CHAPTER 1
INTRODUCTION

Highly contagious exotic animal diseases can cause enormous economic losses to livestock producers, to related industries and to consumers. The U.S. government and the state of California enforce a number of measures to prevent the introduction of such diseases and to eradicate any outbreak at the lowest possible cost—for example, controls of incoming travelers, animals and animal products; monitoring and surveillance of animal health; information provided to livestock producers and others; and vaccination and/or eradication campaigns. In spite of these government efforts and industry collaboration, introduction of an exotic disease into California’s livestock population is a real threat. Constant monitoring and surveillance, rapid diagnosis and preparedness for eradication are required to minimize the probability of occurrence and the costs of an outbreak.

Regulatory agencies with primary responsibility for protecting California’s livestock and dairy industries against exotic diseases are the Division of Animal Health and Food Safety Services of the California Department of Food and Agriculture (CDFA) and the veterinary services of the federal Animal and Plant Health Inspection Service (APHIS). These two agencies and the Department of Medicine and Epidemiology, School of Veterinary Medicine, UC Davis, conducted a study to estimate the value of animal health monitoring and surveillance services in California. This report describes the results.

The study had as major objectives:

• To estimate the value of monitoring and surveillance services for animal health in California by analyzing the potential losses that those services are designed to minimize or prevent.

• To model the potential epidemiological and economic impacts of Foot and Mouth Disease (FMD) in California.

• To analyze current procedures for dealing with an outbreak of an exotic disease, identifying potential problems and solutions.

• To develop a methodology that can be used to evaluate alternative strategies to deal with an outbreak of an exotic disease.

To achieve these objectives an outbreak of FMD in California’s South Valley was modeled. Two important conclusions of the study are:
1. Provided that sufficient human, physical and financial resources are available in time to implement an effective first response to an outbreak of FMD, the value of public animal health services is very high. That value is growing because the probability of an outbreak is increasing due to changes in the travel and trade environment, and greater interaction among firms of the dairy and livestock industries, input suppliers and output buyers.

2. Under the present action plan to deal with a FMD outbreak, a stamping-out policy—the slaughter of all infected and all exposed animals, plus decontamination of infected and exposed premises—would be implemented. It is highly likely that, under current regulations and preparations, implementation of such policy would face enormous problems, seriously compromising its chances of success.

The value of animal health monitoring and surveillance services is equal to the expected losses they prevent. Even though these losses can be caused by a number of diseases, in this report it is assumed that they arise exclusively from a FMD outbreak. Hence, the reported estimates should be considered as a conservative estimate of the true value. FMD was chosen because, of all exotic diseases, it has the potential to cause the largest losses to California producers and consumers. FMD is probably the most contagious of all animal diseases known to man because of (1) its ability to gain entry to susceptible animals through virtually all portals of entry, (2) the small infective dose required for transmission, (3) the short incubation period, (4) the release of virus before the onset of clinical signs, (5) the massive quantities of virus excreted from infected animals, (6) ability of the disease to spread rapidly over large distances and (7) the survival of the virus in the environment (Donaldson and Doel, 1994; Forbes et al., 1994).

The expected losses are defined as the probability of an outbreak of an exotic disease multiplied by its estimated cost. Estimating the probability of occurrence of a FMD outbreak is a major task because the potential routes of entry have changed in recent years. While traditionally it has been assumed that the most likely sources of infection were imports of animals and animal products, import regulations and border controls have reduced this risk to negligible levels. On the other hand, an increasing number of international travelers, a larger volume of trade and faster transportation means have created new potential sources of infection, which have not been sufficiently studied yet. Due to the lack of information on these risks, estimation of the probability of an outbreak is beyond the scope of this project, and will not be dealt with in this report.

The cost of an outbreak is estimated here by simulating an outbreak of FMD that starts in Tulare County, California, and spreads to the entire South Valley (Fresno, Kern, Kings and Tulare counties). The outbreak is simulated for different intervention dates and different production conditions. If such an outbreak is not eradicated promptly, it would eventually spread to the entire San Joaquin and Chino Valleys. One estimate of the cost under this scenario is also included. Although limiting the outbreak to the South Valley is a very unlikely assumption, restrictions in the resources available for
this project prevented more detailed modeling of the spread to other regions in California, or consideration of the spread to other states.

Sources of cost

Although FMD is not considered a public health problem, it may cause huge economic losses. These potential losses have three components: eradication costs, production losses and trade restrictions.

- Eradication costs include cost of slaughter, compensation for destroyed animals and materials, cleaning and disinfection (C&D) of infected premises, and quarantine enforcement.

- Production losses arise from lost production in depopulated premises and industries linked to the livestock sector (e.g., input suppliers, slaughterhouses, or processors). Although FMD has a very high mortality rate among young animals, it usually only reduces milk and beef production in older animals. (See Chapter 2.) However, since stamping-out is the only strategy considered in this report, output losses arise exclusively from depopulation. Under the present guidelines for eradication (APHIS, 1991), infected premises cannot return to full production for at least 60 days after cleaning and disinfection.

- Until recently, FMD-affected countries could not export live animals or unprocessed animal products to countries free of the disease. Because of this restriction, the international beef market has been segmented into FMD-free and FMD-endemic markets. The price difference between the two segments for meat of similar quality can be as high as 50%. Recent changes in trade regulations (WTO sanitary and phytosanitary agreements) allow countries with FMD to export to FMD-free markets if the exports originate in FMD-free regions, and if the disease is contained within a quarantined area. However, the two largest markets for American fresh meats and other animal products, Japan and Korea, do not recognize the regionalization principle yet. (See Chapter 5.)

