

## Potential Risk of Transmission and Spread of Foot-and-Mouth Disease in Kagoshima Prefecture, Japan

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### Abstract

In March 1997, outbreaks of foot-and-mouth disease (FMD) affected pigs in Taiwan. To assess the potential risk of transmission and spread of FMD, a survey on normal movement pattern in livestock farms was carried out in Kagoshima Prefecture, Japan. In a total of 20 farms (9 for pig farrow-to-finish operations, 6 beef cattle farms and 5 dairy cattle farms) participating in the survey, all the movements to or off the farms (e.g. animals, materials and people / number of contacts and destination) were recorded daily over a period of one week using a questionnaire. The movements were classified into 4 grades: risk 4 (very high) to risk 1 (low), respectively, assigned to the types of contacts. The movements off the farm were more frequent than those to the farm in each livestock farm. In particular the movements off the pig farms were concentrated on animal shipping to slaughterhouse with grade risk 4. Mean distance of shipping also extended over a radius of more than 20 km of the control zone for FMD emergency in Japan. Should an outbreak of FMD be detected in a pig farm, FMDV might, therefore, have already spread prior to the diagnosis of the disease over the FMD control zone.

**Discipline:** Animal health

**Additional key words:** epidemiology, risk analysis

### Introduction

Foot-and-mouth disease (FMD) which is a highly contagious viral disease that affects primarily cloven-hoofed animals, often with serious economic consequences, is classified into list A of animal diseases to be reported to the Office International des Epizooties (OIE)<sup>3</sup>. The outbreak of FMD can result in a dramatic decrease in livestock productivity and loss of foreign markets for livestock and animal products<sup>2</sup>.

Foot-and-mouth disease virus (FMDV) is present in all the physiological secretions of infected animals. High concentration of FMDV can be detected in the saliva hours before clinical lesions appear and in feces and milk up to 4 days before clinical signs occur. Thus, infected animals not yet showing clinical signs of the disease may be efficient transmitters of the virus<sup>1</sup>.

Since March 1997, outbreaks of FMD caused by the porcophilic strain of the virus have affected pigs in

Taiwan<sup>4</sup>. The Japanese Government has strictly regulated the ban on importation of all animals and animal products from Taiwan.

If an outbreak of FMD occurs in Japan, all the movements of the animals and animal products would be restricted to limit the spread of FMD to the control zone within a radius of 20 km based on the Manual for Control of Overseas Animal Diseases<sup>5</sup>. A model that predicts the direction and extent of all the livestock movements within the control zone prior to an outbreak of FMD is expected to be developed in Japan, because, in New Zealand, a decision support system (DSS) has already been developed to help control a FMD emergency: EpiMAN (NZ)<sup>7</sup>. A similar DSS for use in the EU was also developed as EpiMAN (EU)<sup>6</sup>.

In order to confirm FMD dissemination through normal movements relating to animals, materials and people from infected premises, a questionnaire survey was conducted on the movements during a period of one week in Kagoshima Prefecture, Japan. In this paper the potential

