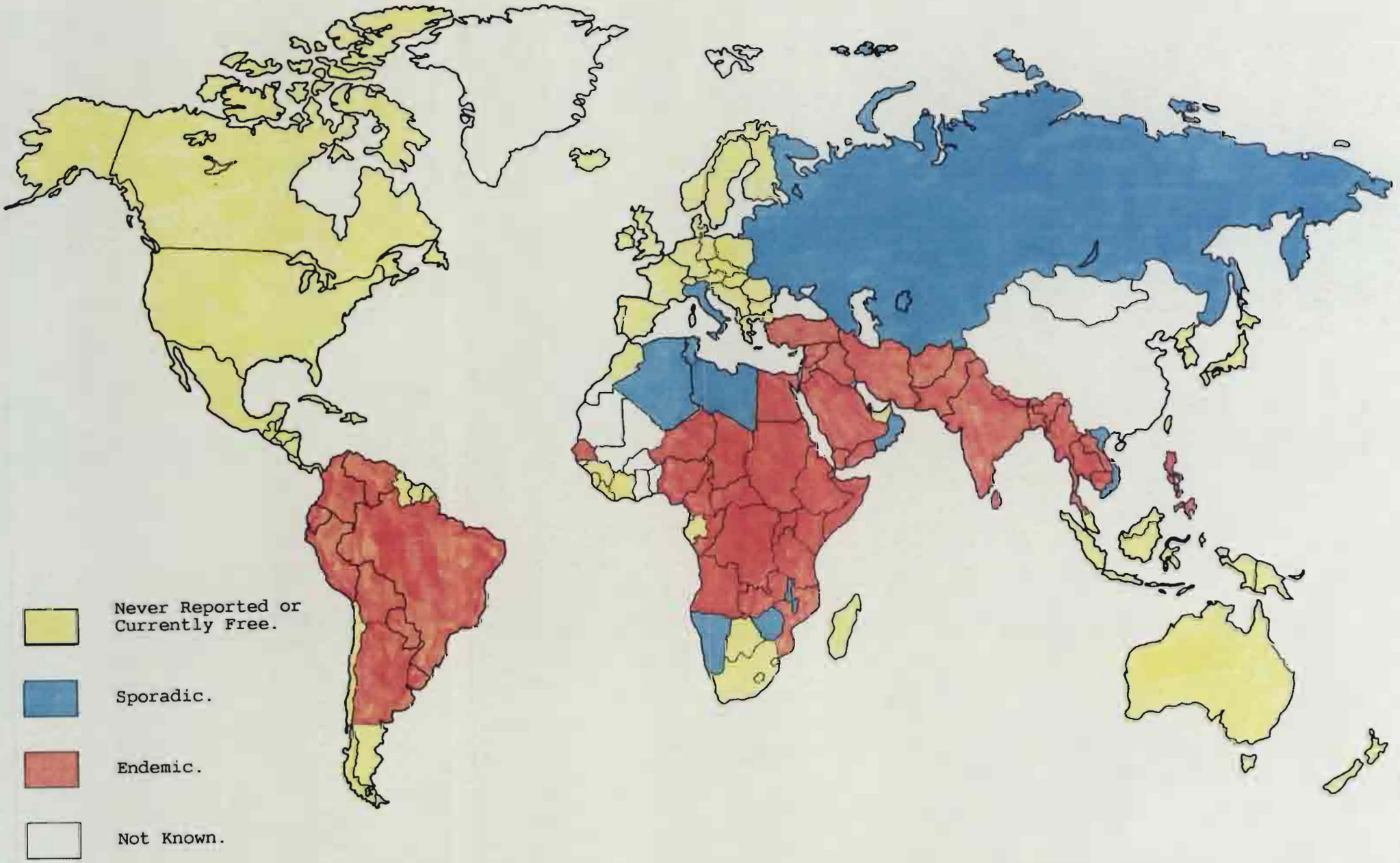
2.3 INTERNATIONAL DISTRIBUTION

Due to the highly resistant and highly infective nature of the virus, the disease is widely distributed. Figure 1 summarises the latest available information compiled from the records of the World FMD Reference Laboratory. Currently 46 countries are free from the disease, but it remains sporadic in 14 countries and endemic in 46 countries. The status is uncertain in a further 22 countries.

In almost all countries which have some incidence of the disease, vaccination is practised, usually in conjunction with other measures. Most countries practising vaccination have been able to reduce the incidence of FMD, but so far only a few have taken the major step of stopping vaccination and relying on stamping out (slaughtering) to control outbreaks.

All EC counties, except Italy, are now FMD-free, but most EC countries still vaccinate against FMD. Many FMD-free importers treat vaccination as being equivalent to the presence of the disease. Hence, although most of Europe is shown as FMD-free in Figure 1; it is classified by most Pacific Basin meat importers as FMD positive.