Increased threat of introduction

For more than half a century, enforcement of import restrictions on animals and animal products from countries known to have FMD has prevented introduction of the virus into the U.S. However, changes in travel and trade patterns and in trade regulations have increased the probability of an outbreak. The speed of international travel has increased substantially in recent years and the number of international travelers into the U.S. continues to grow. The FMD virus can survive for 24 hours in the human respiratory system and, given appropriate conditions, for several weeks in clothes. Thus, it is conceivably possible for a person to visit a FMD-endemic country and bring the virus inadvertently to the U.S. Other possible routes through which the virus could be introduced into the U.S. are smuggling of unprocessed meats and animal products, economic terrorism, and garbage transported in planes and ships (Donaldson and Doel, 1994). Since it is impossible to block all possible routes of introduction of FMD into the U.S., an outbreak must be considered possible.
The U.S. operates a two-tier system of defense against FMD. The first involves border controls of travelers and imports. If an outbreak occurs, then a stamping-out campaign is activated as a second tier. Plans to deal with a FMD outbreak were last updated in 1991 (APHIS, 1991). These instructions contain only brief references to regional disparities, in particular to different animal densities. The magnitude of these differences, however, justifies a closer look at risks and regional strategies for dealing with an outbreak.

**FMD in the United States**

FMD has been introduced into the U.S. on eight occasions since the first reported occurrence in 1870 (McCauley et al., 1979). The most devastating epidemic occurred in 1914. Starting in Michigan, it spread to 22 states after contaminating the Chicago stockyards. During the eradication campaign, some 172,000 cattle, sheep, swine and goats were slaughtered.

In 1924, FMD was found in cattle in Alameda County, California, and the outbreak soon included 16 more counties. Quarantines were established to prevent movements from affected areas of animals, animal parts, manure, hay, fodder, grain and farm vehicles (unless cleaned and disinfected). Infected livestock were driven into trenches, shot and buried. A total of 109,855 cattle, goats, swine and sheep

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<tr>
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<tr>
<td>Herds Affected</td>
<td>948</td>
<td>5</td>
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<tr>
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<td>58,807</td>
<td>277</td>
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<td>sheep</td>
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<td>3,271</td>
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<tr>
<td>goats</td>
<td>1,472</td>
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<td>Total Animals</td>
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<tr>
<td>Days before Diagnosis</td>
<td>63</td>
<td>3</td>
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<tr>
<td>Days before Emergency Declaration</td>
<td>90</td>
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* in nominal dollars.

Table 1: Foot and Mouth Disease California Outbreaks - 1924 vs. 1929

Source: Personal communication from Animal Health Branch (CDFA) and Veterinary services (APHIS).

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and 22,214 deer were killed. The eradication effort cost approximately $7 million with $4.4 million allocated for compensation for destroyed animals. In 1990 dollars, this equals approximately $45 million in livestock losses and $35 million in program costs (Dowell and Krass, 1992). These figures do not include production and trade losses. A second California outbreak occurred in 1929. The total eradication cost was substantially smaller than in 1924 because the disease was rapidly diagnosed and intervention was decisive. Table 1 compares these two FMD outbreaks in California.

FMD has not existed in the U.S. since 1929. The last appearances in neighboring countries were in Canada in 1952 and Mexico in 1954.

Should an outbreak occur today in California, the economic consequences would be significantly larger than in 1924 due to the intensification of production techniques, the integration of regional and state markets, and the larger volume of exports of animal products. As discussed in Chapter 8, if the outbreak were to occur in the southern San Joaquin Valley, containment to a small number of dairies would be extremely difficult. Depopulation of infected premises would create major logistic problems. Preventing the outbreak from spreading into the Chino Valley would also be extremely difficult.

For comparison, a study by New Zealand’s Ministry of Agriculture and Fisheries estimates the cost of a hypothetical FMD outbreak involving 25 properties at $1.2 billion over a one-year period and the loss of about 49,000 jobs (Forbes et al., 1994).

Contents of the Report

Chapter 2 discusses the epidemiology of FMD, with emphasis on the features that determine the characteristics of the model used in the study. Issues related to control and eradication of FMD outbreaks are reviewed in Chapter 3.

The economic importance and characteristics of the livestock and dairy industries, particularly in relation to the threat of exotic diseases, are reviewed in Chapter 4. Most of the information used for this section was collected through personal interviews, surveys of producers, and visits to farms and processing plants. Issues involving FMD and international trade are discussed in Chapter 5, and the current federal action plan in case of an outbreak is described in Chapter 6.

Chapters 7 and 8 describe the simulations of a hypothetical outbreak of FMD in Tulare County, and cost projections. Chapter 9 contains conclusions and recommendations.

Appendices to this report include (1) additional detailed descriptions of California’s livestock industries in Appendix A, (2) a technical description of key parameters of the epidemiological and economic models in Appendices B and C, (3) descriptions of recent outbreaks of FMD in Taiwan and Italy in Appendix E and (4) a review of the literature on modeling infectious diseases, with particular emphasis on FMD, in Appendix F.
Many individuals in livestock production and transportation activities, and in academia and government, were involved as collaborators or provided consultation and background information for this study. Data were gathered from a wide variety of literature and personal interviews. A list of contacts is in Appendix D. Two previous research projects conducted by Animal Health Branch (CDFA) and Veterinary Services (APHIS) provided basic information. The first of these located most premises handling livestock in the San Joaquin Valley and stored that information in a geographical information system (GIS). The second project interviewed a number of livestock producers to identify patterns of movement into and from their premises.