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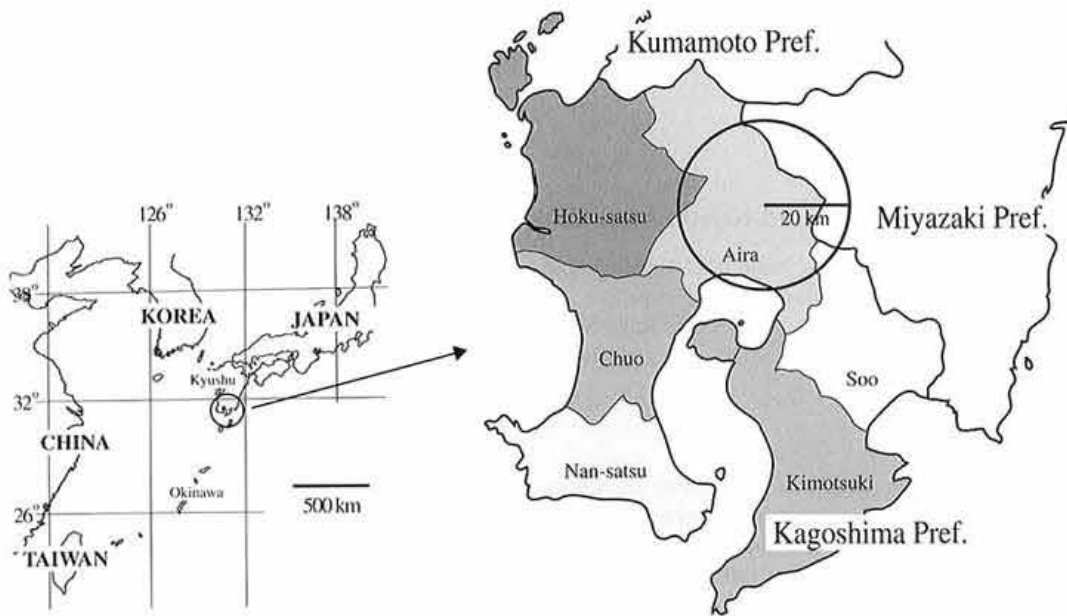


Fig. 1. Location of the pilot area in the Aira region, Kagoshima Prefecture, Japan

risk of transmission and spread of FMD was assessed based on the results of the survey.

## Materials and methods

### 1) Selection of the pilot area

The pilot area was selected in close cooperation with the Aira Livestock Hygiene Service Center, Kagoshima Prefecture, and set up approximately in the same way as the FMD control zone, around infected premises, within a radius of 20 km in the Aira region. The area was located on the border of neighboring 2 Prefectures (Kumamoto and Miyazaki), as shown in Fig. 1.

### 2) Data collection

As shown in Table 1, a total of 2,191 livestock farms with pigs or cattle were located within the pilot area. Also, the pilot area was characterized by a high density of pigs and a large number of small holders of beef cattle for breeding. Then, 20 farms within the pilot area were selected for the survey through the Aira Livestock Hygiene Service Center. The farms consisted of pig

Table 1. Livestock conditions in the pilot area<sup>a)</sup>

Animals	Number of farms	Population
Pigs	71	186,690
Beef cattle	2,061	21,200
Dairy cattle	59	2,910

a): The pilot area was set up in the Aira region (Kagoshima Prefecture) within a radius of 20 km.

farrow-to-finish operations (9 farms), beef cattle for breeding (6 farms) and dairy cattle farming (5 farms).

A questionnaire survey was conducted during a period of one week between August 26 and September 1, 1997. The participating farmers were visited and veterinary inspector officers of the Aira Livestock Hygiene Service Center asked questions about general issues and livestock management. The farmers were also asked to record all the movements to or off their farms (e.g. animals, materials and people / number of contacts and destination) everyday for a period of one week using a questionnaire.

For animal movements to or off the farm the following data were recorded: date, species, number of animals in transport, own vehicle used for transport ("Yes" or "No"), origin and destination address and types (e.g. farms with pigs or cattle, agricultural cooperatives, live-animal market, animal traders, slaughterhouses or others).

### 3) Definition of potential risk of transmission and spread of FMD

Risk and types of contacts were designed assuming that the farm had been recently infected with FMD, but with the animals not showing any clinical signs. Classification of the potential risk of transmission and spread of FMD was based and modified according to the expert rules developed in New Zealand<sup>7)</sup> or The Netherlands<sup>6)</sup>. The types of contacts were classified into 4 grades of risk, as shown in Table 2. Also, the movements were divided into 2 types (to or off the farm). As a result, all