FIGURE 1 : WORLD DISTRIBUTION OF FMD : 1989



3. ECONOMIC IMPACT OF FMD

3.1 GENERAL

The main economic impacts of FMD are:-

(i) its effect on animal production;
(ii) the costs of control measures; and
(iii) its restrictive effect on trade in meat and other animal products.

It is generally accepted that production losses are less significant than (ii) and (iii). Production losses result from abortions and still births, reduced fertility, lower milk production and liveweight losses. Mortalities are not usually significant, except in young animals. In dairy cattle, lactation is temporarily suppressed but generally recovers, but not to former levels of production. Sheep and goats are only slightly affected. Pigs are highly susceptible and, because of the large volumes of virus exhaled by infected animals, often play a key role in amplification and spread of the disease.

3.2 COST OF CONTROL MEASURES

Costs include vaccine production, vaccination campaigns, quarantine and buffer zone maintenance, and slaughter compensation. Vaccination costs US$1.00-$1.50 per animal per year, and about 1.5 billion doses are used annually. Once the incidence has been reduced by vaccination, it is much cheaper to control the disease by stamping out, even if there is a large number of outbreaks.

3.3 IMPACT ON TRADE IN ANIMAL PRODUCTS

World meat supplies fall into two separate pools designated FMD + and FMD -, depending on their country of origin. This distinction is very important for beef, but less so for sheepmeats. The only significant sheepmeat exporters (Australia and New Zealand) are FMD -. No FMD + country exports enough sheepmeat to have an appreciable effect on World mutton or lamb prices.

The common policy of most major meat importing countries is to ban imports of fresh, chilled or frozen meat from FMD + countries. Countries are considered FMD + if they have reported a "recent" outbreak[1] or if the country has animals vaccinated against FMD. Vaccinated animals may carry the disease asymptomatically. If there has been no reported outbreak but the exporting country's veterinary services are considered inadequate, most FMD - countries will treat the exporting country as if the disease is present.

FMD - countries are usually prepared to import canned or cooked meat, and in some cases will import chilled or frozen meat from FMD + countries provided strict procedures are followed. These include deboning; storage at ambient temperature for

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[1] There is no agreed definition on what constitutes a "recent" outbreak, but 12 months appears to be applied in some cases.

24-48 hours to allow the pH drop to inactivate any virus; sourcing animals from a secure disease-free zone; quarantining livestock for at least the incubation period before slaughter; and strict veterinary inspection and certification at all stages. Some South American and African countries export beef to Europe under these conditions.

Several of the large FMD + exporters in South America (e.g. Brazil and Argentina) address the problem by exporting large quantities of canned beef. Although canned/cooked exports generally attract a higher gross price than chilled or frozen meats from these countries, the processing costs and cooking losses result in lower net returns. Hence, FMD + countries which succeed in eradicating the disease may wish to divert supplies from canned beef to the chilled or frozen trade. However, the extent of this shift is difficult to predict in the absence of detailed knowledge about the economics of processed versus fresh meat production, and the price responses which would result.

It is difficult to quantify precisely the effect of FMD on meat prices. Many factors contribute to price determination on World meat markets, but the available data suggest that there is generally a premium for meat from FMD - suppliers. This premium varies between about US$500 and US$1,000 per tonne carcase weight. If one or more major FMD + beef exporters eradicate the disease, this price differential would be reduced.

The incentive to control or eradicate FMD depends on:-

(i) the current stage in the control-eradication progression (see Section 4.1) and the current incidence of the disease;
(ii) whether incentive is considered from the individual livestock owner's viewpoint or the total industry viewpoint; and
(iii) the level of exposure to international meat markets which heavily discount fresh or frozen meat from FMD + countries.

Table 10 in the Main Report summarises the conclusions on incentives for FMD control and eradication. Individual and industry/national incentives are strong at either end of the progression from endemic to FMD-free, but much weaker during the crucial intermediate stage when disease incidence is already low. The individual incentive at this stage is particularly weak where there is a low or zero level of export dependence. During this crucial intermediate stage, a high level of compulsion and strict regulation is necessary to achieve the transition to full eradication.

The proportions of meat production which are exported from the four major FMD + beef exporters are:-

	Chilled/Frozen	Canned/Cooked	Total
Uruguay	40.5%	2.7%	43.2%
Brazil	5.3%	11.4%	16.7%
Argentina	7.4%	6.2%	13.6%
EC (excluding intra-EC)	10.9%	0.5%	11.4%

In EC, Argentina and Brazil, the effect of FMD on cattle prices could be considered only minor. However, the economic incentive for Uruguay to gain FMD - status is considerable, since this country regularly exports 43% of total beef production and also exports some sheepmeat. The incentive for Argentina and Brazil lies in the potential to divert exports of canned meats to fresh categories.