**Table 2. Classification of risks and types of contacts for foot-and-mouth disease**

Grade	Risk	Type of contact
4	Very high	Susceptible animals
3	High	People or vehicles with animal contact Animal products (feces, manure or milk) Animal feed
2	Medium	Other (non-animal) materials (equipment or straw)
1	Low	People or vehicles without animal contact

**Table 3. Assignment table of risk for all the movements (to or off the farm)**

Grade	Categories of movements ( ☆ <to>/ ★ <off> the farm)
4	☆ Animal introduction (e.g. other farms, live-animal market, etc.) ★ Animal shipping (e.g. slaughterhouse, etc.)
3	☆ Visitors related to livestock management (e.g. veterinarians, artificial insemination technicians, animal traders, etc.) ★ Farmers going out for livestock management ☆ Purchase of animal feed ★ Transportation of feces or manure
2	☆ Purchase of livestock materials (e.g. equipment, straw, etc.)
1	☆ Visitors in general (e.g. family, friends, mailman, etc.) ★ Daily life activities (e.g. shopping, etc.)

the movements were classified into 9 categories of risk assigned to the types of contacts: 5 <to> and 4 <off> the farm, as shown in Table 3. The distance (km) between the origin and destination of the movements was defined as the shortest way in a road map.

#### 4) Data compilation and analyses

All the data were coded and entered into Excel (Microsoft) on a personal computer. For example, a cross-assortment of the types of contacts or their distance for each farm was carried out using spreadsheets of Excel (Microsoft) for a period of one week. All the data analyses were carried out according to the procedures of the SAS program<sup>8)</sup> with HP-9000 UNIX workstation on MAFFIN (Ministry of Agriculture, Forestry and Fisheries Information Network, Tsukuba). Continuous data such as number or distance of contacts were analyzed using UNIVARIATE and GLM procedures of the SAS program<sup>8)</sup>.

## Results

### 1) Number of contacts during a period of one week in the livestock farms

The cross-assortment table for 9 categories of move-

ments for each livestock farm is presented in Table 4. As shown in the sum of movements to or off the farm, the movements off the farm were more frequent than those to the farm. Particularly, total movements off the farm classified into grade 3 (high-risk group), accounted for about 34% (143/423). For the grade risk 4 (very high-risk group), the movements were recorded 3 times for animal introduction and 14 times for animal shipping. Shipping from the pig farms to the slaughterhouse was recorded 13 times during a period of one week.

### 2) Movement patterns during a period of one week in the livestock farms

As shown in Table 5, total movements including those to and off the farm during a period of one week were not statistically significant among the livestock farms ( $p=0.537$ ). However, comparison of means between the movements to and off the farm was significant ( $p=0.003$ ). As a result, the movements off the farm were more frequent than those to the farm in each livestock farm.

### 3) Distance (km) of grade risk 4 and 3 movements in livestock farms

The cross-assortment table of the movement dis-

**Table 4. Cross-assortment table of risk grades for all the movements and livestock farms during a period of one week**

Grade	Item	Livestock farm			Sum
		Pigs (9 farms)	Beef cattle (6 farms)	Dairy cattle (5 farms)	
4	Animal introduction	2	0	1	3
3	Visitors related to livestock management	17	16	20	53
	Purchase of animal feed	32	3	7	42
2	Purchase of livestock materials	1	3	3	7
1	Visitors in general	34	24	14	72
	Sum of movements to the farm	86	46	45	177
4	Animal shipping	13	0	1	14
3	Farmers going out for livestock management	23	38	22	83
	Transportation of feces or manure	27	16	17	60
1	Daily life activities	31	29	29	89
	Sum of movements off the farm	94	83	69	246
	Total	180	129	114	423

**Table 5. Comparison of the number of movements to or off the farm in each livestock farm during a period of one week**

Livestock farm	Number of farms	Frequency of all movements		Mean frequency <sup>b)</sup>	
		Mean <sup>a)</sup>	SD	off	to
Pigs	9	20.0	5.12	10.4	9.6
Beef cattle	6	21.5	4.85	13.5	8.0
Dairy cattle	5	22.8	2.17	13.8	9.0

a): Comparison among livestock farms was not significant ( $p=0.537$ ).