4. FMD CONTROL AND ERADICATION

4.1 GENERAL

The availability of vaccines has spearheaded FMD control and eradication programs in most countries, although a few - notably the United Kingdom - have relied successfully on stamping out by compulsory slaughter of affected animals. The usual progression of events in an endemic FMD area is:-

(i) mass prophylactic vaccination of all susceptible livestock;
(ii) stamping out supported by strategic vaccination after the incidence has fallen to manageable levels; and, finally
(iii) cessation of vaccination and reliance on stamping out to extinguish outbreaks, and quarantine measures to prevent them.

There are a number of variations of this progression, depending on the geographic features of the country, the type of livestock industries, financial and manpower resources, and epidemiological considerations. The best strategy varies between countries and regions, but it is possible to identify some key features of successful programs.

4.2 REQUIREMENTS FOR CONTROL AND ERADICATION OF FMD

(i) Detailed planning. This requires reliable livestock and epidemiology statistics to complete benefit - cost studies of alternative strategies. Planning should include budgetary allowances for ongoing program monitoring and further benefit - cost analyses as each milestone is passed.

(ii) Involvement of the farming community. Farmers must have a genuine desire to eradicate the disease or they will not tolerate the cost and inconvenience, particularly in relation to stock movement controls and the necessity of prompt reporting.

(iii) Government support must be adequate in both financial and legislative terms. Funds are required for veterinary field activities, administration, slaughter compensation, operation of a vaccine production laboratory or importation of vaccine, a vaccine control laboratory, a diagnostic laboratory, disease surveillance, communication and publicity.

(iv) International agreements. Campaigns in most cases must be waged on a regional (i.e. multi-national) basis, and the co-operation of neighbouring countries is therefore essential. Island countries have obvious advantages in this respect.

(v) Veterinary services must be strong and well organised with sufficient resources of personnel, vehicles, material, communication facilities, etc.. Staff must be adequately trained and familiar with the supporting legislation. Veterinary field staff must be responsible to, and controlled by, the central veterinary authority alone.

(vi) Vaccine Production and Associated Facilities. If a country decides to produce vaccine locally and carry out its own diagnosis and investigation, the following laboratories are required:-

* A vaccine production laboratory capable of producing sufficient quantities of potent, immunogenic vaccine on schedule. For endemic areas with severe disease challenge, at least 80% of the bovine population should be vaccinated twice annually. Sheep, goats and pigs may also have to be covered if they are present in large numbers. Vaccine storage and cold chain facilities must be adequate.

* A vaccine control laboratory which should be independent of the production laboratory to carry out vaccine quality control tests.

* A diagnostic laboratory to provide rapid and accurate service to characterise field isolates and advise on the selection or manufacture of suitable vaccine strains. This laboratory should also conduct serological surveys and collect and process epidemiology information.

(vii) Police and military support can be very important to enforce unpopular steps such as stock movement restrictions.

(viii) Wildlife control can be important, especially in Africa where some game animals act as reservoirs of infection. Game-proof fences and/or barrier vaccination may be necessary.

(ix) Moving from control to eradication. Reducing the incidence of the disease to the stage where it is clinically insignificant is relatively easy. However, to eradicate the disease it is usually necessary to apply the stamping out policy at some stage. This must involve payment of full compensation to farmers whose animals are slaughtered. If farmers do not have complete confidence that compensation will be paid, they are reluctant to report the disease, and often sell the affected animals instead. Hence, before implementing a stamping out policy, it is first necessary to set aside a contingency fund of adequate size.

4.3 VACCINATION AGAINST FMD

4.3.1 General

With good potent vaccines and a high proportion of coverage, vaccination can quickly reduce FMD to levels where stamping out becomes cost-effective. However, vaccines do not always achieve the results they should.

A major problem is the occurrence of seven virus serotypes with many antigenic variations. There is no cross-protection between serotypes. Vaccines can be polyvalent with respect to serotype, and this increases the chance of adequate protection, but it is still necessary to get good matching of sub-types against the prevailing field strains. This requires a high level of technical support and constant monitoring.

Prophylactic vaccination campaigns may employ vaccination once, twice or three times per year. In western Europe, annual vaccination of cattle has been adequate to control the disease due to good quality vaccine, high levels of coverage, low levels of virus challenge, and efficient application of supporting zoosanitary measures. In South America, on the other hand, despite vaccination three times yearly, in some areas the disease is still present.

There are numerous variations of conventional inactivated vaccines. There are only two major multi-national commercial suppliers - Pitman-Moore (USA) and Rhone Merieux (France) - but many countries produce their own vaccines in Government laboratories.

Following vaccination with a good quality vaccine, cattle are immune after about 10 days. They remain protected against the homologous strain for 4-6 months after primary vaccination, and 9-12 months after revaccination.

The shelf life of conventional vaccines is about 12 months at 4°C, but only two days at 25°C. Vaccine stockpiled for emergency use has to be replaced at regular intervals.

4.3.2 Attenuated Live Virus Vaccines

Because of the short duration of immunity created by inactivated vaccines, attempts have been made to produce live attenuated vaccine. The use of such vaccines is risky and requires constant surveillance. Despite some claimed successes, the approach has generally been unsatisfactory.

4.3.3 Synthetic Vaccines

Problems with conventional vaccines including safety, cost, antigen stability and efficacy have led to substantial efforts to develop synthetic FMD vaccines. The synthetic vaccines use genetic engineering techniques to create the antigenic component of FMD virus particles which, it is hoped, can be used with complete safety. So far it has not been possible to produce a synthetic vaccine with antigenicity approaching that of good conventional vaccines. Two types of synthetic FMD vaccines are being researched:-

(i) Cloned protein vaccine in which FMD virus protein antigen (VP_1) is produced in a bacterium such as E. coli. Unfortunately the viral protein produced in this way has been a poor immunogen, possibly because the physical configuration of the amino acid chain is not folded in a way which presents the important antigenic sites to cells of the immune system.

(ii) Synthetic peptide vaccines. Specific peptide fragments of FMD viral protein have been found to be adequate for inducing immunity in laboratory animals. The most effective is a 20 amino acid peptide. The substitution of a single amino acid at the immunodominant site of this peptide is sufficient to modify its antigenic specificity. Preparation of vaccines composed of a "cocktail" of a large number of peptide sequences may permit the formulation of efficacious multivalent vaccines. Such vaccines would be safe, stable and cheap, but so far it has not been

possible to develop peptide vaccines which provide good protection in cattle.

Peptide vaccines offer many potential advantages, including lack of need for production under disease-secure conditions; easy storage; greater stability; and much greater scope for multivalent vaccines. Significant progress has been made and a new generation of FMD vaccines may be possible within a decade. However, practical FMD control with synthetic peptides look unlikely in the short-term. Current production of conventional vaccines is more than 1.5 billion doses per annum. Production of such a large amount of synthetic peptide vaccine would require modification of laboratories and the retraining of staff. Furthermore, it would take many years before a new vaccine could be tested, registered and produced on a commercial scale. No commercial producer is currently working on synthetic vaccines, although Pitman-Moore did have a research program at one time. This has now been dropped.

It is concluded that major control and eradication programs are likely to be based on the use of conventional inactivated vaccines for 10 years or more.

4.4 REVIEW OF CURRENT CONTROL AND ERADICATION CAMPAIGNS

There are four significant meat exporters which are not FMD-free. These are EC (which is treated as FMD + because of vaccination), Uruguay, Argentina and Brazil. No other FMD + country or region has the capacity to significantly impact on the World meat trade. The review therefore focuses on these countries.

If a major Pacific Basin meat importer changes from FMD - to FMD +, it is likely that the disease would be rapidly contained and stamped out. It is very unlikely that the affected country would relax its importation policy. Further tightening is more likely.

4.4.1 European Community

There was an upsurge of outbreaks in Europe in the 1950s, and large epidemics continued through the 1960s and early 1970s. However, the adoption of mass annual cattle vaccination has dramatically reduced the incidence. Since 1980, only Italy and Portugal have experienced severe epidemics.

In eight of the 12 EC countries, vaccination has been used together with increased use of slaughtering and booster vaccinations wherever outbreaks occurred. In the other four countries (United Kingdom, Ireland, Denmark and Greece), vaccination has not been routinely undertaken and stamping out is the main course of action. These four countries took advantage of some degree of geographical isolation combined with strict quarantine regulations. At present, EC Member States which employ a non-vaccination policy may restrict trade in livestock from those which vaccinate. This is justified on the basis that vaccinated animals may carry the virus while remaining clinically normal. Many third countries (e.g. USA) consider that the presence of vaccinated animals is equivalent to the presence of the disease.

Following the establishment of a single free internal EC market in 1992, livestock and livestock products must move freely between Member States. This will require all members to adopt a common policy towards FMD. The EC has decided that a policy of non-vaccination will be implemented before January 1992 at the latest. This will

probably reduce the number of outbreaks in Europe, as escapes from vaccine plants or faulty vaccines have been suspected in more than one-third of primary outbreaks in the last 20 years.

Cessation of vaccination on or before 1 January, 1992, is timed to allow at least one year before free movement, to ensure that no carriers are present. Uniform stamping out regulations will then apply in all 12 EC countries, but contingency plans are being made to hold stocks of vaccine in reserve. These would be used in an extreme emergency if stamping out failed to contain the disease. However, there will be considerable reluctance to resort to vaccination, as this would prolong any subsequent trade embargo by FMD - importers.