b): Comparison between 2 means of to / off the farm was significant in each livestock farm ( $p=0.003$ ).

tance (km) is presented in Table 6. The mean distance of the movements from the origin to the farm ranged from 15 to 58 km, and that off the farm to the destination from 3 to 153 km. In particular, the mean distance of animal shipping, for grade risk 4, from the pig farm to the slaughterhouse exceeded the radius of 20 km of the control zone for FMD emergency in Japan. Also the movements, namely "farmers going out", for grade risk 3, varied and covered a very long distance (e.g. maximum

900 km for pig or 116 km for beef cattle farms).

## Discussion

Under the WTO system, increased trade of livestock, decreased transit time of animals and animal products, and changes in sanitary standards between exporting and importing countries may result in the exposure to FMD and accidental reintroduction of FMD into

**Table 6.** Cross-assortment table of risk grades (very high and high) for movement distance (km) and livestock farms

Grade	Item	Livestock farm		
		Pigs (9 farms)	Beef cattle (6 farms)	Dairy cattle (5 farms)
4	Animal introduction	32.5 <sup>a)</sup>	— <sup>c)</sup>	30
		50–15 <sup>b)</sup>	—	30–30
3	Visitors related to livestock management	57.5	—	15
		75–2	—	25–5
4	Purchase of animal feed	54.9	21.7	24.4
		130–2	60–1	45–17
4	Animal shipping	50.3	—	60
		115–4	—	60–60
3	Farmers going out for livestock management	152.8	7.2	5.7
		900–3	116–1	20–1
3	Transportation of feces or manure	3	3.5	10
		3–3	7–1	20–3

a): Mean (km), b): Maximum – minimum (km), c): No data.

Japan. Also, because the last outbreak of FMD in Japan was recorded in 1933 and due to the limited number of cases under quarantine, most of the livestock farmers or persons related to animal health in Japan have not been familiar with the disease for a long period of time.

In March 1997, suddenly, outbreaks of FMD associated with smuggled pork from Mainland China affected pigs in Taiwan. Prior to the recognition of the outbreaks, Japan was importing large quantities of pork products (about 260,000 metric tons) from Taiwan. It was considered that the overall risk of transmission of FMD to Japan due to the outbreaks in Taiwan might be very high at that time. If an outbreak of FMD were to occur in Kagoshima Prefecture, since Kagoshima has the largest livestock number and quantity of animal products, particularly in the case of pigs in Japan, economic damage would markedly affect the animal industry in this area.

Thus, this was the first opportunity to survey FMD in Japan, in spite of the small scale of the investigations that covered only 20 livestock farms and a period of one week in Kagoshima Prefecture compared with the experience of New Zealand<sup>7)</sup> or The Netherlands<sup>6)</sup>.

On the other hand, through the survey, the transmission and spread of FMD from infected premises were determined. For instance, we observed that the pig farms, in particular, those for large-scale farrow-to-finish operations, were frequently shipping animals to slaughterhouses, as shown in Table 4. Furthermore, the mean distance of shipping exceeded the radius of 20 km of the FMD control zone (50.3 km in Table 6). Moreover, the

movement of “farmers going out for livestock management” was recorded in 83 instances in the 20 farms and the distance covered by the movement ranged from 900 to 3 km (mean: 152.8 km).

Therefore, the survey was useful for FMD control as information on the potential risk of transmission and spread of FMD could be obtained. These data showed that, if an outbreak of FMD were to be detected in a pig farm, FMDV might, therefore, have already spread prior to the diagnosis of the disease over the FMD control zone. Then, the introduction of animals and animal products affected with FMDV from countries with FMD into Japan should be strictly prohibited through a variety of regulations.

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