If the cessation of vaccination was accompanied, as expected, by a greatly reduced number of outbreaks and there was no widespread epidemic, this may result in the EC gaining access to the so-called "white list". Alternatively, FMD - importers may be prepared to consider some countries of continental Europe free of the disease, even though there is unrestricted movement of livestock and meat within the community.

After 1992, the EC is likely to exercise increasingly stringent meat import controls to protect its FMD-free status. This will particularly involve offal imports from South America and probably an increase in beef supplies from selected parts of Southern Africa, notably Botswana.

For the last 45 years the "iron curtain" has provided an excellent quarantine barrier between eastern and western Europe. With the political changes now taking place, it is difficult to predict what might happen in eastern Europe, but it is possible that they might follow the EC model since several of the eastern European countries do not presently vaccinate, and several conduct limited strategic vaccination. No eastern European country has had an outbreak in the last year. FMD has, however, been reported in the USSR - though not close to the Eastern Block countries. If non-vaccination against FMD is adopted throughout Europe in the years ahead, it is likely that the line separating the non-vaccinating countries from the sporadically infected will be drawn along the western border of the USSR.

Four scenarios covering the future of FMD in Europe have been formulated and considered by leading FMD epidemiologists from the World FMD Reference Laboratory, Pirbright, United Kingdom. The likelihood of each scenario eventuating over three separate timeframes was estimated subjectively on the basis of the best available information and expertise. The results are summarised below. A detailed discussion of each of the scenarios is provided in the Main Report.

Scenario for European Community	Probability (%) 1990-1995	1996-2000	2001-2010
(a) Vaccination discontinued, no further outbreaks in any member country.	15	14	9
(b) Vaccination discontinued, limited sporadic outbreaks in S. Europe contained by stamping out.	70	80	90

Scenario for European Community	Probability (%) 1990-1995	1996-2000	2001-2010
(c) Vaccination continued in S. Europe with continued limited sporadic outbreaks, but vaccination discontinued in N. Europe.	10	5	<1
(d) Vaccination discontinued, major epidemic extending into N. & E. Europe leading to resumption of vaccination.	5	1	<1
	100	100	100

4.4.2 South America

Since the 1950s, South American countries have initiated and developed co-ordinated programs for FMD control. A co-ordinated continent-wide approach is necessary due to the frequency of cross-border livestock movements. This is termed the "Hemispheric Program for Control of FMD in South America". A regional surveillance and reporting system has been established and the continent has been zoned into four ecosystems described as endemic, epidemic, sporadic and virus-free.

The endemic ecosystem exists mainly in the cattle breeding areas and is the main reservoir of infection. Epidemic conditions prevail in fattening areas where younger animals move in from the breeding areas. There are FMD-free areas covering all of Chile, the southern portion of Argentina (Patagonia), the Guyanas, and part of Colombia.

The number of FMD outbreaks in 1989 represents about 10% of the number registered 10 years earlier. This trend is attributed to improved vaccine quality control, strategies at regional rather than national level, continuous development of surveillance and information systems, and a substantial increase in the number of veterinarians and animal health auxiliary personnel.

In many parts of South America the cattle industry is stratified (as in Australia) into breeding, growing and fattening areas. For this system to work effectively, animals must move long distances several times during their lives. Veterinary certificates are required to move livestock and many countries maintain check-points to ensure that only vaccinated animals are moved.

However, alongside these positive organisational features there are factors which contribute to the spread of disease. These factors include:-

(i) low vaccination coverage (i.e. less than 80%) in many areas;
(ii) inadequate disinfection of trucks and market places;
(iii) in some areas livestock movement controls are not effective;
(iv) lack of enthusiasm by farmers who are not directly involved in specialised export businesses;
(v) monitoring and reporting of FMD is inadequate in a number of countries;
(vi) only cattle are vaccinated, despite the existence of large numbers of sheep in some areas;
(vii) vaccine quality is sometimes poor; and

(viii) the organisation and administration of control programs suffers from inadequate manpower and other resources.

The problem of incomplete vaccination coverage is related to the fact that farmers are responsible for vaccinating their own stock. To obtain a vaccination certificate they only need to purchase the vaccine. For extensive ranches the cost of mustering far exceeds the cost of vaccine, so some livestock owners buy the vaccine and obtain the certificate and then fail to administer the vaccine.

The quality of vaccine produced in South America has undoubtedly improved in recent years, and this has been reflected in better control of FMD. This is particularly the case in the River Plate Basin covering north-eastern Argentina, Uruguay and southern Brazil. However, problems still exist with respect to antigen quality and content. Often there is inadequate checking of field strains relative to the vaccine strains due to inadequate sampling frequency and lack of facilities for sub-typing.

The Hemispheric Plan

The "Hemispheric Plan of Action for Eradication of FMD" was instigated in 1989 and is being funded by the Inter-American Development Bank (IDB), the World Bank and USAID. The plan aims to eradicate FMD from South America by the year 2009. It includes three sub-regional projects. Sub-region 1 incorporates the River Plate Basin and Southern Cone; Sub-region 2 is the Andean Region; and Sub-region 3 is the Amazonian Region (see map in Annex 2).

Sub-region 1 is easily the most important of the three. It includes a large proportion of the cattle and most of the export establishments on the continent. From Australia's viewpoint, developments in the other two sub-regions are virtually irrelevant, except via the border effect on Sub-region 1, since FMD eradication in these sub-regions is highly improbable.

The strategy within Sub-region 1 is differentiated by area. The most important area, and the one where the program will be spearheaded is area (b), known as the River Plate area. This includes Argentine Mesopotamia (incorporating the provinces of Corrientes, Entre Rios and Missiones), all of Uruguay and Rio Grande do Sul province of Brazil. The other parts of Sub-region 1 are either already FMD-free (Patagonia and Chile) or not scheduled for eradication until after the year 2000 (rest of Argentina, Paraguay and Santa Catarina province of Brazil).

The funding available under the Hemispheric Plan will undoubtedly assist in providing many of the resources needed to improve control of FMD in South America. However, there is an enormous difference in moving from a state of FMD control to one of cessation of vaccination and implementation of a stamping out policy. This step is essential if South American countries are to gain access to the higher priced FMD - markets. Such a change is of a quantum leap nature, and requires the availability of a contingency fund of sufficient size that, when compulsory slaughtering is applied, farmers are fully and promptly compensated. Otherwise when disease occurs farmers will avoid reporting it, and will market their animals, thus further spreading the disease.

The basic weaknesses of FMD control in South America and those factors which lead to the perpetuation of the disease are likely to continue. It is difficult to foresee, at least in the short-term, any very dramatic extension of the FMD-free areas. Even in the River Plate area, which is given high priority in the Hemispheric Program, complete eradication including cessation of vaccination is unlikely in the next decade. The best which could be expected is the establishment of some disease-free zones (DFZs) to concentrate on beef exports. Four scenarios have been formulated and analysed for the River Plate Basin:-

Scenario for River Plate Basin	Probability (%) 1990-1995	1996-2000	2001-2010
(a) Successful mass vaccination program followed by stamping out leads to eradication with no further outbreaks and discontinued vaccination.	<1	1	5
(b) Successful vaccination program followed by stamping out leads to eradication. Vaccination discontinued and limited sporadic outbreaks contained by stamping out.	1	5	10
(c) Vaccination program reduces incidence followed by stamping out and establishment of Disease-Free Zones (DFZs) with effective stock movement controls. Vaccination discontinued in DFZs, but maintained elsewhere.	9	34	50
(d) Continued incomplete vaccination coverage with uncontrolled livestock movements and endemic or sporadic disease.	90	60	35
	100	100	100

5. IMPACT ON AUSTRALIAN MEAT EXPORTS

5.1 INTRODUCTION

The impact of changes in the World-wide distribution of FMD depends on the likelihood of major FMD + exporters changing to FMD - status, and the quantity of chilled and frozen meat these countries will have available for export. Only two areas - the EC and the River Plate region - are able to have a significant impact on the markets for Australian meat exports. The magnitude and nature of the impact has been assessed by first estimating the quantity of beef likely to be diverted to the FMD - pool, and then estimating the impact this would have on prices and quantities of livestock products. The Econometric Model of Australian Broadacre Agriculture (EMABA) was used to simulate the effects of the incursion of additional EC and South American beef supplies into the FMD - Pacific Basin markets which currently absorb about 85% of Australian beef exports.

5.2 EUROPEAN COMMUNITY

Cattle numbers in the EC have declined slightly in recent years, but have been reasonably constant at around 80 million for the past decade. Beef production fell by 3% in 1989 and a further small decline is forecast for 1990. These falls in production would have markedly reduced exports were it not for the use of substantial quantities of frozen beef from both intervention and private storage stocks. Total stocks of beef held by the EC have fallen sharply since 1987 and are not forecast to increase in the immediate future. In the short-term, exports are forecast to fall in response to reduced production and improved domestic prices, and imports are forecast to rise correspondingly. However, with herd restructuring, increased milk quotas and the trend towards beef animals, beef production could again increase in two to three years time. This will cause net exports to increase, although a return to the very high levels of the mid-1980s is not foreseen.

The main non-vaccinating FMD-free EC States (United Kingdom, Ireland and Denmark) already export substantial quantities of beef (average of 724 kt over the last three years). Additional beef supplies entering Australia's traditional Pacific Basin markets from continental Europe, following cessation of vaccination, are estimated to be in the vicinity of 100 kt. These supplies are likely to become available from 1993 onwards when full FMD-free status is anticipated.

5.3 RIVER PLATE REGION OF SOUTH AMERICA

Because this region includes parts of two large countries (Brazil and Argentina) and one complete country (Uruguay), and industry statistics are more difficult to obtain than for the EC, the levels of future exports are very uncertain. The following estimates can only be considered indicative.

In Argentina the cattle herd has been decreasing almost continuously for 10 years. Beef production has decreased in five successive years, and the productive capacity of the herd is being eroded by the high proportion of females slaughtered. However, while production has been falling, exports have been rising at the expense of domestic consumption. It is considered that domestic demand is unlikely to decline much further

and that exports will stabilise or decline in the next few years. These patterns will be reflected in the Argentine component of the River Plate Basin.

In Brazil, exports of canned meat are likely to continue, but strong domestic demand and rapid population growth will restrict exports of chilled and frozen beef. In the near future there is likely to be an increase in cattle numbers to about 140 million and some increase in exports of canned beef. However, exports of chilled and frozen meat are not expected to increase, unless FMD is eradicated, in which case there would be diversion of meat from canned to fresh categories.

In Uruguay the cattle herd entered a rebuilding phase in 1986, but drought and strong export and internal demand in the past two years has resulted in a herd decline. Heavy female slaughtering severely limits Uruguay's herd rebuilding capacity. Domestic consumption is strong and beef exports are expected to decline slightly in the next few years.

Overall the prospects for the River Plate region in the next few years are reduced production and exports, but if secure Disease-Free Zones can be established, it would be expected to result in a significant shift from the canning market to the fresh beef market. It is estimated that under these circumstances about 260 kt of beef could be diverted into Australia's traditional markets. This could occur from about 1996 onwards.

5.4 IMPACT ON THE AUSTRALIAN INDUSTRY

EMABA is an econometric model comprising some 500 linked equations which simulate responses throughout the Australian broadacre agriculture sector to variables such as market changes, policy adjustments and events in other producing countries. It contains detailed analysis of the Pacific Basin beef markets which are of particular importance to this study because they are the main FMD-free markets and absorb 85% of Australia's beef and veal exports. The methodology adopted using EMABA has been to first establish a baseline simulation of the broadacre sector and its markets (including the Pacific Basin beef markets) to the year 2000. The model was then used to estimate the expected impacts on these markets, and consequent changes to production and prices from added supplies of FMD-free beef.

Three separate "shocks" were applied to the model:-

(i) a 100 kt incursion of FMD-free beef from the EC from 1993 onwards;
(ii) a 260 kt incursion of FMD-free beef from South America from 1996 onwards; and
(iii) a combination of (i) and (ii).

Detailed results are given in Sections 5.4.3, 5.4.4 and 5.4.5 of the Main Report, and Annex 4.

<u>100 kt Incursion of EC Beef</u>

This would reduce prices and increase imports in the main Pacific Rim markets. Prices received for cattle by Australian producers would fall by between 2.2% and 4.4%. In response to this decline, Australian beef production and exports would

increase in the short-term, compared with baseline levels, as producers liquidated herds and reduced retentions. By the year 2000, beef production would be lower by 1.3% and exports lower by 2.5%.

These impacts are significantly less than similar impacts estimated from the EMABA model in 1985. These showed expected price declines of 10.7% in the first year, 9.4% in year 3 and 4.4% by year 5. The current estimates are lower due to the greater absorptive capacity of the Pacific markets, mainly due to liberalisation of the Japanese market.

260 kt Incursion of South American Beef

If the River Plate region establishes disease-free export zones, it may divert about 260 kt of beef from canning and other export markets into the FMD-free Pacific Basin markets from 1996. The EMABA simulation shows that beef farm prices would fall immediately by about 7.6%, and average 7.2% lower between 1996 and 2000. The impact on beef production and exports would also be significant. After an initial increase due to herd reductions, beef production would settle at 11.6% below the baseline situation and exports would decline by about 17% in the long-term.

Combined Effect of EC and South American Incursions

Following an extra 100 kt from EC in 1993 and 260 kt from South America in 1996, Australian beef production would increase above the baseline level for all but the last two years of the simulation period. However, by the year 2000 beef exports would be about 6% lower and farm prices would be significantly lower. The price fall from base levels would be in the order of 10-11% between 1996 and 1999, and almost 20% by the year 2000.

6. RECOMMENDED ACTIONS AND STRATEGIES

6.1 OVERVIEW

Taking into consideration both the probability and impact of the various FMD control/eradication scenarios, it is clear that the industry must address three main issues:-

(i) The high probability that EC FMD-free beef will reduce prices in the Pacific Basin markets within three years. However, price effects are expected to be modest within the context of a generally expanding market.

(ii) The moderate probability (about 40%) that South American beef will begin to affect prices in the Pacific Basin from about 1996 onwards. Diversion from canning to chilled or frozen product means that the quantities are sufficient to reduce beef prices significantly.

(iii) There is about a 38% chance that both (i) and (ii) will eventuate. If this occurs, it would be sufficient to change the 1990s from a decade of growth and prosperity in the Australian cattle industry to one of stagnation or decline. The sheep industry would not be severely affected however.

6.2 RESPONSE TO THE EC THREAT

The threat of EC beef entering the Pacific Basin markets has been averted so far under the Andriessen-Kerin agreement which restrains the EC from using export restitutions for sales to that market. However, after 1994 EC beef will become increasingly acceptable in the Pacific Basin and, given the expected strong growth in demand, it is questionable whether the agreement will hold. The EC will be also able to argue (justifiably) that exports in the vicinity of 100 kt will not seriously depress prices. However, several actions should be taken:-

(i) continued pressure in bilateral and multilateral trade negotiations to uphold the present arrangements for as long as possible; and

(ii) market research in EC to clarify the quantity and type of meat products which are likely to be exported to the Pacific and the markets and market sectors to be targeted. This will help Australian exporters plan their marketing efforts with better information on their competitors' intentions.

Developments in the EC may also provide an opportunity for Australia. EC is a large importer of offals, much of which comes from South America. Because FMD eradication in South America is certain to lag behind EC, and EC import controls are likely to be tightened, this could expand market opportunities for Australian offals in the EC. A market research project should be initiated to explore this apparent opportunity in detail.

6.3 RESPONSE TO THE SOUTH AMERICAN THREAT

Supply of South American beef into the Pacific market would introduce a major competitor about which Australia knows very little. Much more information is needed on the quantity of beef likely to be available, the type of products, its competitiveness in terms of product cost and shipping costs, seasonality of supply, etc.. It is particularly important to have a fuller understanding of the relative economics of canned beef production versus frozen/chilled beef, in order to make better judgements on the quantities likely to be diverted from one to the other if FMD is controlled. This calls for a major study of the South American beef industry, focussing on the River Plate Basin where scope for Disease-Free Zones is considered the greatest.

It is also important for Australian producers and exporters to appreciate that this threat exists, to understanding its potential impact, and to factor it into their forward planning. Probably the most effective way of achieving this would be through the regular ABARE projections.

6.4 IMPACT OF FMD STATUS ON MEAT PRICES

The effect of FMD status on meat prices requires further clarification. The status of the importing and exporting countries is only one of the many factors which influence prices, but this is difficult to identify accurately from the data gathered in this study. To help clarify the level of incentive for FMD + countries to achieve and maintain full eradication, it would be helpful to undertake statistical studies to estimate the influence of FMD status on internationally traded beef and sheepmeat prices. Both cross-sectional and time series analyses could be undertaken using appropriate statistical techniques to quantify the price effect of measurable characteristics among broadly comparable product categories; e.g. frozen boneless beef, frozen lamb carcases, chilled primals, etc.. The study could also provide useful quantification of the value of other measurable meat characteristics.

6.5 FURTHER RESEARCH INTO TRADE IMPLICATIONS

Further development of EMABA and World Beef Models currently being undertaken by ABARE will enable more precise estimation of the implications of various FMD scenarios. In particular, the following areas need to be examined:-

(i) The impact of FMD - meat exports from the EC to regions outside the Pacific Basin market such as the Middle East and parts of South-East Asia. These markets are mostly in the FMD + pool and would become less attractive to EC exporters after 1993. The extent to which this may reduce the differential between FMD + and FMD - prices should be assessed and monitored, as it will influence the incentive for South American countries to press ahead with their eradication programmes.

(ii) The EC's export capability should it gain access to the Pacific Basin market and the impact of this on the EC's traditional markets. The EC's export capability is heavily influenced by policy decisions and is therefore very difficult to predict. The scenario presented here is only one of a number of plausible outcomes and further work will be required to assess the impact of other scenarios as they unfold.

(iii) The attitude of the EC should it become FMD-free, to imports from South America. There is no clear answer to this at present, although some degree of tightening seems likely, and this could present opportunities for Australian exporters, particularly for offals (refer Section 6.2). This matter should be carefully monitored through the Australian representation in Brussels.

(iv) The attitude of Japan, Korea, etc., to the EC's prospective FMD-free status. This is also unclear at present and needs to be monitored by AMLC. The reaction of these importing countries to contained FMD outbreaks in part of the EC (most likely Italy) after the removal of movement controls is of particular interest and importance. A very strict attitude by the importing countries could substantially diminish the EC threat.

(v) The impact of reduced production of canned and cooked beef in South America on prices of these products. It is possible that diversion of a large amount of South American beef away from canning could increase prices to the point where canned beef production in the more remote areas of northern Australia becomes more attractive than frozen boneless products.